

## Monday 08:00-09:20

### ■ MA-01

Monday 08:00-09:20

Beethoven

#### Routing problems

Stream: Combinatorial Optimization

Invited session

Chair: *Juan José Salazar González*, Estadística e Investigación Operativa, Universidad de La Laguna (Tenerife), Av. Astrofísico Francisco Sánchez, s/n, 38271, La Laguna, Tenerife, Spain, [jjsalaza@ull.es](mailto:jjsalaza@ull.es)

#### 1 - Managing infeasibility in a vehicle routing problem with precedence and loading constraints

*Gregorio Tirado*, Estadística e Investigación Operativa I, Universidad Complutense de Madrid, Plaza de Ciencias, 3, 28040, Madrid, Spain, [gregoriotd@mat.ucm.es](mailto:gregoriotd@mat.ucm.es), *Angel Felipe*, *M. Teresa Ortuño*

Transportation industry is forced to face more complex problems every day, making it necessary to introduce new hard constraints such as precedence and loading constraints into the classical vehicle routing problems. In most cases the search performed by heuristics only considers feasible solutions, but for heavily constrained problems like the one considered here this may restrict too much the search process. In our approach we permit the use of infeasible solutions that may violate the capacity or precedence constraints, expanding the search space and making the search process more flexible.

#### 2 - On time dependent 2-path formulations for the (cumulative) TSP

*Maria Teresa Godinho*, Departamento de Matemática, Instituto Politécnico de Beja - CIO, Rua Afonso III, 1, 7800-050, Beja, Portugal, [mtgodinho@estig.ipbeja.pt](mailto:mtgodinho@estig.ipbeja.pt), *Luis Gouveia*

It is well known that the so-called 2-path multi commodity formulations for the TSP do not improve the linear programming (lp) bound of the corresponding 1-path formulations. We show that this is not the case when we use time-dependent formulations. In particular, we discuss: i) A new 2-path time dependent model with an lp bound tighter than the corresponding 1-path model ii) Valid inequalities which enhance the lp bound of the new model iii) Computational results showing that the new model enhanced with the valid inequalities produces very tight lp bounds, especially for the cumulative TSP.

#### 3 - Routing costs estimation in a multiperiod location routing problem

*Maria Albareda Sambola*, Statistics and Operations Research, Technical University of Catalonia, C. Colom, 11, 08222, Terrassa, Spain, [maria.albareda@upc.edu](mailto:maria.albareda@upc.edu), *Elena Fernandez*, *Stefan Nickel*

We address a multiperiod location routing problem where, for a given planning horizon, a location plan and the associated routing patterns have to be designed. Two scales are considered in the planning horizon (short and long periods) to model situations where routes are modified more frequently than locational decisions: facilities fixed for a long period remain fixed during several short periods. Routing costs are approximated through trees rooted at the depots. Computational experiments show that the plant opening patterns obtained using this approximation are close to optimal

#### 4 - Partial order approach to compute shortest paths in multimodal networks

*Felipe Lillo*, School of Computing and Mathematical Sciences, Auckland University of Technology, AUT Tower, WT406, cnr Wakelield & Rutland Street, Auckland CBD, 1142, Auckland, Auckland, New Zealand, [fillovi@aut.ac.nz](mailto:fillovi@aut.ac.nz)

Few network techniques have been developed specifically for modelling multimodal networks. In this work weighted coloured edge graphs are used as modeling tool, where colours represent the transport choices. Optimal paths are gotten by a partial order relation that compares each colour weight, resulting in a Pareto set of paths. A modified Dijkstra's algorithm is experimentally tested, yielding a promising average case for the Pareto set. The algorithm is shown to be practical for networks at least as large as networks found in previous literature but still retains the multimodal traits.

### ■ MA-02

Monday 08:00-09:20

Schumann

#### Driving time regulations in vehicle routing

Stream: Transportation Planning

Invited session

Chair: *Christoph Manuel Meyer*, Department of Economics, Chair of Logistics, University of Bremen, Wilhelm-Herbst-Straße 5, 28359, Bremen, Germany, [meyer@wiwi.uni-bremen.de](mailto:meyer@wiwi.uni-bremen.de)

#### 1 - Distributed decision making in combined vehicle routing and rest period planning

*Christoph Manuel Meyer*, Department of Economics, Chair of Logistics, University of Bremen, Wilhelm-Herbst-Straße 5, 28359, Bremen, Germany, [meyer@wiwi.uni-bremen.de](mailto:meyer@wiwi.uni-bremen.de), *Herbert Kopfer*

In practice the problem of vehicle routing and scheduling under consideration of breaks and rest periods is distributed over two decision making units. Usually, schedulers are responsible for the clustering and routing while drivers perform the rest period planning. In this talk the problem of combined vehicle routing and rest period planning is embedded into the hierarchical planning framework presented by Schneeweiss (2003). The effects of different anticipation functions of the drivers' planning model on the resulting vehicle schedule are analyzed by computational experiments.

#### 2 - Dynamic programming for the vehicle routing problem with the ec social legislation

*Leendert Kok*, Operational Methods for Production and Logistics, University of Twente, P.O. Box 217, 7500AE, Enschede, Netherlands, [a.l.kok@utwente.nl](mailto:a.l.kok@utwente.nl), *Marco Schutten*, *Erwin W. Hans*

We propose a restricted dynamic programming algorithm for the vehicle routing problem including the EC social legislation on driving and working hours. To comply with this legislation, we propose a break scheduling algorithm which schedules necessary breaks and rest periods when customers are added to the end of partial vehicle routes. To the best of our knowledge, this is the first method that satisfies the legislation on both driving and working hours, and the first method that includes all optional rules in this legislation.

#### 3 - Evaluation of telematic data with respect to ec-driver regulations for reporting purposes

*Thomas Bousonville*, Business and Administration, Hochschule für Technik und Wirtschaft des Saarlandes,

Waldhausweg 14, 66123, Saarbrücken, Germany,  
thomas.bousonville@htw-saarland.de, *Teresa Melo*

Due to new driving regulations, digital tachographs for new vehicles and amplified controls of infractions, managers of transportation companies are faced with increasing pressure to comply with the legal framework. Hence it is desirable to compile a periodic report with a comprehensive overview of all incurred infractions. Depending on the time excess a violation may be considered more or less serious. We present a classification of possible violations and for each type we propose thresholds for the severity of the infraction. The telematic data is automatically processed via webservices.

#### 4 - Models and algorithms for vehicle routing problems considering EU social legislation on drivers' working hours

*Michael Drexl*, Fraunhofer ATL, 90411, Nuremberg, Germany, michael.drexl@atl.fraunhofer.de, *Eric Prescott-Gagnon*, *Guy Desaulniers*, *Louis-Martin Rousseau*

The talk describes how rules according to EU social legislation concerning drivers' working hours can be considered in solution procedures for VRPs. The talk demonstrates that the consideration of the rules is non-trivial and highlights the peculiarities of the rules when viewed from an algorithmic perspective. Computational results obtained with two different solution approaches are presented: (i) large neighbourhood search for the VRPTW where routes are (re)constructed using heuristic column generation and (ii) a labelling algorithm for the shortest path problem with resource constraints.

## MA-03

Monday 08:00-09:20

*Reger*

### Sustainable Transport

Stream: Transportation Planning

*Invited session*

Chair: *Melanie Bloos*, Chair of Logistics, Bremen University - Department of Business and Economics, Wilhelm Herbst Str.5, 28359, Bremen, Germany, bloos@uni-bremen.de

#### 1 - Evaluating the public procurement of bus transports in terms of emissions and costs

*Helene Lidestam*, Department of Management and Engineering, Production economics, Linköping University, 58183, Linköping, helene.lidestam@liu.se

The contracts resulting from a public procurement of bus transports in Sweden are very detailed. The specifications of, for example, used bus sizes can lead to unnecessary large buses in the sense that many of them are half empty. Other public procurement processes that could result in more flexible and less specified contracts and in turn reduced CO<sub>2</sub>-emissions will therefore be tested and evaluated by optimization models. Computational results from a large Swedish bus transport company are reported.

## MA-04

Monday 08:00-09:20

*Liszt*

### Scheduling Applications 2

Stream: Scheduling

*Invited session*

Chair: *Hans Heller*, CT PP7, SIEMENS AG, Otto-Hahn-Ring 6, 81739, München, Germany, hans.heller@siemens.com

#### 1 - Integrated maintenance planning and order scheduling

*Andreas Junker*, University of Siegen, Hölderlinstraße 3, 57076, Siegen, Germany, andreas.junker@uni-siegen.de, *Peter Letmathe*

Most preventive maintenance strategies minimize the costs of break downs and of maintenance tasks without taking interdependencies with traditional scheduling problems into account. This contribution investigates opportunities to simultaneously optimize production and maintenance planning by applying the condition-based maintenance strategy. The condition of each machine is measured through different parameters which determine the machine's operating performance whereas the machine's condition deteriorates over time. The presented approach considers a time-discrete and deterministic model.

#### 2 - Production scheduling and inventory management for an ice cream manufacturer using hierarchical planning models

*Andrea Cameron*, Industrial Engineering, Dalhousie University, 5269 Morris Street, Room 208, B3J 2X4, halifax, NS, flaxencurls@gmail.com, *Eldon Gunn*

Two scheduling models were developed for an ice cream facility. A long term, mixed integer programming plan schedules aggregate production to minimize inventory and labour costs while meeting seasonal demand, warehouse, production, and workforce capacities. The short term model schedules production by week to minimize setup and holding costs. Products with shared setups are grouped into families and a 13-week Wagner-Whitin lot size model is created for each family. A mixed integer model finds the least expensive path from weeks 1 to 13 while meeting the aggregated production levels.

## MA-05

Monday 08:00-09:20

*Haydn*

### Analysis of DNA and RNA structures

Stream: Computational Biology, Bioinformatics and Medicine

*Invited session*

Chair: *Jacek Blazewicz*, Instytut Informatyki, Politechnika Poznańska, ul.Piotrowo 2, 60-965, Poznan, Poland, jblazewicz@cs.put.poznan.pl

Chair: *Piotr Formanowicz*, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, piotr@cs.put.poznan.pl

#### 1 - Rna structure elucidation via nmr: processing of spectral data.

*Marta Szachniuk*, Institute of Bioorganic Chemistry, PAS, Noskowskiego 12/14, 61-704, Poznan, Poland,

Marta.Szachniuk@cs.put.poznan.pl, Mariusz Popena,  
Lukasz Popena

RNA is the foreground actor in the storage and communication of biological data. Major contribution to the knowledge of its structure comes from NMR and X-ray crystallography. But despite the progress in these techniques, recognition and analysis of RNA structure is still very difficult. A lot of difficulty is found in the computational part of structure determination. Here, we analyse the first steps of NMR data processing by automated procedures. We present a short survey through several algorithms for resonance assignment and we introduce a new approach based on neural networks.

## 2 - Algorithm for non-classical sequencing by hybridization

Marcin Radom, Institute of Computing Science,  
Poznan University of Technology, 60-965, Poznan,  
Poland, Marcin.Radom@cs.put.poznan.pl, Piotr  
Formanowicz

DNA sequencing is a process of reading the sequence of nucleotides in a given DNA. One of the methods for solving this problem is Sequencing by Hybridization (SBH), which can be divided into classical and non-classical. In non-classical approach there can be multiple types of the oligonucleotides in a single microarray probe, all described by a specific pattern. In this work we present a new algorithm for solving sequencing problems basing on non classical SBH spectrum. This algorithm can solve sequencing problems for long DNA strings and it can handle hybridization errors effectively.

## 3 - Non linear excitation in one dimensional lattices.

Elso Drigo Filho, Department of Physics, Sao Paulo  
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15054-000, Sao Jose do Rio Preto, Sao Paulo, Brazil,  
also@ibilce.unesp.br, Hernan Cortez, Jose Roberto  
Ruggiero

Harmonic one dimensional lattice with an additional Morse potential coupled on site has been used to describe DNA macromolecules properties. In particular, it is conjectured that the non linear excitations (breathers) can be important in the biochemistry process involving this macromolecule. In the present work, we analyse a modification of this lattice introducing a symmetric Morse potential. The existence and stability of the breathers is studied in this modified system. We obtain harmonic bifurcation and determine the effective mass of the mobile breather. Thanks FUN-DUNESP,CNPq, FAPESP.

## MA-06

Monday 08:00-09:20

Koch

### Real-world Planning and Scheduling Approaches 2

Stream: OR and Real Implementations

Invited session

Chair: Falk Pappert, Professur für Modellierung und Simulation, Technische Universität Dresden, Nöthnitzer Straße 46, Zi. 1090, 01187, Dresden,  
falk.pappert@mail.inf.tu-dresden.de

#### 1 - Investigation of mip approaches for batch scheduling in semiconductor manufacturing

Andreas Klemmt, Electronics Packaging Laboratory,  
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klemmt@avt.et.tu-dresden.de, Gerald Weigert

The planning and optimization of semiconductor manufacturing is a very complex task. So, often a dispatching system is used to control the work centers and to optimize their processes. In this research, different approaches of mixed integer programming will be investigated for optimization of batch processes in selected work centers of a wafer fab. The objective is to keep operational due dates under practical conditions. Also a coupling to different heuristics is discussed. On the basis of real manufacturing data it is then investigated which optimization potential exists for the work center.

#### 2 - Block planning-based MILP approach for integrated production and distribution planning in the catering sector

Poorya Farahani, Technical University of Denmark,  
2800, Kgs. Lyngby, Denmark, pf@ipl.dtu.dk, Martin  
Grunow, Hans-Otto Guenther

A catering company located in Copenhagen produces several types of food orders and delivers them to customers. The main concern of this paper is to investigate the effect of integrating production and transportation decisions. Due to the rapid quality decay in catering foods, the focus is on the time interval between the production of the food orders and their delivery at the customers. An iterative procedure and MILP models are developed for both sub-problems. As the production planning model is based on the efficient block planning concept, this sub-problem can be solved to optimality.

#### 3 - Data modeling for assembly processes

Falk Pappert, Professur für Modellierung und Simulation, Technische Universität Dresden,  
Nöthnitzer Straße 46, Zi. 1090, 01187, Dresden,  
falk.pappert@mail.inf.tu-dresden.de, Oliver Rose

Practical problem instance data modeling methods for a simulation-based Scheduling tool are critical for user acceptance and model representation. In our case, it was the goal to facilitate the modeling of assembly processes of several companies and their typical restrictions in a general way. In our paper, we analyze four different tools mainly with respect to clarity, redundancy, completeness, and usability. We considered spreadsheet tables, a business process modeling tool (MO2GO), a network diagram tool, and an editing tool for a standardized non-proprietary modeling language (SysML).

## MA-07

Monday 08:00-09:20

GSI - S 29

### Public Transport Scheduling in Taiwan

Stream: Optimization in Public Transport

Invited session

Chair: Anthony F. Han, Dept. Transportation Technology and Mgt., National Chiao Tung University, 1001 Ta Hseuh Road, 30010, Hsinchu, Taiwan, afhan@pie.com.tw

#### 1 - Commuter bus routing problem: formulation and ta heuristics

Anthony F. Han, Dept. Transportation Technology and Mgt., National Chiao Tung University, 1001 Ta Hseuh Road, 30010, Hsinchu, Taiwan, afhan@pie.com.tw,  
Cheng Wei Chu

Commuter bus routing problem (CBRP) is a variant of Open Vehicle Routing Problem (OVRP) with a heterogeneous fleet. CBRP is a problem commonly faced by many companies for their employee's daily commuting. In this paper, we proposed both an IP formulation and Threshold Accepting (TA) heuristics for the CBRP. We applied the TA heuristics to a big semiconductor manufacturer in Taiwan, and found significant improvement in both cost and time savings for the case company.

## 2 - Mass rapid transit crew scheduling and rostering: constraint programming applications

*Anthony F. Han*, Dept. Transportation Technology and Mgt., National Chiao Tung University, 1001 Ta Hseuh Road, 30010, Hsinchu, Taiwan, afhan@pie.com.tw,  
*Chun-Te Li*

Given a time table, we are concerned with the problem how to find most cost-efficient and legitimate schedules and rosters of train drivers in the operations of a mass rapid transit (MRT) system. We proposed a two-phase approach: first, a CP-MP hybrid method for the scheduling, and second, a CP model for generating the rosters. Both models were applied to a case of Taipei Metro MRT, and yielded good results.

## 3 - A particle swarm optimization algorithm for the fixed-route bus network design

*Wen-Chi Ho*, Chung Hua University, 707, Sec.2, WuFu Rd., Hsinchu, Taiwan 300, R.O.C., 300, Hsinchu, Taiwan, D09703020@chu.edu.tw, *Jau-Ming Su*

In recent years, the government and transit agencies try to provide more efficiency fixed-route bus networks due to the social changes in Taiwan. In fact, the decision is difficult because it involved different stakeholders. This paper proposes a fixed-route bus network model and a particle swarm optimization-based algorithm to assist planners to determine a set of routes and the associated frequencies that achieve the desired objective.

## MA-08

Monday 08:00-09:20

GSI - S 30

### Air transportation

Stream: Optimization in Public Transport

*Invited session*

Chair: *Karl Nachtigall*, Faculty of Transport and Traffic Sciences, Institut für Logistics and Aviation, Technical University of Dresden, Hettnerstraße 1, Gerhart-Potthoff-Bau 106a, 01062, Dresden, Sachsen, Germany, karl.nachtigall@tu-dresden.de

## 1 - Profit optimised seasonal flight scheduling by attention in traffic demand and resource restrictions

*Steffen Marx*, Fakultät für Verkehrswissenschaften, Technische Universität Dresden, Institut für Luftfahrt und Logistik, Professur f. Verkehrsströmungslehre, 01062, Dresden, Germany, steffen.marx@tu-dresden.de

Strategical flight scheduling is nowadays done manually by using historical seasonal flight plans, which on adjusted to the actual market situation and basic conditions. The goal of the planary process is to maximize airline benefit under certain operational constraints. Mostly actual optimisation models about this topic optimise workflows of strategical flight scheduling only serial or using meta heuristics to find a good solution. Main idea of our basic approach is combine all strategical flight scheduling workflows in a global linear optimisation model to find better solutions.

## 2 - Reducing aircraft delays by optimized runway assignment

*Michael Kolonko*, Institut für Mathematik, TU Clausthal, Erzstr. 1, D-38678, Clausthal-Zellerfeld, Germany, kolonko@math.tu-clausthal.de, *Rainer Kiehne*

Limited capacities of runways have been identified as a major source of delay at airports. If there are two runways available, an efficient routing strategy for incoming aircraft can increase the throughput of the system.

In this paper we present several simple strategies that are based on heuristic optimization. They outperform standard assignment strategies in simulation scenarios.

In particular we present the results of a complex simulation study with real traffic data of a German airport. Here, our simple strategies induced less delay than the manual assignment as it is used today.

## 3 - An approach for medium term airline crew planning with anticipation

*Michael Römer*, Juristische und Wirtschaftswissenschaftliche Fakultät, Martin-Luther-Universität Halle-Wittenberg, Universitätsring 3, 06108, Halle (Saale), michael.roemer@wiwi.uni-halle.de

Medium term airline crew planning decisions, including temporary and part-time contracting, vacation planning and assignment of office/simulator activities affect the time-dependent availability of crew in homebases. Therefore, they have a big impact on subsequent decisions such as crew pairing and assignment of flights as well as stand-by and off-duty days. We propose to anticipate these decisions in medium term crew planning and discuss the resulting integration approach and optimization models. Experimental results for the case of vacation planning at a German Charter Airline are presented.

## 4 - Passenger oriented airport operations management

*Christoph Lanz*, Institute of Mathematical Methods in Economics, Vienna University of Technology, Argentinierstrasse 8 / 105-4 ORDYS, 1040, Vienna, christoph.lanz@tuwien.ac.at, *Gernot Tragler*

We present results from a project on "Passenger Oriented Airport Operations Management" which we pursue in cooperation with the Vienna International Airport, the Austrian Airlines AG, and three other associate partners. We aim to optimize the current situation at the airport for all involved parties including passengers and all companies doing business. Using current and predicted future data we construct a model of the airport and its passengers and we apply various optimisation algorithms taking into account the many restrictions of safe and law-abiding airport operations.

## MA-09

Monday 08:00-09:20

GSI - S 5

### Supplier Selection and Evaluation

Stream: Supply Chain Management

*Invited session*

Chair: *Andrea Genovese*, Dipartimento di Ingegneria Economico-Gestionale, University of Naples "Federico II", piazzale Tecchio 80, 80125, Naples, Italy, andrea.genovese@unina.it

## 1 - A neural network approach for supplier performance evaluation

*Asli Aksoy*, Industrial Engineering, Uludag University, Muhendislik Mimarlik Fakultesi, Gorukle Kampusu, 16059, Bursa, Turkey, asliaksoy@uludag.edu.tr, *Nursel Ozturk*

Many manufacturers are dealing with new approaches in order to be more competitive in today's global markets. Effective supplier performance evaluation system is key factor in raising the competitiveness of firms. In this research, neural network based supplier performance evaluation system is presented. Supervised learning technique and backpropagation algorithm is used training phase of the NN. The network is trained with training datasets. Test examples are used to validate the effectiveness of neural network structure.

## 2 - Supplier selection problem: a literature review

*Andrea Genovese*, Dipartimento di Ingegneria Economico-Gestionale, University of Naples "Federico II", piazzale Tecchio 80, 80125, Naples, Italy, andrea.genovese@unina.it, *Giuseppe Bruno*, *Emilio Esposito*, *Renato Passaro*

Supplier selection problem consists of defining models and methods to measure and rank performances of a set of potential suppliers in a given context. It represents an intrinsically multi-criteria decision making problem, as many conflicting factors should be taken into account. In recent years several approaches have been proposed based on different optimization methodologies. This work provides an extensive literature review for the supplier selection problem, identifying the state of the art and possible directions for further researches.

## ■ MA-10

Monday 08:00-09:20

GSI - S 6

### Evolutionary Multiobjective Optimization I

Stream: Evolutionary Multi Objective Optimization

*Invited session*

Chair: *Juergen Branke*, Warwick Business School, University of Warwick, CV4 7AL, Coventry, United Kingdom, juergen.branke@wbs.ac.uk

#### 1 - Integration of multi-objective computing budget algorithm with evolutionary algorithm

*Loo Hay Lee*, Industrial and Systems Engineering, National University of Singapore, Singapore, iselee@nus.edu.sg, *Ek Peng Chew*

In this talk, we will discuss how the multi-objective computing budget allocation algorithms (MOCBA) can be integrated into an evolutionary algorithm in handling multi-objective problems when the fitness of the designs need to be evaluated by time-consuming simulations. Numerical experiment shows that MOCBA is able to enhance the ability of the Evolutionary Algorithm in handling stochastic problems.

#### 2 - Effective weighted hypervolume sampling to incorporate user preferences in evolutionary multiobjective optimization

*Johannes Bader*, Computer Engineering and Networks Lab, ETH Zurich, Gloriastrasse 35, 8092, Zurich, Switzerland, baderj@tik.ee.ethz.ch, *Dimo Brockhoff*, *Anne Auger*, *Eckart Zitzler*

Optimizing the weighted hypervolume indicator is a recently proposed concept to integrate arbitrary user preferences into evolutionary multiobjective optimizers. How to articulate a decision maker's preference towards reference points and extremes and how to optimize the according weighted hypervolume indicator by means of Monte Carlo sampling has been previously shown but the approach heavily relies on the choice of several parameters of the weight distribution. Here, we propose a new technique that eases the definition of weights such that the search is always affected by the sampling.

#### 3 - Nemo-ii: integrating evolutionary multiobjective optimization and decision making

*Juergen Branke*, Warwick Business School, University of Warwick, CV4 7AL, Coventry, United Kingdom, juergen.branke@wbs.ac.uk, *Salvatore Greco*, *Roman Slowinski*, *Piotr Zielniewicz*

We propose an improved version of the Necessary-preference-enhanced Evolutionary Multiobjective Optimizer, NEMO-II. It combines evolutionary computation and a multi-criteria decision analysis method, GRIP. The resulting multiobjective optimizer allows the decision maker to interact by comparing pairs of solutions. This information permits to define the set of all compatible value functions. Then, one can compute how far a solution is from the set of solutions being the most preferred for at least one of these functions. This information is then used for ranking in the evolutionary algorithm.

## ■ MA-11

Monday 08:00-09:20

GSI - S 17

### Evolutionary Multiobjective Optimization V - Applications

Stream: Evolutionary Multi Objective Optimization

*Invited session*

Chair: *Silvio Araujo*, Departamento de Ciências da Computação e Estatística-DCCE, Universidade Estadual Paulista-UNESP, R. Cristovao Colombo, 2265 - Jd Nazareth, 15054-000, São José do Rio Preto, São Paulo, Brazil, saraujo@ibilce.unesp.br

#### 1 - Trade-off optimization in project management: time, budget, and quality

*Baruch Keren*, Industrial Engineering and Management, Sami Shamoon College of Engineering, Bialik/Basel Sts., 84100, Beer Sheva, Israel, baruchke@sce.ac.il, *Yuval Cohen*, *Yossi Hadad*

It is generally accepted that the three major dimensions of project success are time, budget, and quality. Most of the research in project planning is focused on the time-cost trade-off and only a few papers appearing in the literature have considered the three dimensions together. The first part of this paper describes the evolution of linear programming formulations for optimizing project time-cost trade-off. The paper continues by developing as a natural extension a non-linear optimization formulation, taking into account a multiple trade-off structure between time, budget, and quality.

#### 2 - Optimizing additive fabrication processes using evolutionary multiobjective optimization techniques

*Vassilis Dedoussis*, Industrial Management & Technology, University of Piraeus, 80 Karaoli & Dimitriou str., 185 34, Piraeus, Greece, vdedo@unipi.gr, *Vassilis Canellidis*, *John Giannatsis*

In this work evolutionary multiobjective techniques are utilized in a decision support system which provides Stereolithography end users with near optimal build orientation and packing arrangements. To cope with the multi-criteria nature of the problem, the proposed framework examines the feasibility of employing a Genetic Algorithm as a search technique in conjunction with a weighted multi-objective function as a means for the evaluation of the 'score' of possible solutions. Various aspects of the Genetic Algorithm are examined in order to test the robustness and effectiveness of the approach

### 3 - Heuristic method to the one-dimensional cutting stock problem

*Silvio Araujo*, Departamento de Ciências da Computação e Estatística-DCCE, Universidade Estadual Paulista-UNESP, R. Cristovao Colombo, 2265 - Jd Nazareth, 15054-000, São José do Rio Preto, São Paulo, Brazil, [saraujo@ibilce.unesp.br](mailto:saraujo@ibilce.unesp.br), *Andre Lopes*

This study deals with the one-dimensional integer cutting stock problem, which consists of cutting a set of available objects in stock in order to produce ordered smaller items in such a way as to optimize a given objective function. We studied the case in which there is only one type of object in stock available in unlimited quantity. A multi-objective evolutionary algorithm is proposed to solve the problem considering two conflicting objective functions, the minimization of the number of objects to be cut and the minimization of the number of different cutting patterns.

## ■ MA-12

Monday 08:00-09:20

GSI - S 18

### Applications of stochastic programming in the energy sector

Stream: Stochastic Programming

*Invited session*

Chair: *Marida Bertocchi*, Dipartimento di Matematica statistica informatica e applicazioni, Università Degli Studi di Bergamo, Via dei Caniana 2, 24127, Bergamo, BG, Italy, [marida.bertocchi@unibg.it](mailto:marida.bertocchi@unibg.it)

#### 1 - A three-stage stochastic short-term scheduling model for hydro power and wind power coordination

*Maria Teresa Vespucci*, Dept. of Management Engineering, University of Bergamo, via Marconi, 5a, 24044, Dalmine (BG), Italy, [mtvespucci@tin.it](mailto:mtvespucci@tin.it),  
*Francesca Maggioni*, *Marida Bertocchi*, *Mario Innorta*

In this paper we develop a stochastic programming model for the short-term optimal scheduling in an electricity production system consisting of hydropower, pumped storage and wind-power plants. The uncertainty on wind power production is taken into account by a three-stage stochastic program, as information evolves over time and uncertainty is disclosed in stages. By integrating wind generation and hydropower with pumped storage, intermittency in wind power generation can be efficiently managed, as wind power in excess can be used for storing potential energy.

#### 2 - Portfolio optimization in the natural gas value chain

*Kjetil Midthun*, Applied Economics, SINTEF, S.P Andersens vei 5, 7465, Trondheim, Norway, [Kjetil.Midthun@sintef.no](mailto:Kjetil.Midthun@sintef.no), *Asgeir Tomasgard*, *Matthias P. Nowak*

We present a short-term portfolio optimization model for a large natural gas producer. The model includes spot market sales, production plans, storage management and fulfillment of long-term contracts. The paper discusses the value of actively using the storage capacity provided by the line-pack of the pipelines to maximize profit for the producer. We also study the value of using a stochastic model as compared to a deterministic model. The model is tested over two 60-days periods using real market data and realistic production and transportation capacities.

### 3 - A stochastic approach to the decision support procedure for a generation company operating on day-ahead and physical derivatives electricity markets

*Cristina Corchero*, Estadística i Investigació Operativa, Universitat Politècnica de Catalunya, c/Jordi Girona 1-3, Campus nord, Ed. C5, dspt 224, 08034, Barcelona, [cristina.corchero@upc.edu](mailto:cristina.corchero@upc.edu), *Maria Teresa Vespucci*, *F. Javier Heredia*, *Mario Innorta*

A decision support procedure was developed for the short-term hydro-thermal resource scheduling problem of a price-taker GenCo operating both the Day-Ahead and Derivatives Electric Market. The derivatives products considered are the physical futures contracts which entail a quantity of energy that has to be produced mandatorily. A stochastic programming model is introduced for the unit commitment and the economic dispatch problem with both technical and market constraints. The spot-price uncertainties are considered and introduced in the model through a set of scenarios.

## ■ MA-13

Monday 08:00-09:20

GSI - S 31

### Stochastic programming I.

Stream: Stochastic Programming

*Invited session*

Chair: *Tong Ji*, CARISMA, Brunel University, M113 John Crank Building, Brunel University, UB8 3PH, London, United Kingdom, [tong.ji@brunel.ac.uk](mailto:tong.ji@brunel.ac.uk)

#### 1 - Scheduling commercials on tv using stochastic programming

*Erdem Gundogdu*, Industrial Engineering, Istanbul Kultur University, IKU Atakoy Campus Room:210 Bakirkoy, 34156, Istanbul, [gundogduerdem@gmail.com](mailto:gundogduerdem@gmail.com), *Ilkay Gultas*

The price of slots purchased by clients differs with several factors. There are also regulations that the TV companies must obey. Also clients ask not to locate theirs with their competing products in the same break. Therefore, the commercials must be scheduled in a manner that each client is satisfied. Traditionally, these schedules are done manually so that it requires a tedious work and is an error-prone process. Thus, we try to reformulate the scheduling problem with a stochastic programming approach. We aim to satisfy the clients while reducing the errors and increasing the profits.

#### 2 - Reverse logistics network design with unknown parameters

*Selin Soner Kara*, Yildiz Technical University, Yildiz Teknik Universitesi Endüstri Muh. Bölümü, Besiktas, 34349, Istanbul, Turkey, [ssoner@yildiz.edu.tr](mailto:ssoner@yildiz.edu.tr), *Semih Onut*

Waste management is an important and rapidly growing industry for developing countries, such as Turkey. Increasing industrial development and rapid urbanization cause an increasing gap between demand and supply of products. In this study, a two-stage stochastic model is presented to determine a long-term strategy under uncertainty for a large-scale real-world recycling network design problem which includes optimal locations and optimal flow amounts between the nodes in the multi-facility environment.

#### 3 - Stochastic portfolio optimization in the nigerian electricity sector

*Erkan Kalayci*, Institute of Applied Mathematics, 06531, Ankara, Turkey, [erk\\_kal@hotmail.com](mailto:erk_kal@hotmail.com), *Miray Aslan*, *Gerhard-Wilhelm Weber*

Since years Nigeria has a problem of shortage of electricity and has the highest uncertainty of electricity supply in the world. Among the main reasons are lack of enough power plant capacity, ineffective transmission and distribution networks, obsolete equipments and low electricity tariff. The aim of this study is to model and to solve a stochastic portfolio optimization for the whole Nigerian electricity sector to maximize overall profit, given that at every time supply and demand are in balance, through generating possible scenarios for gas prices, exchange rates and energy demand.

#### 4 - Optimal trading strategy using financial derivatives

*Tong Ji*, CARISMA, Brunel University, M113 John Crank Building, Brunel University, UB8 3PH, London, United Kingdom, [tong.ji@brunel.ac.uk](mailto:tong.ji@brunel.ac.uk), *Gautam Mitra*

Stock market is not perfectly frictionless in short run; transactions of an institutional investor can be exercised substantially different from the decision price. It is now customary to divide a large trade into several consecutive transactions. The investors now have to trade off between the adverse effect of their own trading activities and uncertain future price movement. We proposed that investor can reduce their implementation shortfall due to price uncertainty by trading on both spot and derivative markets. An optimal trading strategy is derived using stochastic programming model.

## ■ MA-14

Monday 08:00-09:20

GSI - S 32

### Location and uncertainty

Stream: Location Analysis

*Invited session*

Chair: *Oded Berman*, Rotman School of Management, University of Toronto, 105 St. George Street, L4J 3B7, Toronto, ON, Canada, [berman@rotman.utoronto.ca](mailto:berman@rotman.utoronto.ca)

#### 1 - Facility location with yield uncertainty: model and solution approach

*Jens Wollenweber*, Decision Support Systems, Fraunhofer ATL, Nordostpark 93, 90411, Nürnberg, Germany, [jens.wollenweber@atl.fraunhofer.de](mailto:jens.wollenweber@atl.fraunhofer.de)

We consider a multi-product capacitated facility location problem with stochastic yields. The objective is to choose location of facilities and to allocate products to the facilities in order to minimize total expected costs. Besides the uncertainty we take large switchover times into account if more than one product is assigned to a facility. We model the problem as a mixed-integer program and develop methods based on Lagrangian relaxation to obtain lower bounds. Furthermore we solve a simplified problem by a standard solver and apply an improvement heuristic to obtain feasible solutions.

#### 2 - A joint location inventory warehouse model

*Francisco Silva*, Economics and Business, University of the Azores, Rua da Mae Deus, Ponta Delgada, 9500, Ponta Delgada, Portugal, [fsilva@uac.pt](mailto:fsilva@uac.pt), *Daniel Serra*

In this paper we present a mixed integer discrete warehouse joint location inventory problem. Demand in each node is considered to follow a normal distribution. The objective function has two main components: transportation costs and inventory costs that are conflictive between them. The number of warehouses to locate is not fixed a priori. Since the formulation is non linear, a heuristic is presented to solve it, together with test problems. Finally, the model is used to locate warehouses of lottery terminals in Spain.

#### 3 - Hardening facilities against random disruptions

*Maria Paola Scaparra*, Kent Business School, University of Kent, The University, CT2 7PE,

Canterbury, United Kingdom,  
[M.P.Scaparra@kent.ac.uk](mailto:M.P.Scaparra@kent.ac.uk)

We consider a median system with  $p$  facilities which are vulnerable to random disruptions. We present a stochastic protection model which identifies the optimal allocation of protection resources among the facilities so as to minimize the expected operational costs to serve the customers. We show how to obtain a network-flow-type linear model for this problem. The resulting model can be directly solved by commercial MIP solvers. We also propose a GRASP algorithm to solve large problem instances and report results for several benchmark problems.

#### 4 - Coordinating replenishment periods in location-inventory model

*Oded Berman*, Rotman School of Management, University of Toronto, 105 St. George Street, L4J 3B7, Toronto, ON, Canada, [berman@rotman.utoronto.ca](mailto:berman@rotman.utoronto.ca),  
*Dmitry Krass*, *M. Mahdi Tajbakhsh*

We consider a periodic review location-inventory model where distribution centers follow order-up-to-level (R, S) inventory policies. System coordination is ensured by controlling replenishment periods. An algorithm for optimal center location, customer allocation and replenishment period choice is presented

## ■ MA-15

Monday 08:00-09:20

Einstein

### Vehicle routing problems

Stream: Vehicle Routing

*Invited session*

Chair: *M. Grazia Speranza*, Dept. of Quantitative Methods, University of Brescia, C.da Santa Chiara, 50, 25122, Brescia, Italy, [speranza@eco.unibs.it](mailto:speranza@eco.unibs.it)

#### 1 - A bi-objective branch-and-cut algorithm for the multi-modal traveling salesman problem

*Gilbert Laporte*, Canada Reserach Chair in Distribution Management, HEC Montreal, CRT, University of Montreal, CP 6128 Succursale Centre-ville, H3C 3J7, Montreal, QC, Canada, [gilbert@crt.umontreal.ca](mailto:gilbert@crt.umontreal.ca),  
*Frédéric Semet*, *Nicolas Jozefowicz*

The multi-modal traveling salesman problem is defined on a valuated graph where a transportation mode is associated with each edge. The goal is to identify a Hamiltonian cycle minimizing both the total length and the number of used transportation modes. First, we propose an integer program for the problem and introduce some additional valid constraints. Next we describe a multi-objective branch-and-cut algorithm able to find the complete optimal Pareto set in one run. Finally, computational results are presented.

#### 2 - A heuristic for the pickup and delivery TSP with lifo loading and multiple stacks

*Michel Gendreau*, CIRRELT, Université de Montréal, C.P. 6128, succ. Centre-ville, H3C 3J7, Montreal, Quebec, Canada, [michelg@crt.umontreal.ca](mailto:michelg@crt.umontreal.ca),  
*Jean-François Côté*, *Jean-Yves Potvin*

We propose an "Adaptive Large Neighborhood Search" heuristic for a routing problem in which a single vehicle must move objects between specified locations. Objects have a standard width and are thus placed in a given number of "stacks" in the vehicle. Once loaded, objects cannot be moved to other stacks or resequenced in their stack, and only the (current) last object of each stack is available for delivery. Computational results on special cases of the problem indicate that the proposed heuristic compares very favorably with existing ones for these cases.

### 3 - A generalised vehicle routing problem with mixed deliveries and pickups

Gábor Nagy, Kent Business School, University of Kent, CT2 7PE, Canterbury, United Kingdom, G.Nagy@kent.ac.uk, Said Salhi, Niaz Wassan

The VRP with deliveries and pickups is an important problem within reverse logistics. We aim to introduce flexibility in allowing pickups to be loaded onto the vehicle, but subject to a restriction on the mixture of delivery and pickup goods onboard. A mathematical formulation is provided and optimal results or bounds are found for small instances. We develop a heuristic solution algorithm, based on the powerful meta-heuristic reactive tabu search. The obtained results demonstrate the usefulness of this practical logistic problem while providing results for benchmarking purposes.

### 4 - Multiperiodic vrp models and GRASP algorithms for goods distribution with reverse flows

Pierre Dejax, Industrial Engineering - IRCCyN, Ecole des Mines de Nantes, BP 20722, 44307, Nantes Cedex 3, pierre.dejax@emn.fr

We consider generic problems for the multiperiodic distribution planning and routing in a network with a central warehouse and retail stores, including return flows of pallets or products. Time windows, split delivery or storage at the retail stores are considered. We have developed a heuristic solution technique based on different classical and hybrid variations of the the GRASP metaheuristic and a column generation approach. We present results based on experimentations on set of 1848 instances of various characteristics generated from the Solomon's testbed for the VRPTW with 25 sites.

## MA-16

Monday 08:00-09:20

Koenig

### Multiple Criteria Integer and Linear Programming

Stream: Multi-Objective Optimization and Decision Theory 1

Invited session

Chair: Dogan Ozgen, Industrial Engineering Department, Yildiz Technical University, Yildiz, Barbaros Boulevard, 34349, ISTANBUL, Besiktas, doganozgen@gmail.com

#### 1 - Optimizing a linear function over the epsilon-efficient set of a multiobjective mixed integer linear programming problem.

Alejandro Crema, Escuela de Computación, Facultad de Ciencias, Universidad Central de Venezuela, Apartado 47002, 1041-A, Caracas, Venezuela, Caracas, Venezuela, alejandro.crema@ciens.ucv.ve, Norma Guzmán

Optimizing a linear function over the epsilon-efficient set of a multiobjective Mixed Integer Linear Programming (MILP) problem is a topic of unquestionable practical as well as mathematical interest. In this work we present an algorithm to solve the problem given a tolerance for the difference between the supreme and the obtained value. The approach proposed defines a sequence of progressively more constrained single objective MILP problem that successively eliminates undesirable points from further consideration.

#### 2 - Multiobjective possibilistic linear programming approach for multiechelon supply chain design

Dogan Ozgen, Industrial Engineering Department, Yildiz Technical University, Yildiz, Barbaros

Boulevard, 34349, ISTANBUL, Besiktas, doganozgen@gmail.com, Bahadır Gulsun

Designing multiechelon supply chain is a complex and imprecise multiobjective decision making problem. In this paper, we first define a multi-objective possibilistic linear programming considering various conflicting objectives simultaneously; i) min cost, ii) min transportation time. After we apply the steps of possibilistic linear programming approach to be able to proposing alternative results for decision makers. An illustrative example is given. Computational results indicate that this approach can give better than crisp LP approaches because some critical parameters can be defined imprecisely.

## MA-17

Monday 08:00-09:20

Rheinaue

### Scheduling with batching and lot-sizing

Stream: Scheduling under Resource Constraints

Invited session

Chair: Mikhail Kovalyov, Faculty of Economics, Belarusian State University, Nezavisimosti 4, 220030, Minsk, Belarus, kovalyov\_my@yahoo.co.uk

#### 1 - Batching with buffered rework

Mikhail Kovalyov, Faculty of Economics, Belarusian State University, Nezavisimosti 4, 220030, Minsk, Belarus, kovalyov\_my@yahoo.co.uk, Sergey Kovalev, Erwin Pesch

We consider the imperfect production of several products on the same facility. Operations on product items are performed in batches. Defectiveness of an item is determined by a given function of its product, its preceding product, and the position of its operation in the batch. Defective items are kept in a buffer and then are remanufactured on the same facility. The objective is to minimize maximum lateness with respect to product due dates. NP-hardness is proved, and a heuristic group technology solution approach is suggested. The results apply for scheduling car paint shops.

#### 2 - A new problem of lot-sizing and sequencing under uncertainties

Alexandre Dolgui, IE & Computer Science, Ecole des Mines de Saint Etienne, 158, cours Fauriel, 42023, Saint Etienne, France, dolgui@emse.fr, Frédéric Grimaud, Genrikh Levin, Kseniya Shchamialiova

A problem of lot-sizing and sequencing of manufacturing items for a production line with random machine breakdowns and random rejects is considered. Set-up times are taken into account. The goal is to maximize the probability of a desired output for a given period. The approach is based on the decomposition of the initial problem in two sub-problems: a travelling salesman problem and a knapsack problem. An iterative optimization procedure is proposed. Some tests are given and comparisons with heuristics and simulation are reported.

#### 3 - A new batch scheduling problem in machining environment

Alexandre Dolgui, IE & Computer Science, Ecole des Mines de Saint Etienne, 158, cours Fauriel, 42023, Saint Etienne, France, dolgui@emse.fr, Olga Guschinskaya, Nikolai Guschinsky, Genrikh Levin

This presentation concerns a new scheduling problem for machining lines. This problem can be formulated as scheduling for a single max-batch machine with inclusion, exclusion and precedence constraints between jobs and under the condition that the time of a batch can exceed the time of its longest job. This problem is solved using the constrained shortest path approach. Dominance properties were developed to decrease the digraph's size. An illustrative example is reported.

#### 4 - Structural properties for job shop scheduling under batch availability

*Liji Shen*, TU Dresden, Striesener Str. 14, 01307, Dresden, Germany, [liji@liji.de](mailto:liji@liji.de), *Udo Buscher*

As a prominent variant of batch scheduling problems, batch availability stipulates that all jobs assigned to the same batch are released simultaneously. Practical applications arise when, for instance, products are placed on pallets for manufacturing. Scheduling with transport issues also resembles this specific requirement. In our study, we focus on investigating the job shop problem subject to batch availability. Structural properties are first presented, based on which, we propose two algorithms, which ensure solution feasibility and enable an efficient determination of objective values.

## ■ MA-18

Monday 08:00-09:20

*Lenné*

### Mathematical Programming in Networks 2

Stream: Mathematical Programming

*Invited session*

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, [gweber@metu.edu.tr](mailto:gweber@metu.edu.tr)

Chair: *Armin Fügenschuh*, Optimierung, Zuse Institut Berlin, Takustraße 7, 14195, Berlin, Germany, [armin.fuegenschuh@googlemail.com](mailto:armin.fuegenschuh@googlemail.com)

#### 1 - Global optimization and complementarity for solving a traffic problem

*Isabel Ribeiro*, Engenharia Civil (SMF), Faculdade de Engenharia da Universidade do Porto, Rua Dr. Roberto Frias, s/n, 4200-465, Porto, Portugal, [iribeiro@fe.up.pt](mailto:iribeiro@fe.up.pt), *Maria Lurdes Simões*

In this talk, we discussed an optimal cycle length for a signalized intersection regulated by pretimed control problem, which is formulated as a Mathematical Programming Problem with Complementarity Constraints (MPCC). The model describes the evolution of the queue lengths (number of waiting vehicles) of each lane as a function of the time and the green split allocation at isolated intersections. A parametric enumerative method is proposed for solving the MPCC. Computational experience with real problems is included to highlight the efficacy of the procedure in practice.

#### 2 - Material flow networks as modeling language for material flow based optimization problems

*Hendrik Lambrecht*, IAF, Hochschule Pforzheim, Tiefenbronner Str. 65, 75175, Pforzheim, Germany, [hendrik.lambrecht@hs-pforzheim.de](mailto:hendrik.lambrecht@hs-pforzheim.de), *Mario Schmidt*, *Andreas Möller*

An important issue in designing DSS is the user-software interface. As is known, visualization strongly enhances comprehension which is crucial for obtaining meaningful results. It also facilitates communication among the people working on the solution to a specific problem. We propose the use of graph-based material flow networks (MFN) as an alternative to algebraic modeling languages for the optimization of material flow systems. Results from the BMBF-funded research project KOMSA are presented: a concept that combines MFN with direct search optimization as well as a software prototype.

## ■ MA-19

Monday 08:00-09:20

*Haber*

### Generalized Convex Functions

Stream: Convex Optimization 1

*Invited session*

Chair: *Attila Gilanyi*, Institute of Mathematics, University of Debrecen, Pf. 12, 4010, Debrecen, [gilanyi@math.klte.hu](mailto:gilanyi@math.klte.hu)

#### 1 - On approximately s-convex functions

*Pál Burai*, Applied Mathematics and Probability Theory, University of Debrecen, Faculty of Informatics, Pf.: 12., 4010, Debrecen, [burai.pal@inf.unideb.hu](mailto:burai.pal@inf.unideb.hu), *Attila Házy*

We present some regularity theorems on approximately s-convex functions. Here s-convexity is a generalization of convexity.

#### 2 - Bernstein-doetsch type results for breckner s-convex functions

*Attila Házy*, Department of Applied Mathematics, University of Miskolc, Miskolci Egyetem, 3515, Miskolc-Egyetemváros, [matha@uni-miskolc.hu](mailto:matha@uni-miskolc.hu), *Pál Burai*

As a possible generalization of the concept of s-convexity due to Breckner, we introduce the so-called (H,s)-convexity. In our talk we present some properties and some inequalities for this type functions. The main goal of this paper is to prove some (Bernstein-Doetsch type) regularity properties of (H,s)-convex functions.

#### 3 - On two variants of fenchel duality: stable and totally unstable duality

*Radu Ioan Bot*, Faculty of Mathematics, Chemnitz University of Technology, Reichenhainer Str. 39 Zi. 612, 09107, Chemnitz, Germany, [bot@mathematik.tu-chemnitz.de](mailto:bot@mathematik.tu-chemnitz.de)

For two proper and convex functions defined on a separated locally convex vector space we consider two variants of the classical Fenchel duality, which were recently introduced in the literature, namely the so-called stable Fenchel and totally Fenchel unstable duality. In this talk we investigate, on the one hand, the relations between these concepts and give, on the other hand, an overview on the regularity conditions which guarantee stable Fenchel duality. We also provide answers to some open problems raised in connection with totally Fenchel unstable functions in real Banach spaces.

#### 4 - On convex functions of higher order

*Attila Gilanyi*, Institute of Mathematics, University of Debrecen, Pf. 12, 4010, Debrecen, [gilanyi@math.klte.hu](mailto:gilanyi@math.klte.hu), *Zsolt Pales*

In the present talk, based on the classical concept of convex functions as well on its generalization by E. M. Wright and motivated by T. Popoviciu's convexity notions, higher-order convexity properties of real functions are investigated. In particular, we characterize higher-order Jensen-convex and Wright-convex functions via generalized derivatives, we prove the localizability of such type convexities, and we present some results on the comparison of different forms of higher-order convexity.

## ■ MA-20

Monday 08:00-09:20

Mann

### DEA - Efficiency and Productivity Measurement

Stream: DEA and Performance Measurement

Invited session

Chair: *Dimitris Margaritis*, Finance, AUT, 42 Wakefield St, 1010, Auckland, dmargaritis@aut.ac.nz

#### 1 - Are the cooperatives the weakest link in European banking? a non-parametric metafrontier approach

*Alexandra Kontolaimou*, Department of Economics, University of Patras, University Campus Rio, 26504, Patras, Greece, akonto@upatras.gr, *Kostas Tsekouras*

This paper analyses productive efficiency of cooperative banks as compared to their commercial and savings counterparts, taking into account potential technology heterogeneity due to different ownership structures in European banking. We introduce a methodology in order to identify technology gaps among different bank types and decompose them into input- and output-invariant components. Our findings suggest that the European technological edge is defined by commercial banks, while significant technology gaps are found for cooperatives stemming from relatively high output-based inefficiencies.

#### 2 - A dynamic Malmquist productivity index

*Dimitris Margaritis*, Finance, AUT, 42 Wakefield St, 1010, Auckland, dmargaritis@aut.ac.nz, *Shawna Grosskopf*, *Rolf Fare*

In this paper we extend the Malmquist productivity index into a dynamic index, by allowing for reallocation of resources over time. Thus today's resource decisions have an impact on tomorrow's production. We obtain the dynamic version of the index by applying distance functions to a dynamic production model. We also show how to estimate the dynamic distance functions using a data envelopment approach (DEA). We include an empirical illustration which compares the dynamic to the original Malmquist productivity index.

#### 3 - Transportation network performance measurement- the impact of the downtown space reservation system: a network-dea approach

*Yueqin Zhao*, ISE, Virginia Tech, 7054 Haycock Road, 22043, Falls Church, VA, yueqinz@vt.edu, *Konstantinos Triantis*

Transportation is a multiple input/output system. Transportation providers are interested in system efficiency and effectiveness. The users are concerned with their mobility. The community cares about environment issues. To represent these perspectives in a performance evaluation framework, network-DEA is used. The perspectives are inter-related through the DEA network. An example is provided with the data from a micro-traffic simulation of the Downtown Space Reservation System. The network-DEA model complements the micro-simulation by accounting for a macro level measurement consideration.

#### 4 - Profit efficiency of bank branches: the impact of the environment

*Michel Dietsch*, IEP, Université de Strasbourg, 47, avenue de la Forêt Noire, 67000, Strasbourg, michel.dietsch@urs.u-strasbg.fr

This paper attempts to estimate efficiency of a sample of 1.618 branches of a large French bank, while taking account the impact of the environment. Using the directional distance function and the linear programming methodology, it estimates gross technical inefficiency levels ignoring the environmental effect. Then, it re-estimates the frontiers by environment to get adjusted measures of net technical inefficiency and environmental inefficiency. At the branch level, the average inefficiency contribution of environment to total inefficiency is greater than 40%.

## ■ MA-21

Monday 08:00-09:20

Hauptmann

### Quantitative Health Care Policy Decision Making

Stream: Health Care Management

Invited session

Chair: *Marion Rauner*, Dept. Innovation and Technology Management, University of Vienna, Bruennerstr. 72, A-1210, Vienna, Austria, marion.rauner@univie.ac.at

#### 1 - The role of health care management games for teaching and policy decision making

*Marion Rauner*, Dept. Innovation and Technology Management, University of Vienna, Bruennerstr. 72, A-1210, Vienna, Austria, marion.rauner@univie.ac.at, *Sigrun Schwarz*, *Markus Kraus*, *Jörg Gesslbauer*, *Panosch Barbara*

Operations Research, internet, and e-learning highly increased the potential of this tool for teaching and policy making in the last years. First, we give a short overview on general management games. We then especially focus on the importance of Operations Research techniques for health care games.

#### 2 - A dynamic model of drug supply and demand

*Gernot Tragler*, OR and Nonlinear Dynamical Systems, Vienna University of Technology, Argentinierstr. 8/105-4, A-1040, Vienna, Austria, tragler@eos.tuwien.ac.at, *Jonathan Caulkins*

Illicit drug consumption imposes enormous health care costs to societies all around the globe. For many years OR has already set a focus on the management of drug epidemics, but so far, the supply and demand of drugs has hardly been analysed in a joint study. Here we present a dynamic model of both the supply and the demand of drugs with the main objective of minimizing the social costs that arise from drug use. In mathematical terms, we present a system of ODEs with three state variables representing the number of susceptibles, the number of users, and the throughput capacity of supply.

#### 3 - An integrated simulation and optimization approach to support surgical department management

*Angela Testi*, DIEM-Dip.Economia e Metodi quantitativi, Università di Genova, via Vivaldi 5 -16126 GENOVA-ITALIA, FACOLTA' DI ECONOMIA, 16126, GENOVA, testi@economia.unige.it, *Elena Tanfani*

We study an integrated use of optimization and simulation for the management and capacity planning of a surgical department. In particular a discrete event simulation model is developed to take care of the stochastic nature of the system under study. Moreover, an optimization model for the so called Master Surgical Schedule Problem (MSSP) generates optimal allocation plans for the operating rooms that can be used as input data for the simulation model. The simulation experiments give insight towards performance improvement based on different operative rules for operating rooms and stay area.

#### 4 - Simulation modelling for bipolar disorder — the pam project

*Sally Brailsford*, University of Southampton, School of Management, SO17 1BJ, Southampton, United Kingdom, s.c.brailsford@soton.ac.uk, *S Mohiuddin*

Personalised Ambient Monitoring is a multidisciplinary project using a set of sensors placed in the home, or worn on the body, to monitor BD patients' daily activity patterns or 'signatures'. PAM aims to provide early feedback to patients when their behaviour starts to deviate from normal, so they can seek medical help and avoid a serious episode. We use MC simulation to determine value and effectiveness of PAM in the face of uncertainty about the acceptability and reliability of the sensors, and the accuracy of the algorithms used to determine deviation from normal activity.

## ■ MA-22

Monday 08:00-09:20

Arndt

### Optimization Modeling in Practice I

Stream: OR Applications in Industry

*Invited session*

Chair: *Bjarni Kristjánsson*, Maximal Software, Ltd., Boundary House, Boston Road, W7 2QE, London, Iceland, bjarni@maximalsoftware.com

#### 1 - Deploying flexible OR solutions with AIMMS

*Guido Diepen*, Paragon Decision Technology, Schipholweg 1, 2034 LS, Haarlem, Netherlands, Guido.Diepen@AIMMS.com

AIMMS is a modeling system for optimization-based decision support applications. We will demonstrate how a customer in the petrochemical industry uses one single AIMMS solution in a variety of situations: edited by the modeler, used as a component within a framework, and used by different types of end-users. Furthermore, we will show how AIMMS can be used to create a Server Based Optimization framework: each client will delegate the actual solving of its problems to one (or more) central servers. This setup allows for more efficient use of available solvers, as well as of computing power.

#### 2 - Using utility computing to provide mathematical programming resources

*Franz Nelissen*, GAMS Software GmbH, Eupener Str. 135-137, 50933, Cologne, Germany, FNelissen@gams.com

Utility computing (or on-demand computing) is the packaging of computing resources, such as computation, memory, and storage, as a metered service similar to a physical public utility.

We will start with a brief overview on the history of utility computing applied to mathematical programming projects and show two different prominent available technologies (Amazon's Computing Cloud / Sun's Network.com). Using some example applications we will discuss how these approaches are already suitable for the requirements of (commercial) mathematical programming problems.

#### 3 - GAMS — features you might not know about

*Alex Meeraus*, GAMS Development Corporation, Washington, DC, United States, alex@gams.com, *Michael Bussieck*, *Jan-Hendrik Jagla*, *Franz Nelissen*, *Lutz Westermann*

In the last decade the General Algebraic Modeling System (GAMS) has been improved in various ways. Some of the improvements are visible and known to most of the users like the availability of new solvers or changes you can see in the integrated development environment. Others are more hidden and the user might not know that these exist like the Macro Facility and the Matching Operator.

In this talk we give an overview of features which were added in the recent and not so recent past. We will focus on things which were not talked about in scientific presentations before.

## ■ MA-23

Monday 08:00-09:20

Planck

### AHP VI

Stream: Analytic Hierarchy Processes, Analytic Network Processes

*Invited session*

Chair: *Selin Hanife Eryuruk*, Textile Engineering Department, Istanbul Technical University, Inonu Cad. No.87 Gumussuyu, Beyoglu, 34437, Istanbul, Turkey, hanifecaliskan@yahoo.com

#### 1 - AHP and topsis to evaluate the emerging industry credit ability for banking sector

*Yi-Shan Chen*, Graduate School of Management,, Ming Chuan University,, 250 Chung Shan N. Rd. Sec. 5,, 11103, Taipei, Taiwan, ys13.chen@msa.hinet.net, *Chin-Tsai Lin*, *Jung-Ho Lu*

This paper proposes an evaluation of emerging industry credit model. The paper presents an evaluation framework through modified Delphi Method. Next, a case demonstrate proposed model, followed the relative weights of evaluative criteria and sub-criteria are determined using the analytic hierarchic process (AHP) model, the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) approach to rank the alternatives. Importantly, the proposed model can assist the banking sector to assess the emerging industry credit ability.

#### 2 - A locational decision making of a logistics center for turkish clothing industry

*Selin Hanife Eryuruk*, Textile Engineering Department, Istanbul Technical University, Inonu Cad. No.87 Gumussuyu, Beyoglu, 34437, Istanbul, Turkey, hanifecaliskan@yahoo.com, *Murat Baskak*, *Fatma Kalaoglu*

The clothing industry is one of the most competitive and high value-added sector in the world however in recent years clothing industry has suffered difficult times. Logistics is a very important strategy to get competitive advantages like time, cost and customer satisfaction. This paper presents a locational decision making of a logistics center for Turkish Clothing Industry in Marmara Region in Turkey. A numerical study with a questionnaire survey database aimed at the clothing industry of Turkey was conducted and Analytic Hierarchy Process (AHP) was used to evaluate the questionnaire results.

#### 3 - A new approach of the AHP method: application for trend determination

*Szabolcs Duleba*, Economics and Logistics, College of Nyíregyháza, Hungary, 4400 Nyíregyháza, Ferenc krt.2., 4400, Nyíregyháza, duleba@nyf.hu

Usually the extrapolation of relevant data from the past has been used by the scientific literature to determine different trends. This practice can be less effective in the case of fast changing markets. Moreover, in the recently ongoing world economic crisis, many of the traditional economic forecasting models are proved to be wrong. Expectable changes can much better be forecasted, if the extrapolation is supplemented by a synthesis of opinions from experts and key-players of the sector considering the future. In the paper, a model is set up to elaborate logistics trends by the AHP method.

#### 4 - An integrated approach for global supplier selection decision

*Aycan Aytekin*, International Trade, Bogazici University, Hisar Campus Bebek, 34342, Istanbul, Turkey, [ycnaytekin@yahoo.com](mailto:ycnaytekin@yahoo.com), *Arzu Tektas*

Global supplier selection is a significant issue in the competitive international trade environment. The issue is analyzed integrating Analytic Hierarchy Process and Linear Programming (LP). The hierarchy includes criteria like supplier's country risk, competitiveness, international trade characteristics, logistics cost, quality, safety and environmental concern. LP selects the best suppliers to maximize the buyer's total purchasing value. The approach is implemented on a multinational chemical company in Turkey. The results may form a basis for similar studies and applications.

## ■ MA-24

Monday 08:00-09:20

GSI - S 20

### Semi-infinite Optimization

Stream: Semi-Infinite Optimization

*Invited session*

Chair: *Jan-J Ruckmann*, School of Mathematics, University of Birmingham, Edgbaston, B152TT, Birmingham, United Kingdom, [J.Ruckmann@bham.ac.uk](mailto:J.Ruckmann@bham.ac.uk)

#### 1 - A genetic algorithm framework for multilocal optimization

*A. Ismael F. Vaz*, Dept. Production and Systems, University of Minho, School of Engineering, Campus de Gualtar, 4710-057, Braga, Portugal, [aivaz@dps.uminho.pt](mailto:aivaz@dps.uminho.pt), *Lino Costa*

Multilocal optimization is devoted to determine multiple local optima for an optimization problem. A special interest in the computation of global optima is addressed.

We propose an hybrid algorithm that couples a genetic algorithm with a local search quasi-Newton method. A biobjective approach is used to optimize the objective function simultaneously with the gradient norm of the Lagrangian function.

An useful application of such an algorithm is in the context of reduction type methods for semi-infinite programming. Some numerical results will be shown with a set of test problems.

#### 2 - Explicit solution of the lower level problems for the cooling layout optimization in injection molding

*Volker Maag*, Optimization, Fraunhofer-Institut für Techno- und Wirtschaftsmathematik, Fraunhofer-Platz 1, 67655, Kaiserslautern, Germany, [maag@itwm.fhg.de](mailto:maag@itwm.fhg.de), *Karl-Heinz Küfer*

Injection molding is an important mass production procedure. Since the cooling of the mold has an essential influence to the production costs and the product quality, the design of the cooling system must be optimal. The geometric constraints of the problem are complex and of semi-infinite type. Yet, it is possible to model them in such a way that the solution of the lower level problems can be explicitly expressed as a continuously differentiable function. This observation is based on a known generalization of the implicit function theorem and eases solving the problem significantly.

#### 3 - Solving sip by penalty techniques: merit functions and filter method

*Ana I. Pereira*, Polytechnic Institute of Braganca, Campus de Sta Apolonia, Apartado 134, 5301-857, Braganca, Portugal, [apereira@ipb.pt](mailto:apereira@ipb.pt), *Edite M.G.P. Fernandes*

We present a brief review of reduction type methods to solve non-linear semi-infinite programming (SIP) problems. During the last decades a variety of techniques that apply the local reduction theory have been proposed in the literature. Besides the well-known sequential quadratic programming to solve the reduced finite problem, some penalty based techniques have been used with success. In general, they rely on continuous merit functions for SIP. However, the so-called filter method, an alternative to merit functions, has already been tested. Comparisons with both strategies are presented.

## ■ MA-25

Monday 08:00-09:20

GSI - S 25

### Assignment Games

Stream: Cooperative Game Theory

*Invited session*

Chair: *Tamás Solymosi*, Operations Research, Corvinus University of Budapest, Fovam ter 8, 1093, Budapest, Hungary, [tamas.solymosi@uni-corvinus.hu](mailto:tamas.solymosi@uni-corvinus.hu)

#### 1 - A glove market partitioned matrix related to the assignment game

*Marina Nunez*, Economic and Financial Mathematics, University of Barcelona, Av Diagonal, 690, 08034, Barcelona, Spain, [mnunez@ub.edu](mailto:mnunez@ub.edu), *Carles Rafels*

To any assignment market we associate the unique exact assignment game defined on the same set of agents and with a core that is a translation of the core of the initial market. Also the kernel and the nucleolus of an assignment game are proved to be the translation of the kernel and the nucleolus of its related exact assignment game by the vector of minimum core payoffs. Agents on each side of the market are classified by means of an equivalence relation and the equivalent classes partition the matrix of the related exact assignment game into glove markets.

#### 2 - Axiomatizations of the Shapley value on the class of assignment games

*Miklos Pinter*, Mathematics, Corvinus University of Budapest, Fovam ter 13-15., 1093, Budapest, [miklos.pinter@uni-corvinus.hu](mailto:miklos.pinter@uni-corvinus.hu)

We consider various axiomatizations of the Shapley value on the class of assignment games. We conclude that the class of assignment games is a very pathological class from the uniqueness point of view, since except to van den Brink's special characterization, all axiomatizations we consider fail to characterize the Shapley value. As byproducts, we give some examples on the relations between some of the axioms.

#### 3 - Longest paths to the core in assignment games

*Tamás Solymosi*, Operations Research, Corvinus University of Budapest, Fovam ter 8, 1093, Budapest, Hungary, [tamas.solymosi@uni-corvinus.hu](mailto:tamas.solymosi@uni-corvinus.hu)

We consider the problem of computing the buyer-/seller-optimal vertices of the core of an assignment game. Although the proof of Shapley and Shubik (1972) for the existence of these vertices can be easily turned to a computational method, we propose a network approach. We define a directed graph and show that the lengths of the longest paths to its nodes give exactly the minimum core pay-offs to the associated players. We also demonstrate how this characterization can be used in analyzing the sensitivity of the optimal core-allocations to changes in the underlying data matrix.

#### 4 - Symmetrically multilateral-bargained allocations in multi-sided assignment markets

*Oriol Tejada*, passeig joan de borbo 70 3o 3a, 08003, Barcelona, Catalunya, oriol.tejada@ub.edu, *Carles Rafels*

We extend Rochford's (1983) notion of symmetrically pairwise-bargained equilibrium to assignment games with more than 2 sides. A symmetrically multilateral-bargained (SMB) allocation is a core allocation so that any agent is in equilibrium with respect to a negotiation process among all agents based on what every agent could receive in her preferred alternative matching to the optimal matching that is formed. We prove that, for balanced multi-sided assignment games, the set of SMB is always nonempty and that, unlike the two-sided case, it does not coincide in general with the kernel.

### ■ MA-26

Monday 08:00-09:20

GSI - S 35

#### Knapsack Problems

Stream: Discrete Optimization

*Contributed session*

Chair: *Tugba Saraç*, Department of Industrial Engineering, Eskisehir Osmangazi University, Meselik Kampusu, 26480, Eskisehir, Turkey, tsarac@ogu.edu.tr

#### 1 - Meta/exact hybridization to improve intensification in combinatorial optimization problems

*Samir Mahdi*, Compute science, University Mentouri, Constantine. labo MISC, 93 bld pasteur belle vue, 25000, Constantine, Algeria, s.mahdi\_dz@yahoo.fr, *Salim Chikhi*, *Mohamed Batouche*

In this paper we propose to hybridize the metaheuristic MA/PM and B&B to solve combinatorial optimization problems. Our idea is to add in the metaheuristic, an exact method, which has an absolute research power, in order to improve the intensification around the best current solution found by the metaheuristic, during the research. We have realized experiments on well-known benchmarks in the literature of the knapsack problem. The results obtained show the effectiveness of Meta/Exact hybridization.

#### 2 - A cooperative local search-based algorithm for the multiple-scenario max-min knapsack problem

*Abdelkader Sbihi*, Dept. of Information Systems and Aided Decision, Audencia-Nantes School of Management, 8 route de la Jonelière, BP 31222, 44312, Nantes Cedex 3, France, asbihi@audencia.com

The Multiple-Scenario Max-Min Knapsack Problem (MSM2KP) is a variant of the Knapsack Problem. It models situations such that we face many scenarios and the aim is to identify the best one offering a better alternative. Each scenario considers a different item profit with one weight. The aim is to maximize the profit for the worst scenario. Our cooperative method uses a limited-area local search applied in the elite neighborhood and a wide range one applied to perform an improving sequence of path exchange. The results are promising and we show the method efficiency

#### 3 - A clonal selection algorithm for the quadratic multiple knapsack problem

*Tugba Saraç*, Department of Industrial Engineering, Eskisehir Osmangazi University, Meselik Kampusu, 26480, Eskisehir, Turkey, tsarac@ogu.edu.tr, *Berna Ulutas*

Knapsack Problem (KP) is one of the well known combinatorial optimization problems. In this study, we considered a KP called as quadratic multiple knapsack problem (QMKP) with  $k$  knapsacks and quadratic objective function. We proposed a clonal selection algorithm for QMKP. The performance of the developed algorithm is evaluated and the obtained results are compared with the previous studies in the literature.

### ■ MA-27

Monday 08:00-09:20

GSI - S 21

#### Hinterland Transportation

Stream: Container Terminal Operations

*Invited session*

Chair: *Koichi Shintani*, Department of Shipping Technology, Oshima National College of Maritime Technology, 1091-1 Komatsu, Suo-oshima, 7422193, Oshima, Yamaguchi, Japan, shintani@oshima-k.ac.jp

#### 1 - Multiple berth allocation problem

*Hossein Jula*, Electrical Engineering, Penn State Harrisburg, W-256 Olmsted Bldg., 777 Harrisburg Pike, 17057, Middletown, PA, hjula@psu.edu, *Hwan Chang*, *Anastasios Chassiakos*, *Petros Ioannou*

When, under some predicted or unpredicted scenarios, a calling vessel cannot moor at its home berth location, other berth locations (within the same terminal or adjacent terminals) may accommodate the vessel. This leads to a more complex variant of the Berth Allocation Problem (BAP) which, in this paper, is referred to as the multiple Berth Allocation Problem (mBAP). This paper presents a heuristic solution methodology for the mBAP. Several experimental scenarios are generated to evaluate the proposed solution methodology for the mBAP.

#### 2 - The impact of foldable containers on empty container management

*Koichi Shintani*, Department of Shipping Technology, Oshima National College of Maritime Technology, 1091-1 Komatsu, Suo-oshima, 7422193, Oshima, Yamaguchi, Japan, shintani@oshima-k.ac.jp, *Rob Konings*, *Akio Imai*

This paper analyzes the possibility of foldable container usage in order to save container repositioning costs. Integer programming models are employed to find the optimal empty container repositioning in order to calculate the costs. The study finds that the foldable containers substantially save the repositioning costs, compared to standard containers. It is also shown that comparative advantages of the foldable containers depend on container traffic situations such as empty transfer distance, degree of trade imbalance, etc.

## ■ MA-28

Monday 08:00-09:20

GSI - S 1

### Financial Optimization 1

Stream: Financial Optimization

*Invited session*

Chair: *J. E. Beasley*, CARISMA, Brunel University, Department of Mathematical Sciences, Kingston Lane, UB8 3PH, Uxbridge, Middlesex, United Kingdom, john.beasley@brunel.ac.uk

#### 1 - Collapses of global financial institutions in 2008 and their risk management practices

*Chaiho Kim*, OMIS Department, Santa Clara University, 500 El Camino Read, 95070, Santa Clara, CA, United States, ckim@scu.edu

Many of the world's leading investment banks have collapsed in 2008. This paper will examine some of the major factors which led to their failures with emphasis on their risk management practices. The paper will identify those risks which turned out to be most critical and yet their risk management practices led them to brush them off as being not important. The findings will be based not only on newspapers and other publications but also reviews of 2008 annual reports and other SEC filings such as 10K and 8K of the companies.

#### 2 - Empirical analysis of online algorithms for multiple trading problems

*Günter Schmidt*, Saarland University, Box 151150, 66041, Saarbrücken, Germany, gs@itm.uni-sb.de, *Esther Mohr*

We suggest different active trading algorithms which try to solve this type of problem. Their effectiveness is analyzed from a worst case and an average case point of view. We compare average case and worst case bounds using simulation on historical data for the past ten years. We give an answer to the questions how parameters effect the quality of the algorithms and if they show a superior behaviour to buy-and-hold policies.

#### 3 - Corporate structure optimisation for multinational companies

*J. E. Beasley*, CARISMA, Brunel University, Department of Mathematical Sciences, Kingston Lane, UB8 3PH, Uxbridge, Middlesex, United Kingdom, john.beasley@brunel.ac.uk

We consider a multinational tax planning problem that involves designing a corporate structure (across different countries) so as to remit profits from a number of subsidiaries to a single parent company, whilst minimising the tax paid (maximise the amount received at the parent company). This corporate structure is constrained to be a (directed) tree structure. We present a nonlinear mixed-integer zero-one formulation that is linearisable as well as a tabu search algorithm. Computational results are given for both the optimal and heuristic solution of publicly available test problems.

## ■ MA-29

Monday 08:00-09:20

GSI - S 2

### Dealing with uncertainty in long-term electricity planning

Stream: Energy and Emission Markets

*Invited session*

Chair: *Efraim Centeno Hernández*, Instituto de Investigación Tecnológica, Universidad Pontificia Comillas, Santa Cruz de Marcenado 26, 28015, Madrid, Spain, efraim.centeno@upcomillas.es

#### 1 - Bilevel optimization analysis of electricity generation capacity expansion

*Efraim Centeno Hernández*, Instituto de Investigación Tecnológica, Universidad Pontificia Comillas, Santa Cruz de Marcenado 26, 28015, Madrid, Spain, efraim.centeno@upcomillas.es

A bilevel optimization model to analyze the decision of building new power plants from the point of view of a generation company based on its profitability is proposed. Upper level includes profit as objective function and lower level represents electricity spot market behaviour using a conjectured variation schema. This schema is an extension of Nash-Cournot market equilibrium and allows representing different degrees of competition in the market.

#### 2 - Generation capacity expansion under long-term uncertainties in the us electric market

*Sabine Goutier*, OSIRIS, EDF R&D, 1 AVENUE DU GENERAL DE GAULLE, 92140, CLAMART, sabine.goutier@edf.fr, *Julian Bouchard*, *Alexandre Klein*

In this paper, we deal with generation capacity expansion under long-term uncertainties regarding fuel prices and CO<sub>2</sub> emissions regulation. We present a model based on stochastic dynamic programming which gives optimal generation investment planning for perfectly competitive power markets. Using DOE's fuel price scenarios, we show that taking into account uncertainties on fuel costs and on CO<sub>2</sub> emissions regulation can change the optimal investment decisions. Moreover, we show that, for generators, the level of risk-aversion is a major factor influencing the investment decisions.

#### 3 - Assessing energy storage value for power systems with a large penetration rate of intermittent renewables

*Julien Martin*, R&D OSIRIS, EDF, 1 ,av. du général De Gaulle, 92141, Clamart, julien2.martin@edf.fr

This paper focuses on modeling issues to study the interest of utility companies for energy storage capacities/capabilities on a prospective "low-carbon electricity" scenario.

Within the 2030-2050 timeframe, the massive integration of intermittent renewables may affect system reliability by increasing difficulties to balance supply and demand while respecting physical constraints. A major objective/stake is to quantify which difficulties could appear and which technological solutions should be targeted and combined to supply extra-flexibility required to deal with renewables intermittency.

#### 4 - Tools for long term strategic spanish electricity sector analysis.

*Jose Villar*, Instituto de Investigacion Tecnologica, Universidad Pontificia Comillas, Alberto Aguilera 23,

Madrid, 28015, Madrid, Spain,  
jose.villar@iit.upcomillas.es

MORSE is a set of tools developed for Endesa, for long term analysis of the Spanish electricity sector. It models its main business, such as electricity pool, commercialization, regulated activities, etc, and computes the yearly accumulated deficit of the sector. Pool is solved with a supply function market equilibrium computed by EQUITEC, where GENCO's are represented by technologies. EQUITEC computes agent conjectures assuming linearity and robustness near equilibrium, and has a Montecarlo version for statistical outputs. MORSE includes a genetic solver to attain predefined targets.

## ■ MA-30

Monday 08:00-09:20

GSI - S 26

### Dynamic Programming II

Stream: Dynamic Programming

Invited session

Chair: *Lidija Zadnik Stirn*, Biotechnical Faculty, University of Ljubljana, Vecna pot 83, 1000, Ljubljana, Slovenia, Slovenia, lidija.zadnik@bf.uni-lj.si

#### 1 - Structuring new product development (npd) pipelines considering resource constraints

*Yu Xiong*, University of York, The York Management School, Sally Baldwin Buildings, Heslington, YO10 5DD, York, North Yorkshire, yx515@york.ac.uk,  
*Kiran Fernandes*

This paper investigates two key issues within the New Product Development process, viz.: How to allocate resources to multiple pipelines and then to multiple stages of a single pipeline with a constrained budget. Existing literature has focused on increasing the likelihood of having at least one successful product in a pipeline but has not considered the balance of achieving maximum probability of success with a given budget constraint. We present a normative model (dynamic programming) for structuring pipelines for resource constrained situation.

#### 2 - Multiple criteria decision analysis within a dynamic environmental system

*Lidija Zadnik Stirn*, Biotechnical Faculty, University of Ljubljana, Vecna pot 83, 1000, Ljubljana, Slovenia, Slovenia, lidija.zadnik@bf.uni-lj.si

To solve a multicriteria and long term management problem of an environmental system, a discrete dynamic and multicriteria decision support model (DSM) is generated. SWOT analysis and AHP/ANP (eigenvalue and DEA procedure) are employed to evaluate conflicting objective functions. Then, states, decisions, weighted values of objective functions and networks are used to determine the optimal policy by Bellman's iteration method within a sequential decision process. To illustrate the developed DSM, computational experiences from the field of natural resources are presented.

## ■ MA-31

Monday 08:00-09:20

GSI - S 34

### Discovery of patterns in data

Stream: Data Mining

Contributed session

Chair: *Takeaki Uno*, National Institute of Informatics(NII), 101-8430, Tokyo, Japan, uno@nii.co.jp

#### 1 - Mining the most representative models of patient care process with process mining methodology

*Hongying Fei*, Production and Operations Management, FUCAM (Catholic University of Mons), 151 chaussee de binche, 7000, Mons, Belgium, fei@fucam.ac.be, *Nadine Meskens*

In order to construct a process model for the purpose of evaluating and developing the care processes for a specific set of patients, we apply the process mining to this study to extract the most representative model of patient care process from a set of event data collected from a Belgian University Hospital. Instead of proposing a tool for designing processes, the main idea is to use the discovered process model as an objective start point to deploy systems that support care processes or as a feed-back mechanism to check if the prescribed clinical pathways can fit the executed ones.

#### 2 - High speed pattern mining for huge data - algorithm and implementation -

*Takeaki Uno*, National Institute of Informatics(NII), 101-8430, Tokyo, Japan, uno@nii.jp

Frequent pattern mining is the problem of finding all the frequently appearing patterns from huge databases, and is a central problem of data mining. We here present fast algorithms while straightforward algorithms need quite long time. We approached from the theoretical enumeration algorithm techniques, and developed several algorithms including one got the best award in an academic international competition. We briefly explain the techniques and the performance of the algorithms. The implementations are available at the author's home page (<http://research.nii.ac.jp/uno/>).

#### 3 - A new algorithmic method for telecom event correlation using association rule mining

*Behrad Analui*, #500, 7th Floor, Entrance 13, Block A4 ,EKBATAN Residential Area, 1394743999, Tehran, Iran, Islamic Republic Of, behrad.analui@gmail.com

Event Correlation is a technique to examine relations between events received from different elements in telecom network in order to find and isolate the root cause and reduce the down time. For this purpose usually a set of rules is defined and applied to the coming events. In this paper we propose a new algorithmic method for defining rule sets based on association rule mining of historical events store in a database. This method is especially beneficial when applied to a large multi-vendor telecom network where adding a new element from a new vendor results in changing the whole rule set.

## ■ MA-32

Monday 08:00-09:20

GSI - S 4

### Banking

Stream: Financial Modelling

Contributed session

Chair: *Andreas Georgiou*, Department of Business Administration, University of Macedonia, 156 Egnatia Street, 54006, Thessaloniki, Greece, acg@uom.gr

#### 1 - Introducing a modified qfd design for quality improvement in the greek banking sector

*Andreas Georgiou*, Department of Business Administration, University of Macedonia, 156 Egnatia Street, 54006, Thessaloniki, Greece, acg@uom.gr,

*Katerina Gotzamani, Andreas Andronikidis, George Paltayian*

Over the past two decades, advances in technology and a movement in global politics away from central control of economies initiated changes that continue to take place in the banking industry. In this respect the Greek banking system is also characterized by increased competition. We step on the Quality Function Deployment framework to detect and translate bank customers' needs into goals and present three houses of quality structuring the model. Then, we discuss initial results obtained by a field research that aimed to capture the importance of the criteria used in the first house.

## 2 - Optimal centralisation of liquidity management

*Christian Schmaltz, CPQF, Frankfurt School of Business, Sonnemannstr. 9-11, 60314, Frankfurt, Germany, c.schmaltz@kdb.eu, Sebastian Pokutta*

Large banking groups face the question of optimally generating and allocating liquidity: in a central liquidity hub or in decentralized nodes. We rephrase the question as a production problem under uncertainty with time zone gaps. As expected, in a deterministic setup liquidity should be managed centrally. However, under stochastic liquidity demand and different time zones, we find that liquidity is preferably managed and generated decentrally to a certain extend. The corresponding tradeoff threshold is a function of the volatility and the characteristics of the bank network.

## 3 - Bank loan loss provision decisions: empirical analysis of taiwan's banks

*Tsai Lien Yeh, International Business, Ming Chuan University, 2F, No. 9, Lane 17, Yung-Kang St., Taipei, Taiwan, 10650, R.O.C., 10650, Taipei, Taiwan, tlyeh@mail.mcu.edu.tw*

By adopting the stochastic frontier model, this study examines the efficiency frontier of loan loss provision (LLP) in the Taiwan banking industry. The determinants of the inefficiency LLP are also analyzed. The results are: 1. LLP estimation is significantly and positively correlated with loan loss, risky loans and total loans. 2. Larger banks are more concerned with setting an appropriate level of LLP than smaller banks in order to maintain stable long term income and meet capital adequacy requirements. 3. Banks with higher non-interest expenses also manage LLP inefficiently.

## ■ MA-33

Monday 08:00-09:20

GSI - S 7

### Applications of Operations Research in Mining

Stream: Mining

*Invited session*

Chair: *Doreen Thomas, Mechanical Engineering, University of Melbourne, Melbourne, 3010, Melbourne, Victoria, doreen.thomas@unimelb.edu.au*

#### 1 - Using lagrangean relaxation of resource constraints for open pit mining production scheduling

*Ambros Gleixner, Optimization, Zuse Institute Berlin (ZIB), Takustr. 7, 14195, Berlin, Germany, gleixner@zib.de*

We consider a mixed-integer programming formulation for the open pit mining production scheduling problem with block processing selectivity and demonstrate the use of lagrangean relaxation of the resource constraints in several ways: rapid computation of dual bounds provably as strong as given by the linear programming relaxation, determining approximate cutoff grades, model aggregation and effective heuristics for finding near-optimal solutions.

#### 2 - Determining the transition from open pit to underground mining

*Alexandra Newman, Division of Economics and Business, Colorado School of Mines, 1500 Illinois Street, 80401, Golden, CO, United States, newman@mines.edu, Candace Yano*

Extraction of an ore body can start as an open pit and may continue underground. Although tactical mine schedules often involve production blocks, we consider longer-term decisions of strata (i.e., many blocks at the same height). We specify which strata to mine above ground and when to mine these strata, when to begin installation of underground infrastructure, and which strata should be mined underground and when. We show how this integer program can be transformed into a series of networks, and present numerical results for a mine in South Africa using various discount rates.

#### 3 - Strategic design of underground mine access, a gilbert arborescence problem

*Doreen Thomas, Mechanical Engineering, University of Melbourne, Melbourne, 3010, Melbourne, Victoria, doreen.thomas@unimelb.edu.au*

We investigate the problem of designing a minimum cost flow network interconnecting  $n-1$  sources and a single sink, each with known locations and flows. The network may contain additional nodes, known as Steiner points. We show that for concave increasing cost functions, a minimum cost network of this sort has a tree topology, and hence can be called a Minimum Gilbert Arborescence (MGA). We characterise the local topological structure of Steiner points in MGAs for linear cost functions. This problem has applications to the design of drains, gas pipelines and underground mine access.

## ■ MA-34

Monday 08:00-09:20

GSI - S 8

### II Application of Fuzzy Logic & Real Options to Corporate Management Decision-Making

Stream: Application of Fuzzy Logic & Real Options to Corporate Management Decision-Making

*Invited session*

Chair: *Christer Carlsson, IAMSR, Abo Akademi University, DataCity B6734, 20520, Turku, Finland, christer.carlsson@abo.fi*

#### 1 - Optimal staged expansion of a municipal wastewater plant using option theory

*Yuri Lawryshyn, Department of Chemical Engineering and Applied Chemistry, University of Toronto, 200 College Street, M5S 3E5, Toronto, Ontario, yuri.lawryshyn@utoronto.ca, Sebastian Jaimungal*

We consider a municipality faced with the question of how big to make their new wastewater treatment facility to meet the demand of 10% expected growth in the number of new connections. Previously, we developed a real options framework for determining optimal plant size and showed that the model takes on the form of an Asian option. In this study, we introduce an approximate analytical solution and optimize both plant size and timing of a staged expansion. Simulations are presented to quantify the risk of the different strategies.

## 2 - Fuzzy pay-off method for real option valuation

*Mikael Collan*, Institute for Advanced Management Systems Research, Åbo Akademi University, Lemminkäisenkatu 14 B 6th floor, 20520, Turku, Finland, mcollan@abo.fi

Real option analysis offers interesting insights on value of assets and on profitability of investments, which has made real options a growing field of academic research and practical application. This paper presents a new method for real option valuation from fuzzy numbers that is based on findings from earlier real option valuation methods and from fuzzy real option valuation. The method is intuitive to understand and far less complicated than any previous real option valuation model to date.

## ■ MA-35

Monday 08:00-09:20

GSI - S 9

### Facilitated Decision Analysis

Stream: Facilitated Modelling Interventions

*Invited session*

Chair: *Simon French*, Manchester Business School, University of Manchester, Booth Street West, M15 6PB, Manchester, United Kingdom, simon.french@mbs.ac.uk

#### 1 - Developing MCDM tools for research project assessment

*Theodor Stewart*, Statistical Sciences, University of Cape Town, Upper Campus, 7701, Rondebosch, South Africa, theodor.stewart@uct.ac.za, *K. Nadia Papamichail*

The aim of this paper is to explore how decision analysts design and deliver decision workshops. We present a case study that discusses a decision making process unfolding in a research funding council in South Africa. A series of decision workshops was organised to develop MCDM tools for assessing research project applicants. Lessons learned and reflections on the study are presented.

#### 2 - Extending the use of scenario planning and mcda: an application to food security in trinidad & tobago

*Camelia Ram*, Operational Research Group, London School of Economics, Houghton Street, WC2A 2AE, London, c.ram@lse.ac.uk, *Gilberto Montibeller, Alec Morton*

One way of coping with strategic uncertainty is exploring challenging futures or scenarios. There has been extensive research into how formal evaluation of strategic options given scenarios might be carried out in practice, but typically small numbers of scenarios are used. This paper presents a technique for efficiently developing a larger cohort of variable, qualitatively defined scenarios; and investigates how a multi-criteria framework can be applied to measure robustness. The technique is implemented through a case study of food security in Trinidad & Tobago in the next eight years.

#### 3 - Facilitated decision conferences in public participation:

*Simon French*, Manchester Business School, University of Manchester, Booth Street West, M15 6PB, Manchester, United Kingdom, simon.french@mbs.ac.uk

"You are charged with over-enthusiastic application of facilitated stakeholder workshops in the context of public participation. How do you plead?" "Guilty!" Driven by political imperatives to reduce a democratic deficit, there have been many applications of facilitated workshops in public participation to help public bodies shape and make societal decisions. In this paper I will discuss their use of from the perspective of my experience and explain my concerns. I will argue that we need to evaluate our work in public participation much more scientifically than we have up until now.

## ■ MA-36

Monday 08:00-09:20

GSI - S 11

### Stochastic Control in Finance II

Stream: Optimal Control in Finance and Insurance

*Invited session*

Chair: *Nicole Baeuerle*, Institute for Mathematical Stochastics, University of Karlsruhe, Englerstr. 2, 76128, Karlsruhe, Germany, baeuerle@stoch.uni-karlsruhe.de

#### 1 - Asset allocation and liquidity breakdowns

*Peter Diesinger*, Department of Mathematics, University of Kaiserslautern, Erwin-Schrödinger-Straße, 67663, Kaiserslautern, Germany, diesinger@mathematik.uni-kl.de, *Holger Kraft, Frank Thomas Seifried*

We analyze the portfolio decision of an investor facing the threat of illiquidity, where illiquidity is understood as a state of the economy in which the investor is not able to trade at all. The efficiency loss due to illiquidity is addressed and quantified. For general utility functions, we show that the value function of a model in which only finitely many liquidity breakdowns can occur converges uniformly to the value function of a model with infinitely many breakdowns. The results are illustrated for an investor with a power utility function.

#### 2 - Impulse control of credit portfolios

*Roland Seydel*, MPI for Mathematics in the Sciences, Inselstrasse 22, 04103, Leipzig, seydel@mis.mpg.de, *Ruediger Frey*

In our talk, we present a case study of a bank in a Markov-switching economy that can reduce its loan exposure by discrete impulses. We start with a short introduction into the model and its real-world background. The value function of impulse control is associated with the (viscosity) solution of a PDE called quasi-variational inequality (QVI). This QVI is solved numerically, and practical insights and conclusions from the numerical results are discussed.

#### 3 - Investment, income, and incompleteness

*Holger Kraft*, Goethe-University, Frankfurt am Main, Germany, assetpricing@finance.uni-frankfurt.de

The utility-maximizing consumption and investment strategy of an individual investor receiving an unspanned labor income stream seems impossible to find in closed form and very difficult to find using numerical solution techniques. We suggest an easy procedure for finding a simple and admissible consumption and investment strategy which is near-optimal. We first explain and implement the strategy in a simple setting with constant interest rates, a single risky asset, and an exogenously given income stream, but we also show that the success of the strategy is robust.

#### 4 - Optimal investment in the foreign exchange market with proportional transaction costs

*Luitgard Veraart*, Department of Mathematics, Institute for Stochastics, University of Karlsruhe, Kaiserstr. 89, 76133, Karlsruhe, veraart@stoch.uni-karlsruhe.de

We consider an investor in the foreign exchange market who can trade in two currencies, domestic and foreign. The investor seeks to optimise the expected mark-to-market value of the portfolio while aiming for a certain target proportion of the holdings in foreign currency compared to total wealth. This target proportion is exogenously given and can be thought of a constraint imposed by risk management. The exchange rate is modelled as a geometric Brownian motion. Proportional transaction costs are charged. We present a numerical algorithm which solves the resulting free boundary problem.

## ■ MA-37

Monday 08:00-09:20

GSI - S 12

### Revenue and Demand Management

Stream: Revenue Management

*Invited session*

Chair: *Catalina Stefanescu*, Management Science and Operations, London Business School, Regent's Park, NW14SA, London, cstefanescu@london.edu

Chair: *Houyuan Jiang*, Judge Business School, University of Cambridge, Trumpington Street, CB2 1AG, Cambridge, United Kingdom, h.jiang@jbs.cam.ac.uk

#### 1 - Multivariate demand: modeling and estimation from censored sales

*Catalina Stefanescu*, Management Science and Operations, London Business School, Regent's Park, NW14SA, London, cstefanescu@london.edu

Current practice focuses on univariate demand forecasting, but in many industries there is evidence of correlated product demand. We propose a class of models for multi-product multiperiod aggregate demand forecasting, and develop an approach for estimating the parameters from censored sales data. We show that the algorithm is computationally attractive under different demand and censoring scenarios. We analyze two booking data sets from the entertainment and the airline industries, and show that these models increase the revenue by up to 11% relative to alternative forecasting methods.

#### 2 - Choose-and-book: an electronic outpatient appointment system

*Houyuan Jiang*, Judge Business School, University of Cambridge, Trumpington Street, CB2 1AG, Cambridge, United Kingdom, h.jiang@jbs.cam.ac.uk, *James Z. Pang*, *Sergei Savin*

Choose and Book is a national electronic referral system for outpatient appointments in England. The system gives patients a choice of appointment service provider, date and time. Choose and Book is instrumental in helping to measure and manage 18-weeks' pathways for patients. We have identified a simple threshold policy and prove that this simple policy is optimal. We study monotone properties and comparative statics. To the best of our knowledge, our study is the first attempt to address time slots allocation for Choose and Book systematically in a quantitative framework.

#### 3 - Consumer choice modelling inputs into airline revenue management applications

*Tim Ryley*, Department of Civil & Building Engineering, Loughborough University, Loughborough, Leicestershire, LE11 3LU, Loughborough, T.J.Ryley@lboro.ac.uk

Stated choice models have been developed from air travel household surveys in the East Midlands region of the UK; the focus is on leisure trips using low-cost airlines, and an aviation industry facing economic and environmental challenges. Logit-based models are estimated from a range of air travel attributes: fare, departure/arrival time, car parking charge, and a flight energy rating. Model outputs, such as forecasts using cost and time scenarios, across different consumer segments, are presented. These results can be input into more consumer-focused airline revenue management applications.

#### 4 - Aggregating algorithm for pricing and capacity planning under uncertain demand

*Tatsiana Levina*, School of Business, Queen's University, 143 Union str, K7L 3N6, Kingston, Ontario, Canada, tlevin@business.queensu.ca, *Yuri Levin*, *Mikhail Nediak*, *Vladimir Vovk*

We study the problem of pricing and stocking of perishable items when demand and the reservation price distributions are unknown. The company learns consumer demand through successive observations over consecutive planning horizons, views the problem as a game against nature and applies Aggregating Algorithm to find the policies which are asymptotically optimal in the long run. The proposed methodology is general and independent of the form of the distributions.

## ■ MA-38

Monday 08:00-09:20

GSI - S 13

### Bilevel Programming

Stream: Variational Inequalities and Bi-Level Problems

*Invited session*

Chair: *Stephan Dempe*, Mathematics and Computer Sciences, Technische Universität Freiberg, 09596, Freiberg, Germany, dempe@math.tu-freiberg.de

#### 1 - Fuzzy necessary optimality conditions for bilevel set optimization problems

*Nazih Abderrazzak Gadhi*, Department of Mathematics Dhar Em Mehrez, Sidi Mohammed ben Abdellah University, B.P. 3536 Marrakech Amerchich, 40000, Marrakech, ngadhi@hotmail.com, *Stephan Dempe*

In this paper, using an extremal principle introduced by Morukhovich, we establish optimality conditions for a bilevel set valued optimization problem. Intermediate set valued optimization problems are introduced to help us in our investigation.

#### 2 - The pessimistic approach for a bilevel problem with linear lower level

*Sebastian Lohse*, Institut für Num. Mathematik und Optimierung, TU Bergakademie Freiberg, 09596 Freiberg, 09599, Freiberg, lohses@math.tu-freiberg.de

We consider a bilevel programming problem with linear lower level and with a special structure of the set of parameters — one set of right-hand-side parameters and one set of objective function parameters. At first it is shown, that a global pessimistic solution always exists even without lower semicontinuity of the optimal solution mapping. Examples will prove, that our assumptions are necessary. In the second part an algorithm is presented under additional assumptions using an idea of Fukuda and Terlaky for vertex enumeration of a polyhedron.

### 3 - Feasible direction method for bilevel programming problem

*Ayalew Mersha*, Mathematics and Informatics, TU Freiberg, Am Mühlteich 6, 09599, Freiberg, Sachsen, ayalew@math.tu-freiberg.de

In this talk, we investigate the application of feasible direction method for an optimistic nonlinear bilevel programming problem. The convex lower level problem of an optimistic nonlinear bilevel programming problem is replaced by relaxed KKT conditions. The feasible direction method developed by Topkis and Veinott is applied to the auxiliary problem to get a Bouligand stationary point for an optimistic bilevel programming problem.

### 4 - A bilevel matroid problem

*Diana Fanghaenel*, Institut für Informatik, Universität zu Köln, Pohligstr. 1, 50969, Köln, Germany, fanghaenel@informatik.uni-koeln.de

We investigate a bilevel matroid problem, where a matroid is given and different weight vectors for the decision makers. At this, the follower determines an independent set of the matroid with maximum weight. The leader's weight of this independent set gives the objective function value of the leader. To influence the chosen independent set, the leader can increase the weights of the follower, but in return for the increase he has to pay a penalty. We want to present solution algorithms to determine the optimal decision of the leader for several matroids.

## ■ MA-39

Monday 08:00-09:20

GSI - S 14

### Game Theory 1

Stream: Game Theory

*Contributed session*

Chair: *Jirka Poropudas*, Systems Analysis Laboratory, Helsinki University of Technology, P.O. Box 1100 FIN, 02015 HUT Finland, 02015, Espoo, Finland, jirka.poropudas@tkk.fi

#### 1 - Goal programming to model fairness concerns in cooperation

*Nerda Zura Zaibidi*, Mathematics, University of Portsmouth, Computing and Mathematics, Lion Gate Building, University of Portsmouth, PO1 3HF, Portsmouth, United Kingdom, Nerda.Zaibidi@port.ac.uk, *Patrick Beullens*, *Dylan Jones*

In decision problems about cooperation between independent players, we have to consider how each player will fare under the cooperation. In a Goal Programming (GP) framework, a set of goals for each player can be considered but modelling the relative importance of each player is less straightforward as no general agreement between the players may present itself. In this paper, this problem is dealt with by incorporating explicitly in the GP model each player's opinion about fairness. Solutions of this GP model offers predictions about which strategies will likely to gain overall acceptance.

#### 2 - Game theoretic metamodels in simulation analysis of air combat

*Jirka Poropudas*, Systems Analysis Laboratory, Helsinki University of Technology, P.O. Box 1100 FIN, 02015 HUT Finland, 02015, Espoo, Finland, jirka.poropudas@tkk.fi, *Kai Virtanen*

We present the statistical estimation of game theoretic metamodels from discrete event simulation data depicting a system with an inherent game setting where multiple players try to achieve their own objectives. The estimated games are used in interpretation of the simulation data as well as in sensitivity and what-if analyses. Furthermore, the games are applied to optimization of simulation output. In an example analysis, game theoretic metamodels are used both to validate an air combat simulation model and to compare air combat tactics and hardware systems.

#### 3 - Do relative payoffs matter in contests? an experimental analysis

*Nicole Becker*, Ruhr Graduate School in Economics, c/o TU Dortmund, Wirtschafts- und Sozialwissenschaftliche Fakultät, Volkswirtschaftslehre (Mikroökonomie), 44221, Dortmund, Germany, Nicole.Becker@uni-dortmund.de, *Sina Risse*

We study the influence of social preferences on contest outcomes in an experiment. First we use the decomposed game technique to directly classify the players according to their social values. In a second step subjects are randomly matched to engage in a two-player contest. In more competitive environments spiteful behaviour should be more pronounced. Therefore, subjects also participate in a contest with four players. Theory predicts that anti-social preferences increase equilibrium efforts. This may serve as an explanation for the commonly known overdispersion paradox in contests.

## ■ MA-40

Monday 08:00-09:20

GSI - S 27

### Development and Economy

Stream: OR for Development and Developing Countries

*Invited session*

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

#### 1 - Network organisation

*Katarzyna Grzybowska*, Institute of Management Engineering, Poznan University of Technology, ul. Strzelecka 11, 60-965, Poznan, Poland, katarzyna.grzybowska@put.poznan.pl, *Agnieszka Ponikierska*

A trend to create groups of enterprises can be observed; whose model of operation makes use of assets of large, SMEs companies. It is a higher level of organisational changes. This trend is described as network organisation. It can be defined as relatively lasting connection of autonomous and specialised units or enterprises. Such an approach is based on establishing strategic alliances between partners within a supply chain. Long term partnership are signed between suppliers and customers. It also allows for gaining knowledge of technologies used by the partners, exchange of experience.

#### 2 - Will security culture deliver between organizations?

*Ke-Wei Tseng*, National Chung Hsing University, National Chung Hsing University 250, Kuo Kuang Rd., Taichung 402, 886, Taichung, Taiwan, ligreen0122@yahoo.com.tw, *Ming-Chih Tsai*

This study aims to clarify how supply chain collaboration affects the organizational security culture of supply chain members. Variables of institutional theory and security culture evolution are employed to be the interorganizational driving factors and the inside organizational effects. Social exchange theory will be used as the bridge to connect the interorganizational cause and the intraorganizational change. The relationships between the cause and effect are tested herein. The results indicate what culture change firms will make under certain supply chain collaborative factors.

## ■ MA-41

Monday 08:00-09:20

GSI - S 28

### OR in Agriculture and Forest Management I

Stream: OR in Agriculture and Forest Management

*Invited session*

Chair: *Lluís M Pla*, Mathematics, University of Lleida, Jaume II, 73, 25001, Lleida, Spain, [impla@matematica.udl.es](mailto:impla@matematica.udl.es)

#### 1 - Modelling classical swine fever spread using a spatial hybrid model

*Benjamin Ivorra*, Matemática Aplicada, Universidad Complutense de Madrid, Plaza de ciencias, 3, 28040, Madrid, Spain, [ivorra@mat.ucm.es](mailto:ivorra@mat.ucm.es), *Angel Manuel Ramos*, *Beatriz Martínez-Lopez*, *Jose Manuel Sánchez-Vizcaino*

Classical swine fever (CSF) is a highly contagious viral disease of pigs that causes severe commercial restrictions to the affected countries. During this talk, we introduce a spatial hybrid model (SHM) developed for the spread of CSF. It is based on the combination of a stochastic 'Individual Based' model (modelling the farm to farm evolution of the spread), with a deterministic 'SIR' model (modelling the intra-farm evolution of the spread). The parameters of the models are estimated using real data. The SHM is validated and results are compared to those obtained with other models.

#### 2 - Incorporation of clinical signs for characterization of individual sows in the sow replacement problem.

*Sara Verónica Rodríguez-Sánchez*, Mathematics, University of Lleida, 25001, Lleida, Spain, [srodriguez@matematica.udl.cat](mailto:srodriguez@matematica.udl.cat), *Tina Jensen*, *Lluís Miquel Pla*, *Anders Kristensen*

The current high mortality in Danish sow herds is not only regarded as an economical problem, but also a significant animal welfare problem. Coping with the increased mortality is therefore given high priority. The aim of this study is to incorporate a weak sow Index (WSI) used to characterize clinical signs into an existing sow replacement model thus taking the clinical signs into account when optimal replacement policies are determined. The effects of the WSI on the optimal replacement policies will be studied, and the economic value of the individual clinical observations will be calculated.

#### 3 - A two-stage stochastic program for planning production in breeding farms

*Lluís Miquel Pla*, Mathematics, University of Lleida, Fac. Dret i Economia, Jaume II, 73, 25001, Lleida, [impla@matematica.udl.cat](mailto:impla@matematica.udl.cat), *Sara Verónica Rodríguez-Sánchez*, *Victor Alborno*

This paper presents a two-stage stochastic program with recourse for breeding farms. The proposed model considers a medium-term planning horizon and specifically allows an optimal replacement and schedule of purchases to be obtained for the first stage. This model takes into account the uncertainty present in some parameters, such as litter size, mortality and fertility, explicitly incorporated via a finite set of scenarios. The proposed model is solved by using the algebraic modelling software OPL Studio, in combination with the solver CPLEX to solve the different instances considered.

## ■ MA-42

Monday 08:00-09:20

GSI - S 3

### Optimal Control III

Stream: Optimal Control

*Invited session*

Chair: *Shahlar Maharramov*, math, Yasar university, Selcuk yasar camp, Univers.str, No:35-37, Bornova, 35500, Izmir, Izmir, Turkey, [shahlar.maharramov@yasar.edu.tr](mailto:shahlar.maharramov@yasar.edu.tr)

#### 1 - Stochastic optimal control and stochastic dnss sets: exemplified by a model of illicit drug markets

*Roswitha Bultmann*, Institute for Mathematical Methods in Economics (IWM), Research Unit for Operations Research and Nonlinear Dynamical Systems (ORDYS), Vienna University of Technology, Argentinierstr. 8/105-4, A-1040, Vienna, [bultmann@tuwien.ac.at](mailto:bultmann@tuwien.ac.at), *Gernot Tragler*

Skiba or DNSS sets are an important characteristic of many deterministic optimal control models. They may occur if the optimized system exhibits multiple equilibria. However, multiple equilibria and DNSS sets in stochastic optimal control models have hardly been studied so far. By taking well-known deterministic models that exhibit history dependence as our starting point and reformulating these models in a stochastic setting, we are able to get a better understanding of stochastic DNSS sets and their properties. We illustrate our findings by a model of illicit drug markets.

#### 2 - Indifference prices for CO2 emission allowances

*Olivier Davidau*, Center for Applied Mathematics, Mines Paristech, Rue Claude Daunesse - B.P. 207, 06904, Sophia Antipolis Cedex, France, [olivier.davidau@cma.ensmp.fr](mailto:olivier.davidau@cma.ensmp.fr), *Mireille Bossy*, *Nadia Maïzi*, *Pourtallier Odile*

An electricity producer involved in the European Emission Trading Scheme has to estimate the price under which he decides to buy allowances. His preferences are represented by an utility function of his terminal wealth which he tries to maximize in an uncertain environment. If his emissions during the period exceeds his allowances he has to pay a tax. So we have to resolve a stochastic control problem, the control of the producer being the amount of electricity he produces. The uncertainty factors arise from the stochastic structure of electricity prices which produces spikes.

## ■ MA-43

Monday 08:00-09:20

GSI - S 10

### Portfolio and Risk Management 1

Stream: Long Term Financial Decisions

*Invited session*

Chair: *Ettore Croci*, Faculty of Economy, Dipartimento di Science, University of Milan-Bicocca, 20126, Milan, Italy, [ettore.croci@unimib.it](mailto:ettore.croci@unimib.it)

### 1 - Optimal asset allocation and sharing rule for pension funds with stochastic force of mortality and demographic assets

Francesco Menoncin, Economics, Brescia University,  
Via S. Faustino, 74/B, 25122, Brescia, Italy,  
menoncin@eco.unibs.it

We study both the optimal asset allocation and the optimal share of performances for a pension fund which operates in a complete financial market where the prices of risky assets are driven by some stochastic state variables. Furthermore, we take into account a stochastic force of mortality whose risk (i.e. both mortality and longevity risk) can be hedged through a demographic asset as a derivative on this force of mortality. The framework is useful for both a defined contribution and a defined benefit pension scheme.

### 2 - Minority squeeze-out regulation in Germany — efficiency, fairness, and economic consequences

Ettore Croci, Faculty of Economy, Dipartimento di  
Science, University of Milan-Bicocca, 20126, Milan,  
Italy, ettore.croci@unimib.it, Olaf Ehrhardt

To facilitate delistings of stock companies after an acquisition, national legislations in Europe give firms who own a large fraction of the targets' equity capital the right to acquire the remaining outstanding shares. Squeeze-out offers has been used extensively in Germany. We provide a cost-benefit analysis of the current squeeze-out procedures in Germany, using a brand-new database of squeeze-outs with unique data, and offer new insights on this procedure taking into account both the minority investors' point of view and firms' strategies.

## ■ MA-44

Monday 08:00-09:20  
GSI - S 16

### Parametric Optimization I

Stream: Parametric Optimization  
Invited session

Chair: Bernd Kummer, Mathematik, Humboldt-Universität  
zu Berlin, 10099 Berlin, 12489, Berlin, Germany,  
kummer@mathematik.hu-berlin.de

#### 1 - Asymptotic properties of solutions to parametric optimal control problems with varying index of singular arcs

Olga Kostyukova, Institute of Mathematics, Belarusian  
National Academy of Sciences, Surganov str. 11,  
220072, Minsk, Belarus, kostyukova@im.bas-net.by

We consider parametric linear-quadratic optimal control problems with terminal and control constraints. The family has the specific feature that the class of optimal controls is changed for an small change in the parameter. In the perturbed problem, the behavior of the trajectory is described by solutions of singularly perturbed boundary value problems. We study the asymptotic properties of the solutions to perturbed problems and use these properties in the construction and justification of stable procedures for finding exact or approximate solutions of the perturbed problems.

#### 2 - Penalty techniques for state constrained optimal control problems with the wave equation

Martin Gugat, Institute of Applied Mathematics,  
University of Erlangen-Nuremberg, Martensstr. 3,  
91058, Erlangen, Germany, gugat@am.uni-erlangen.de

We consider a system that is governed by the wave equation and controlled by Dirichlet boundary control. For the penalization of terminal constraints, we compare the convergence of three methods: a differentiable penalty method, an exact penalization and a smoothed exact penalization. We give upper bounds for the error in terms of the penalization parameter. We also consider the  $L^1$ -penalization of distributed inequality state constraints that prescribe an upper bound for the  $L^\infty$ -norm of the state and prove the convergence with respect to the  $L^2$ -norm.

### 3 - Handling set constraints like usual inequalities

Bernd Kummer, Mathematik, Humboldt-Universität zu  
Berlin, 10099 Berlin, 12489, Berlin, Germany,  
kummer@mathematik.hu-berlin.de

In many papers on optimization or variational conditions, set constraints of the type  $h(x)$  in  $C$  with polyhedral  $C$  are studied in place of usual inequalities  $g(x) \leq 0$ , and one finds notes that  $<$  of course  $>$  the latter are only a partial case of the first ones. We show how set constraints can be reduced to usual inequalities without obtaining weaker statements concerning optimality or stability conditions, based on canonical variations like  $h(x)$  in  $p + C$  and  $g(x) \leq b$ . Moreover, basic stability statements for inequalities can be directly used for set constraints.

## ■ MA-45

Monday 08:00-09:20  
GSI - S 33

### Analysis of Deterministic and Stochastic Discrete Systems 1

Stream: Discrete Optimal Control  
Invited session

Chair: Dmitrii Lozovanu, Institute of Mathematics and  
Computer Science, Academy of Sciences of Moldova,  
Academiei 5, IMI, MD-2020, Chisinau, Moldova,  
Moldova, Republic Of, lozovanu@math.md

#### 1 - Application of fad-methodology to the solution of optimal control problems for complex dynamic systems

Alla Albu, Applied optimization problems,  
Dorodnicyn Computing Centre of Russian Academy of  
Sciences, Vavilova 40, 119333, Moscow, Russian  
Federation, alla.albu@mail.ru, Vladimir Zubov

An effective method is proposed to calculate the cost function gradient in a complex optimal control problem for the substance crystallization process. The method is based on the Fast Automatic Differentiation methodology (FAD), which makes it possible to calculate the precise value of the gradient of the cost function for the selected approximation of the optimal control problem. The given example shows that the application of FAD-methodology is a necessary and inevitable element of the solution of complex optimal control problems. This work was supported by RFBR (08-01-90100-MoI\_a).

#### 2 - Study and modification of the fast automatic differentiation technique

Vladimir Zubov, Mechanics of continuum media,  
Dorodnicyn Computing Centre of Russian Academy of  
Sciences, Vavilova 40, 119333, Moscow, Russian  
Federation, zubov@ccas.ru, Andrey Albu

It is shown that the numerical solution of the discrete optimal control problem derived using the FAD technique doesn't always converge to the exact solution of the optimal control problem for any approximation of the cost functional if the approximation of connections is prescribed. A modification of FAD is proposed where such matched approximations of the cost functional and differential connections are used that the obtained discrete adjoint problem approximates the continuous adjoint problem. This work was supported by RFBR (o 08-01-90100-Mol\_a).

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## Monday 09:45-11:45

### ■ MB-01

*Monday 09:45-11:45*

*Maritim*

### Opening Session

Stream: Plenaries

*Plenary session*

Chair: *Gerhard J. Woeginger*, Department of Mathematics and Computer Science, Eindhoven University of Technology, 5600 MB, Eindhoven, Netherlands, gwoegi@win.tue.nl

Chair: *Erwin Pesch*, FB 5, University of Siegen, Hoelderlinstr. 3, 57068, Siegen, Germany, erwin.pesch@uni-siegen.de

#### 1 - Opening session

1. Beethoven's "Song of Joy"
  2. Welcome speeches - President of EURO - Mayor of Bonn - President of GOR
  3. General remarks
  4. Announcements of GOR Awards - Winner of GOR Science Award - Winner of GOR Doctoral Dissertation Award
  5. Announcement of EURO Awards - Finalists of EURO Doctoral Dissertation Award - Winner of EURO Distinguished Service Award
  6. EURO Gold Medal - Introduction and appraisal of the winner - Presentation by the winner
  7. Practical guidelines for the conference
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## Monday 12:00-13:20

### ■ MC-01

Monday 12:00-13:20

Beethoven

#### Precedence-constrained scheduling and graph optimization problems

Stream: Combinatorial Optimization

Invited session

Chair: *Valery Gordon*, United Institute of Informatics Problems, Surganov str. 6, 220012, Minsk, Belarus, [gordon@newman.bas-net.by](mailto:gordon@newman.bas-net.by)

##### 1 - On Hamiltonian properties of triangular grid graphs

*Valery Gordon*, United Institute of Informatics Problems, Surganov str. 6, 220012, Minsk, Belarus, [gordon@newman.bas-net.by](mailto:gordon@newman.bas-net.by), *Yury Orlovich*, *Frank Werner*

Cyclic properties of triangular grid graphs are considered. Such properties are important in applications connected with problems arising in molecular biology, in telecommunications and in the design of cellular networks. We prove that all connected, locally connected triangular grid graphs (with the only one exception of a special 13-vertices graph) are fully cycle extendable. We also show that the hamiltonian cycle problem for triangular grid graphs, in general case, is NP-complete, but a hamiltonian cycle in connected, locally connected triangular grid graph can be found in polynomial time.

##### 2 - A monotone approximation algorithm for scheduling with precedence constraints

*Rob van Stee*, AG1, MPI Informatik, Campus E1 4, 66123, Saarbrücken, [vanstee@mpi-inf.mpg.de](mailto:vanstee@mpi-inf.mpg.de), *Sven Krumke*, *Anne Schwahn*, *Stephan Westphal*

In this paper, we consider the problem of scheduling jobs in a multiprocessor setting where there are precedence constraints between tasks, and where the performance measure is the makespan, the time when the last task finishes.

We consider the version of this problem where the machines are related: each machine has a speed at which it runs, which does not depend on the job being run. In our model, each machine belongs to a selfish user. We provide a monotone (i.e. truthful) approximation algorithm.

##### 3 - Periodic schedules for linear precedence constraints : algorithms and questions

*Claire Hanen*, Université de Paris 10 Nanterre, LIP6, 200 avenue de la République, 92001, Nanterre, France, [claire.hanen@u-paris10.fr](mailto:claire.hanen@u-paris10.fr), *Alix Munier-Kordon*

We address a cyclic scheduling problem in which tasks have to be repeated infinitely often and are subject to linear precedence constraints. We first consider a subclass of schedules, periodic schedules and we build polynomial algorithms to check existence and to compute their optimal throughput. We then introduce a second subclass which dominates the previous one, quasi-periodic schedules, and we derive pseudo-polynomial algorithms. We then discuss the ratio between the optimal periodic (or quasi-periodic) throughput and the optimal throughput.

##### 4 - On eulerian extension problems and their application to sequencing problems

*Wiebke Höhn*, Institut für Mathematik, Technische Universität Berlin, Straße des 17. Juni 136, 10623,

Berlin, Germany, [hoehn@math.tu-berlin.de](mailto:hoehn@math.tu-berlin.de), *Tobias Jacobs*, *Nicole Megow*

We present a new technique for investigating the complexity of sequencing problems such as the Gilmore-Gomory type Traveling Salesman Problem and related flowshop scheduling problems. We show that those sequencing problems have a natural interpretation as Eulerian Extension Problems which leads to new structural insights and solution methods. In fact, our method provides the entire set of optimal solutions, instead just a single one. Besides the theoretical significance, this is meaningful for practical applications in which often a secondary optimization criteria plays a role.

### ■ MC-02

Monday 12:00-13:20

Schumann

#### Methods for Vehicle Routing and Scheduling

Stream: Transportation Planning

Invited session

Chair: *Stefan Irnich*, Deutsche Post Endowed Chair of Optimization of Distribution Networks, RWTH Aachen University, Templergraben 64, 52062, Aachen, Germany, [sirnich@or.rwth-aachen.de](mailto:sirnich@or.rwth-aachen.de)

##### 1 - Cutting on the set partitioning formulation of the vehicle routing problem with time windows

*Simon Spoorendonk*, DIKU, Department of Computer Science, University of Copenhagen, Universitetsparken 1, 2100, Copenhagen O, Denmark, [spooren@diku.dk](mailto:spooren@diku.dk)

In recent papers cutting planes derived from the set partitioning formulation of the VRPTW have shown to be very successful. In a column generation context cutting planes on the master problem formulation can complicate the subproblem significantly. This is due to a possible augmentation of variables and constraints that may be needed in order to compute the correct reduced cost of a column. We discuss the impact of such an augmentation and show how to apply set partitioning derived cuts (Chvatal-Gomory rank-1 cuts and clique inequalities) in a column generation algorithm for the VRPTW.

##### 2 - Partial path column generation for the vehicle routing problem with time windows

*Björn Petersen*, DIKU, Department of Computer Science, University of Copenhagen, Universitetsparken 1, 2100, Copenhagen, Denmark, Denmark, [bjorn@diku.dk](mailto:bjorn@diku.dk)

Traditionally, column generation models of the VRPTW have consisted of a set partitioning master problem with each column representing a route, starting and ending at the depot. Elementary routes have shown to be superior on difficult instances. However, the pricing problems do not scale well when the number of feasible routes increases. We suggest to relax that 'each column is a route' into 'each column is a part of the giant tour'. This way, the length of the partial path can be bounded and a better control of the size of the solution space for the pricing problem can be obtained.

##### 3 - On approximation algorithm for some stochastic vehicle routing problems

*Anastasia Shakhshneyder*, Mechanic-Mathematical department, Novosibirsk State University, st. Pirogova 2, Novosibirsk, Russia, 630090, Novosibirsk, Russian Federation, [a.shakhshneyder@gmail.com](mailto:a.shakhshneyder@gmail.com), *Edward Gimadi*

We consider k-customer vehicle routing problem with equally distributed independent random instances. We analyze the case of one depot and multi-depot problem. We construct the polynomial approximation algorithms to solve these problems using the procedure "Nearest city". We apply the probabilistic analysis of the algorithms. As a result we obtain the estimates of relative error, failure probability and the conditions when the algorithms are asymptotically optimal. All results are valid for directed and undirected graphs. This work is supported by RFBR (projects 08-01-00516, 07-07-00222).

#### 4 - Efficient constraint handling in heuristic and exact vehicle routing

*Stefan Irnich*, Deutsche Post Endowed Chair of Optimization of Distribution Networks, RWTH Aachen University, Templergraben 64, 52062, Aachen, Germany, [sirnich@or.rwth-aachen.de](mailto:sirnich@or.rwth-aachen.de)

Efficient constraint checking is crucial in heuristics and exact algorithms for vehicle routing. A uniform way of stating constraints is resources. The update of resources along a route can be done with resource extension functions (REFs). We survey the key properties that REFs should have in order to guarantee efficient local search and efficient pricing in column-generation algorithms. Pricing based on shortest-path computations requires particular properties of REFs. We exemplify our theoretical findings by discussing several types of standard as well as non-standard constraints.

## ■ MC-03

Monday 12:00-13:20

Reger

### Transportation and Environment

Stream: Transportation Planning

*Invited session*

Chair: *Klaus-Christian Maassen*, Mercator School of Management, University of Duisburg-Essen, Lotharstrasse 65, 47048, Duisburg, Germany, [klaus-christian.maassen@uni-due.de](mailto:klaus-christian.maassen@uni-due.de)

#### 1 - Extending the cell-transmission-model for evacuation planning in urban areas

*Klaus-Christian Maassen*, Mercator School of Management, University of Duisburg-Essen, Lotharstrasse 65, 47048, Duisburg, Germany, [klaus-christian.maassen@uni-due.de](mailto:klaus-christian.maassen@uni-due.de), *Alf Kimms*

The Cell-Transmission-Model (CTM) by Daganzo (1994) was introduced as a traffic simulation model. Its basic ideas were picked up recently to formulate an optimization model for evacuation planning purposes. We will address two major weaknesses of the recent model, namely the high computing time as well as missing limitations for traffic flows and show how to overcome them. Stimulated by this, we formulate the extended CTM (exCTM) and use two more optimization models to enhance the generated solutions. In a computational study we show that the exCTM outperforms the standard CTM.

#### 2 - A tabu search heuristic algorithm for the waste collection vehicle routing problem with time windows (vrptw)

*Aida Mauziah Benjamin*, CARISMA, Brunel University, John Crank Building, UB8 3PH, Uxbridge, United Kingdom, [Aida.Benjamin@brunel.ac.uk](mailto:Aida.Benjamin@brunel.ac.uk), *J. E. Beasley*

In this problem it is assumed that there is a single depot, a set of waste disposal sites, a set of customers at which waste is collected and an unlimited number of homogeneous vehicles. Besides, we also take into consideration a driver rest period. The nearest neighbour greedy technique is used to obtain an initial solution. Next, we use a neighbour set algorithm to improve the solution, followed by a tabu search phase. The algorithm is tested on ten publicly available waste collection VRPTW benchmark problems. The results obtained compare well with other results presented in the literature.

#### 3 - Metaheuristic solution methods for waste collection problems

*Vera Hemmelmayr*, Department of Business Administration, University of Vienna, Bruenner Straße 72, 1210, Vienna, Austria, [vera.hemmelmayr@univie.ac.at](mailto:vera.hemmelmayr@univie.ac.at), *Karl Doerner*, *Richard Hartl*

In this talk we consider a real world waste collection problem. In many cities, towns and villages specific types of waste are collected in public waste collection points. The bins at this waste collection points have to be emptied on a regular basis. For each type of waste fixed tours have to be calculated for a fixed planning horizon. The problem is modeled as a Periodic Vehicle Routing Problem with Intermediate Facilities (PVRP-IF). We propose solution methods based on Variable Neighborhood Search.

#### 4 - Application of reverse logistics to construction and demolition waste collection planning

*Nicole Sunke*, Chair of Business Administration, Construction Management and Economics, University of Siegen, Paul-Bonatz-Str. 9-11, 57068, Siegen, Germany, [nicole.sunke@uni-siegen.de](mailto:nicole.sunke@uni-siegen.de), *Frank Schultmann*

A huge potential for sustainable construction can be found in the appropriate treatment of construction and demolition waste (C&D waste). However, reverse logistic problems for the collection C&D waste have fairly been neglected so far. These planning problems will be highlighted from the perspective of the main actors in the collection process. Constraints on the planning problems will be addressed and models for reverse logistics and necessary modifications in dependency on the type of material and actor involved will be discussed.

## ■ MC-04

Monday 12:00-13:20

Liszt

### Complex Scheduling Problems

Stream: Scheduling

*Invited session*

Chair: *Johann Hurink*, Department of Applied Mathematics, University of Twente, P.O. Box 217, 7500 AE, Enschede, Netherlands, [j.l.hurink@utwente.nl](mailto:j.l.hurink@utwente.nl)

#### 1 - Time-constrained project scheduling with adjacent resources

*Johann Hurink*, Department of Applied Mathematics, University of Twente, P.O. Box 217, 7500 AE, Enschede, Netherlands, [j.l.hurink@utwente.nl](mailto:j.l.hurink@utwente.nl), *Leendert Kok*, *Jacob Jan Paulus*, *Marco Schutten*

We develop a decomposition method for the Time-Constrained Project Scheduling Problem (TCPSP) with Adjacent Resources (AR). For AR the resource units are ordered and the units assigned to a job have to be adjacent. On top of that, ARs are not required by single jobs but by job groups. As soon as a job of such a group starts, the AR units are occupied, and they are not released before all jobs of that group are completed. The developed decomposition method separates the AR assignment from the rest of the scheduling problem. Test results demonstrate the applicability of the decomposition method.

## 2 - Time-constrained project scheduling

*Marco Schutten*, MB / OMPL, University of Twente, P.O. Box 217, 7500 AE, Enschede, Netherlands, [m.schutten@utwente.nl](mailto:m.schutten@utwente.nl), *Tom Guldemond*, *Jacob Jan Paulus*, *Johann Hurink*

We present an approach for scheduling with deadlines and apply this approach to the Time-Constrained Project Scheduling Problem. To be able to meet these deadlines, it is possible to work in overtime or hire additional capacity. For this problem, we develop a 2-stage heuristic. In the first stage we construct partial schedules in which jobs may be scheduled for a shorter duration than required. The second stage uses an ILP formulation to turn a partial schedule into a feasible schedule, and to perform a neighborhood search. We present experimental results on modified RCPSP benchmark instances.

## 3 - Stochastic scheduling subject to preemptive-repeat breakdowns with incomplete information

*Xiao-qiang Cai*, Department of Systems Engineering and Engineering Management, The Chinese University of Hong Kong, Shatin, NT, Hong Kong, Hong Kong, [xqcai@se.cuhk.edu.hk](mailto:xqcai@se.cuhk.edu.hk), *Xianyi Wu*, *Xian Zhou*

We study the problem of scheduling a set of jobs on a single machine subject to stochastic breakdowns, where a machine breakdown causes the loss of the work done on the job being processed. The processing times, the machine uptimes, and the machine downtimes, are random variables with incomplete information on their probability distributions characterized by unknown parameters. We derive the optimal static and dynamic policies. As a by-product, we also show that our incomplete information model subsumes the traditional models with complete information as extreme cases.

## 4 - Throughput optimization in two-machine flowshops with flexible operations

*Yves Crama*, HEC - Management School, University of Liège, Boulevard du Rectorat 7 (B31), 4000, Liège, Belgium, [Y.Crama@ulg.ac.be](mailto:Y.Crama@ulg.ac.be), *Hakan Gultekin*

We consider a two-machine flowshop which produces identical parts. Each part requires a number of operations. Some of these operations (called flexible operations) can be performed on either machine, while others are preassigned to one of the machines. The same flexible operation can be performed on different machines for different parts. The problem is to determine the assignment of the flexible operations to the machines for each part, in order to maximize the throughput rate. We consider various cases depending on the number of parts and the capacity of the buffer between the machines.

## MC-05

Monday 12:00-13:20

Haydn

## Protein structures - analysis and prediction

Stream: Computational Biology, Bioinformatics and Medicine

Invited session

Chair: *Jacek Blazewicz*, Instytut Informatyki, Politechnika Poznańska, ul.Piotrowo 2, 60-965, Poznań, Poland, [jblazewicz@cs.put.poznan.pl](mailto:jblazewicz@cs.put.poznan.pl)

Chair: *Piotr Lukasiak*, Institute of Computing Science, Poznań University of Technology, ul.Piotrowo 2, 60-965, Poznań, Poland, [Piotr.Lukasiak@cs.put.poznan.pl](mailto:Piotr.Lukasiak@cs.put.poznan.pl)

### 1 - Survival models based on logical analysis of data and community detection

*Julien Darlay*, Laboratoire G-SCOP, 46, avenue Félix Viallet, 38031, Grenoble, France, [julien.darlay@g-scop.inpg.fr](mailto:julien.darlay@g-scop.inpg.fr), *Nadia Brauner*

Logical Analysis of Data (LAD) is a supervised learning method based on combinatorial optimization. It was recently adapted to survival analysis where one wants to predict a time to event with possible censored data (only a lower bound on the time to predict is known). LAD method relies on the concept of patterns that describe observations with close survival properties. Our objective is to identify similar patterns in order to be able to choose the "better" ones. We use graph theory modeling this problem with clique partitioning and community detection.

### 2 - Role of graphs in protein structure analysis

*Maciej Milostan*, Institute of Computing Science, Technical University of Poznań, 60-965, Poznań, Poland, [maciej.milostan@cs.put.poznan.pl](mailto:maciej.milostan@cs.put.poznan.pl), *Jacek Blazewicz*, *Piotr Lukasiak*

Probably one of the most important scientific task in a structural biology is to analyze structural and functional features of proteins. Popular approach in such analysis is to represent the properties of protein molecules in form of graphs, e.g. contact graphs, surface graphs etc., and then analyze these graphs by common OR methods. Various kinds of graph analysis algorithms can be applied to tackle different problems in context of proteins. We show the methods of construction of protein graphs based on various contacts definitions and show an overview of their potential applications.

### 3 - Bspred method — the new approach used for predicting

*Piotr Lukasiak*, Institute of Computing Science, Poznań University of Technology, ul.Piotrowo 2, 60-965, Poznań, Poland, [Piotr.Lukasiak@cs.put.poznan.pl](mailto:Piotr.Lukasiak@cs.put.poznan.pl), *Jacek Blazewicz*, *Arkadiusz Hoffa*, *Maciej Antczak*

The new method of binding sites prediction called BSpred has been proposed. Identifying the interface between the interacting protein and another molecule provides important clues to the function of a protein and can be useful in complex structures prediction. The BSpred approach predicts protein binding sites based on protein-ligand sequential context templates extracted from the known, crystal structures from the Protein Data Bank. Based on the data from CASP8 accuracy of prediction is on the level higher than 60%. Proposed approach can be successfully applied for the considered problem.

## ■ MC-06

Monday 12:00-13:20

Koch

### OR Applications in Warehouses and Routing Management

Stream: OR and Real Implementations

*Invited session*

Chair: *Angel A. Juan*, Applied Mathematics I, Technical University of Catalonia, Plaça Josepines, 1, 5<sup>o</sup> 1<sup>a</sup>, 08224, Terrassa (Barcelona), Spain, angel.alejandro.juan@upc.edu

Chair: *Javier Faulin*, Department of Statistics and OR, Public University of Navarre, Los Magnolios Building, 1st Floor, Campus Arrosadía., 31006, Pamplona, Navarra, Spain, javier.faulin@unavarra.es

#### 1 - Evolutionary approaches to maximizing the self availability in a chaotic warehouse

*Sacramento Quintanilla*, Economía Financiera y matemática, University of Valencia, Avda. Naranjos s/n, 46071, Valencia, Spain, Maria.Quintanilla@uv.es, *Francisco Ballestin*, *M. Pilar Lino*, *M. Angeles Pérez*, *Vicente Valls*

The logistic distribution is an important link in the company value chain. The application of recent technologies like RFID allows an easier management of chaotic warehouses in real time. In this context we introduce some algorithms to obtain the optimal location of the current stock and the in/out products. A defrag approach is designed to relocate the stock when the best and the current self availability differ too much. In all the algorithms we take into account the m3, some criteria for high rotation items and / or dangerous products. We distinguish two cases: fixed and no fixed layout.

#### 2 - Simuroute: using Monte Carlo simulation and splitting techniques to produce a solutions set to the cvrp

*Javier Faulin*, Department of Statistics and OR, Public University of Navarre, Los Magnolios Building, 1st Floor, Campus Arrosadía., 31006, Pamplona, Navarra, Spain, javier.faulin@unavarra.es, *Angel A. Juan*, *Scott Grasmán*, *Fernando Lera-Lopez*

Given a Capacitated Vehicle Routing Problem-CVRP instance, the SimuRoute algorithm incorporates a randomness criterion to the classical Clarke and Wright Savings heuristic and starts an iterative process in order to obtain a set of alternative solutions, each of which outperforms the CWS algorithm. We also incorporate splitting techniques to enhance the method performance. Therefore, our methodology provides more flexibility during the routing selection process, which may help to improve the quality of service offered to clients.

#### 3 - Determination of the transport and delivery capacity in a postal company

*Manuel Mateo*, Departament Business Administration, Universitat Politècnica Catalunya, Avda Diagonal, 647, 7th, E-08028, Barcelona, Spain, manel.mateo@upc.edu, *Paolo Gaianigo*, *Imma Ribas*

A private postal company had to determine the capacity of the transport and delivery, two bottlenecks of its process. The transport in metropolitan areas of Madrid and Barcelona is analyzed and a new organization is proposed to face an increase of demand. Delivery is the process that enables the arrival of mail at the destination. The study is based on historical and practical data. The objective is to develop a model which can predict the quality level in terms of the quantity of work and the number of resources needed. The model helps to decision-making according to strategic objectives.

#### 4 - A tabu search approach for the green cvrp

*Javier Faulin*, Department of Statistics and OR, Public University of Navarre, Los Magnolios Building, 1st Floor, Campus Arrosadía., 31006, Pamplona, Navarra, Spain, javier.faulin@unavarra.es, *Francisco Arcelus*, *Sergio Ubeda*

We describe a new application of the well-known tabu search approach to solve CVRP with environmental criterion minimisation. This criterion is based on the calculation of CO2 emissions, which is highly dependent on several factors such as speed, load and distance. A case study is given to show how green routes can be obtained and to analyse whether those routes also meet the efficiency objectives or not. The results show that the tabu search approach adapts to the environmental criteria better than heuristics and also produces routes which are distance effective and cleaner.

## ■ MC-07

Monday 12:00-13:20

GSI - S 29

### Rescheduling in railways

Stream: Optimization in Public Transport

*Invited session*

Chair: *Marco Laumanns*, Institute for Operations Research, ETH Zurich, Raemistrasse 101, 8092, Zurich, Switzerland, laumanns@ifor.math.ethz.ch

#### 1 - Precise operation — accurate and fast rescheduling: potential benefits and challenges in the field of railway operations research

*Marco Lüthi*, Inst. for Transport Planning and Systems, ETH Zurich, Wolfgang-Pauli-Str. 15, HIL F34.2, 8093, Zürich, Switzerland, luethi@ivt.baug.ethz.ch

Rail traffic has grown significantly within the last few years. To handle the more and more dense traffic efficiently, even in case of delays or incidents, research focuses on developing strategies and algorithms in order to calculate new schedules in real-time. However, developing an automated dispatching system for a mixed traffic railway network is very difficult and the implemented models so far are not satisfying all complex and detailed requirements. Some of the most demanding challenges, possible performances and quality improvements will be demonstrated in this presentation.

#### 2 - Design of an effective algorithm for fast response to the re-scheduling of railway traffic during disturbances

*Johanna Törnquist Krasemann*, School of Engineering, APS, Blekinge Institute of Technology, Box 520, 37225, Ronneby, johanna.tornquist@bth.se

The increased occurrence of railway traffic disturbances shows that effective re-scheduling is important. In previous research we have designed an optimization-based approach which seems promising. However, for some scenarios it is difficult to find good solutions within seconds. Therefore, we have developed a greedy algorithm which effectively delivers good solutions within the permitted time. To quickly retrieve a feasible solution the algorithm performs a depth-first search using an evaluation function to prioritise when conflicts arise and then branches according to a set of criteria.

#### 3 - A model for real-time-dispatching of connection conflicts in railway operation

*Stephan Kurby*, DB Netz AG / Technische Universitaet Dresden, Schweizer Strasse 3b, 01069, Dresden, Germany, stephan.kurby@dbnetze.com, *Matthias Bär*

The shown approach is a contribution to the real-time-dispatching in railway operation. Developed was a macroscopic decision model to minimize the weighted follow-up costs of the connection-decisions (delay of connection-holding trains versus connection is not held). At the local decision the resulting effects to the net will be considered according to their relevance. A microscopic dispatching system does check and improve the macroscopic located solutions. The result shall be a conflict free, workable and robust dispatch schedule which can immediately enter live railway operation processes.

#### 4 - Impact of rescheduling trains with transfer connections in disturbed traffic conditions

Marco Pranzo, Dipartimento di Ingegneria dell'Informazione, Università di Siena, Siena, Italy, pranzo@dii.unisi.it, Francesco Corman, Andrea D'Ariano, Dario Pacciarelli

Train conflict detection and resolution is the problem of minimising deviations from the timetable while satisfying rail operational constraints. This paper presents a novel methodology to determining the wait or no wait decision of transfer connections when rescheduling trains in presence of disturbances. We formulate the scheduling problem via alternative graphs and develop algorithms to improve punctuality and get reliable transfer connections. A computational study on a complex and densely occupied network is carried out to assess which connections are more critical to delay management.

## MC-08

Monday 12:00-13:20

GSI - S 30

### Railway planning

Stream: Optimization in Public Transport

Invited session

Chair: Dennis Huisman, Econometric Institute, Erasmus University, Rotterdam, Netherlands, huisman@few.eur.nl

#### 1 - The line planning game for railway systems

Anita Schoebel, Fakultät für Mathematik, Georg-August Universität Göttingen, Lotzestrasse 16-18, 37083, Göttingen, Germany, schoebel@math.uni-goettingen.de, Silvia Schwarze

We present a game-theoretic model for the line planning problem in public transportation, in which each line acts as player. Each player aims to minimize its own delay, which is dependent on the traffic load along its edges. We show that there exists a line plan at equilibrium, which minimizes the sum of delays of the transportation system. This result is achieved by showing that a potential function exists. Moreover, we propose methods for calculating equilibria and present numerical results in which we compare our approach to other line planning models.

#### 2 - Simultaneous railway line planning and network design

Ángel Marín, Matemática Aplicada, Universidad Politécnica de Madrid, E.T.S. Ingenieros Aeronáuticos, Plaza Cardenal Cisneros, 3, 28040, Madrid, Spain, angel.marin@upm.es, Federico Perea, Juan A. Mesa

Network Design (ND) decides the network (tracks and stations). Line Planning (LP) decides the configuration of lines, including their frequencies. To obtain the robustness of complex systems different concepts of robustness are considered. They must be studied at each planning level and in a global way, trying to increase the system efficiency in presence of failure. We combine ND and LP into one unique problem. Given that the unique model may be computationally intractable, we present an iterative approach dealing with the robustness of the integrated problem.

#### 3 - Train scheduling for large and highly utilized railway networks

Gabrio Curzio Caimi, Institute for Operations Research, ETH Zurich, HG G21.2, Rämistrasse 101, 8092, Zurich, Switzerland, caimig@ifor.math.ethz.ch, Marco Laumanns, Martin Fuchsberger, Kaspar Schüpbach

We consider the generation of conflict-free train schedules in large congested railway networks. First, on the macro level we propose an extension of the well-known PESP model using a simplified track topology to create a flexible timetable. On the micro level, this flexibility helps obtaining a solution when checking for feasibility, considering the detailed topology locally. There, we propose a resource constrained integer multicommodity flow model that enables to precisely and efficiently detect potential conflicts, and generates much stronger bounds compared to previous formulations.

#### 4 - A bundle approach for solving large scale train timetabling problems

Thomas Schlechte, Optimization, Zuse-Institute-Berlin, Takustrasse 7, 14195, Berlin, Berlin, Germany, schlechte@zib.de, Ralf Borndörfer, Steffen Weider

This talk focuses on the macroscopic train timetabling problem (TTP), which consists in finding a conflict free set of train routes of maximum value in a given railway network. We model the (TTP) as a large scale integer program and solve it by a Branch and Bound and Price approach. Furthermore we present in detail the computational improvement by using the bundle method to solve a Lagrangean Relaxation instead of a LP Relaxation. All experiments are performed on scenarios for a part of the German long distance area; available at ttplib.zib.de.

## MC-09

Monday 12:00-13:20

GSI - S 5

### Remanufacturing

Stream: Supply Chain Management

Invited session

Chair: Mohd Omar, Mathematical Department, University of Malaya, 50603, Kuala Lumpur, mohd@um.edu.my

#### 1 - A manufacturing and remanufacturing aggregate planning model considering a supply function of recovered products

Jordi Olivella, Institute of Industrial and Control Engineering and Department of Management, Technical University of Catalonia, Avda Canal Olímpic, s/n, 08860, Castelldefels, Barcelona, Spain, jorge.olivella@upc.edu, Amaia Lusa, Albert Corominas

A mathematical programming model is proposed for aggregate planning considering manufacturing and remanufacturing of used products with undistinguishable final products (e.g., single use photograph camera). The recovered products may have different qualities. A (non linear) relation between the proportion of recovered used products and the price offered to the customers in exchange of taking them to a recovering point is considered and the optimal price at each planning period is determined by the model. A computational experiment of the nonlinear model and its linear version is presented.

## 2 - Centralization vs. advance quality information in re-manufacturing

*Ismail Serdar Bakal*, Industrial Engineering, Middle East Technical University, ODTU Endustri Muh. Bolumu, Inonu Bulvari, 6531, Ankara, Turkey, bakal@ie.metu.edu.tr, *Z. Pelin Bayindir, Muruvvet Unal*

We investigate a reverse supply chain consisting of a collector and a remanufacturer in a single-period context. Both the quantity of returns and demand for remanufactured products are price-sensitive. The quality of returns is uncertain and revealed by an inspection process. We assume two quality classes, and the cost of remanufacturing depends on the quality class. In this setting, we develop models to determine the optimal acquisition fee for the returns and the selling price for remanufactured products, and we explore the effects of decentralization and advance quality information.

## 3 - A production model under a linearly increasing demand process with recovery

*Mohd Omar*, Mathematical Department, University of Malaya, 50603, Kuala Lumpur, mohd@um.edu.my

This paper considers a production system that satisfies a linearly increasing demand for finished products by supplying both new items and recovered items. New items are fabricated from raw materials. Used items are continuously collected from customers to be repaired and sold again. In this paper, we consider a policy that alternates between  $v$  production runs and  $w$  repair runs. We illustrate the algorithm with some numerical examples, and then we conclude the paper with some sensitivity analysis.

## ■ MC-10

Monday 12:00-13:20

GSI - S 6

## Evolutionary Multiobjective Optimization II

Stream: Evolutionary Multi Objective Optimization

*Invited session*

Chair: *Marco Laumanns*, Institute for Operations Research, ETH Zurich, Raemistrasse 101, 8092, Zurich, Switzerland, laumanns@ifor.math.ethz.ch

### 1 - Multi-objective metaheuristics: from design to implementation

*El-Ghazali Talbi*, Laboratoire d'Informatique Fondamentale de Lille, Bâtiment M3 - Cité Scientifique, 59655, Villeneuve d'Ascq, France, France, talbi@lifl.fr, *Arnaud Liefooghe, Laetitia Jourdan*

A unifying view of multi-objective metaheuristics is presented. Following the main issues of fitness assignment, diversity preservation and elitism, a conceptual global model is proposed and is validated by regarding a number of state-of-the-art algorithms. The presented model is then incorporated into a general-purpose software framework dedicated to the design and implementation of evolutionary multiobjective optimization techniques: ParadisEO-MOEO. This package has proven its validity and flexibility by enabling the resolution of many realworld and hard multiobjective optimization problems.

### 2 - Evolutionary multi-objective optimization of expensive problems using surrogate ensembles

*Yaochu Jin*, Honda Research Institute Europe, Carl-Legien-Str. 30, 63073, Offenbach, yaochu.jin@honda-ri.de

We propose a generalized framework for surrogate-assisted hybrid multi-objective optimization algorithm, where an evolutionary search is complemented with a local search algorithm (sequential quadratic programming). Instead of using a single model, or a single ensemble, the local search algorithm uses two sets of surrogates, one global model that aims at a global modeling of the fitness landscape, and an ensemble model that consists of different types of models for exact approximation of the local fitness function.

### 3 - Finding the best fixed-size pareto front approximation

*Marco Laumanns*, Institute for Operations Research, ETH Zurich, Raemistrasse 101, 8092, Zurich, Switzerland, laumanns@ifor.math.ethz.ch, *Rico Zenklusen*

We address the problem of approximating the Pareto front of multi-objective optimization problems with a fixed number of points. We show that already for three objectives it is NP-hard to find the best approximation set of given size. For the online version, where we are given the search points sequentially, we present an archiving scheme producing a sequence of approximation sets that converges almost surely to a best possible approximation set of given size. We also propose a simple alternative scheme that guarantees convergence of a fixed-size set of sub-optimal approximation quality.

## ■ MC-11

Monday 12:00-13:20

GSI - S 17

## Portfolio Decision Analysis: Cases and Applications I

Stream: Multiple Criteria Decision Analysis

*Invited session*

Chair: *Alec Morton*, Management/ Operational Research, London School of Economics, Houghton St, London, wc2a2ae, London, England, United Kingdom, a.morton@lse.ac.uk

Chair: *Ahti Salo*, Systems Analysis Laboratory, Helsinki University of Technology, P.O. Box 1100, Otakaari 1 M, 02015, TKK, Finland, ahti.salo@tkk.fi

Chair: *Jeff Keisler*, Boston College of Management, University of Massachusetts, 100 Morrissey Blvd., 02125-3393, Boston, MA, United States, jeff.keisler@umb.edu

### 1 - Robust portfolio methods for counterterrorism resource allocation

*Don Kleinmuntz*, Strata Decision Technology & Univ of Southern California, 2001 South First Street, Suite 200, 61820, Champaign, IL, United States, dnk@strata-decision.com

Terrorism risk requires cost-effective prioritization of countermeasures. This presentation describes a decision analysis approach that is useful when decision makers have deadlines, limited data, and few analytical resources, showing how robust portfolio optimization methods can guide efforts to gather more complete information on vulnerable targets and potential corrective measures. Analyses performed for the California Governor's Office of Homeland Security demonstrate the tools in action.

### 2 - Rams: a software for multicriteria resource allocation

*João Carlos Lourenço*, Centre for Management Studies of IST, Technical University of Lisbon, 1049-001 ,

Lisbon, Portugal, joao.lourenco@ist.utl.pt, *Carlos Bana e Costa, Alec Morton*

Multicriteria resource allocation is a challenging problem for decision makers and analysts. A particular issue is that of the robustness of portfolios to variations in criteria weights, projects value scores and costs. In this talk we present a new software (RAMS - Resource Allocation Management System) which uses an intuitive Pareto-front display to give decision makers an overview of the optimal solutions at different levels of spend, but which also allows in-depth interactive exploration and robustness checks around some attractive portfolios.

### 3 - Supporting the selection of infrastructure maintenance projects with robust portfolio modelling

*Pekka Mild*, Systems Analysis Laboratory, Helsinki University of Technology, Otakaari 1 M, P.O. Box 1100, 2150, Espoo, Finland, pekka.mild@hut.fi, *Juuso Liesiö, Ahti Salo*

In infrastructure management, annual maintenance programmes often contain dozens of projects that are selected from hundreds of candidates in view of multiple prioritization criteria. We report experiences from the wide-scale use of Robust Portfolio Modelling (RPM) in this decision problem at the Finnish Road Administration. Due to the large problem size, we develop an approximate algorithm that computes non-dominated portfolios which are then analyzed to obtain robust yet flexible decision recommendations in the presence of portfolio constraints and incomplete preference information.

### 4 - Applying robust portfolio modeling methodology for the management of uncertainties in forest planning

*Mikko Kurttila*, Joensuu Research Unit, Finnish Forest Research Institute, P.O. BOX 68, 80101, Joensuu, Finland, mikko.kurttila@metla.fi, *Eero Muinonen, Pekka Leskinen, Harri Kilpeläinen, Antti Punkka, Ahti Salo*

Although forest planning processes include numerous uncertainties, most of existing planning tools are deterministic. This neglect of uncertainties may lead to erroneous decisions and inefficient utilization of the resources. We therefore examine how the recently developed Robust Portfolio Modeling (RPM) methodology can be used in various multi-objective forest planning situations in order to use incomplete inventory data and to capture uncertainties about the planning objectives and future timber prices. We also outline development needs that arise from the requirements of forest planning.

## ■ MC-12

Monday 12:00-13:20

GSI - S 18

### Industrial applications of stochastic programming

Stream: Stochastic Programming

*Invited session*

Chair: *Pavel Popela*, Institute of Mathematics, Brno University of Technology, Technicka 2, 612 00, Brno, Czech Republic, Czech Republic, popela@fme.vutbr.cz

### 1 - Stochastic programming applications in quality control and reliable design

*Pavel Popela*, Institute of Mathematics, Brno University of Technology, Technicka 2, 612 00, Brno, Czech Republic, Czech Republic, popela@fme.vutbr.cz

The purpose of the paper is to review the development of real-world stochastic programming applications at the Czech Republic region during the last fifteen years. The focus is on the recent achievements and applications related to researchers of the Brno University of Technology. The applications involve blending stones for concrete production, optimum control for casting problems, scheduling for machine tool design, etc. Features, differences, and similarities of the presented models will be discussed from the both user's and modeller's point of view and recommendations will be included.

### 2 - Stochastic programming approach to energy producing system

*Michal Tous*, Institute of Process and Environmental Engineering, Brno University of Technology, Faculty of Mechanical Engineering, Technicka 2, 61669, Brno, Czech Republic, tousmichal@seznam.cz, *Martin Pavlas, Petr Stehlik*

An optimum choice of a technology for effective utilization of biomass and/or alternative fuel integrated into complex energy producing systems is subjected to economic requirements and strongly influenced by environmental constraints and targets. The key challenge was to build a stochastic programming model that allows us to find optimal decisions about the use of fuel of various types (fossil coal and renewable biomass) with respect to the different time horizons, various demands and uncertain future with respect to technology considered, and the existing equipment design.

### 3 - Modelling to generate alternatives in waste management facility expansion planning using simulation-optimization

*Julian Scott Yeomans*, OMIS, Schulich School of Business, York University, 4700 Keele Street, SSB S338, M3J 1P3, Toronto, Ontario, Canada, syeomans@schulich.yorku.ca

Environmental policy formulation can prove complicated when the system components contain stochastic uncertainty. It has been shown that it is preferable to create several good alternatives that provide different approaches to the public decision-making problems. This study shows how simulation-optimization can be used to generate multiple policy alternatives that satisfy required system criteria and are maximally different in decision space. The efficacy of this stochastic modelling-to-generate-alternatives approach is demonstrated on a waste management facility expansion planning case.

## ■ MC-13

Monday 12:00-13:20

GSI - S 31

### Applications of stochastic programming methodologies

Stream: Stochastic Programming

*Invited session*

Chair: *Andras Prekopa*, RUTCOR, Rutgers University, New Jersey, USA, 640 Bartholomew Road, 08854-8003, Piscataway, New Jersey, United States, prekopa@rutcor.rutgers.edu

### 1 - Bounding the values of financial derivatives using a combination of the discrete moment problem and binomial tree calculation

*Mariya Naumova*, RUTCOR, Rutgers Center for Operations Research, Rutgers University, 640 Bartholomew Road, 08854, Piscataway, NJ, olik.myn@gmail.com, *Andras Prekopa*

The recombining binomial tree option price calculation procedure is combined with bounding technique, applied on each level of the tree. The bounds are obtained from the solutions of discrete moment problems, where we assume that some of the moments of the random asset price are known. The method can be advantageous also in the case, where the asset price probability distribution is completely known but the option price calculation is hard, whereas the bounds can easily be obtained. Several illustrative examples will be presented

## 2 - Optimal portfolio selection based on multiple value at risk

*Kunikazu Yoda*, Rutcor, Rutgers Center for Operations Research, Rutgers University, 640 Bartholomew Rd, 08854, Piscataway, NJ, United States, kyoda@rutcor.rutgers.edu, *Andras Prekopa*

A variant of Kataoka's portfolio selection model is formulated in which lower bounds are imposed on several VaR values, where the bounds are taken from a reference probability distribution. Under mild condition it is shown that if we want at least one VaR value to be equal to its lower bound then the problem is equivalent to a disjunctive LP. The numerical solution technique will be discussed and numerical examples will be presented.

## 3 - Programming under probabilistic constraints with uniformly distributed random variable

*Olga Myndyuk*, Rutcor, Rutgers Center for Operations Research, Rutgers, The State University of New Jersey, 640 Bartholomew Rd, 08854, Piscataway, NJ, United States, olgamyn@eden.rutgers.edu

We assume that in the underlying LP the vector on the right hand side has multivariate uniform distribution in a convex set. We solve the probabilistic constrained stochastic programming problem by the supporting hyperplane and the logarithmic barrier methods. The combination of these methods provide us with lower and upper bounds for the optimum values. The problem to calculate the volumes of convex polyhedra will also be discussed. Numerical results will be presented.

## 4 - A two stage stochastic programming model for capacity expansion planning in the automotive industry

*Cormac Lucas*, School of Information Systems, Computing and Mathematics, CARISMA, Uxbridge, Uxbridge, Middlesex, United Kingdom, cormac.lucas@brunel.ac.uk, *Gautam Mitra*, *Thomas Sommer-Dittrich*

A multi-period planning model for capacity expansion is considered. The model has been developed as part of a project with a German car manufacturer. The aim of the project is to determine the configuration of the pre-assemblies. Special aspects were considered to capture the operational nature of the problem. The planning problem takes into consideration uncertain demands and is formulated as a two stage stochastic program with recourse decisions. We present results of our empirical investigation and illustrate the benefit of introducing uncertainty analysis in this planning model.

## MC-14

Monday 12:00-13:20

GSI - S 32

## Location and queuing

Stream: Location Analysis

Invited session

Chair: *Vladimir Marianov*, Electrical Engineering, Pontificia Universidad Catolica de Chile, Vicuna Mackenna 4860, 7820436 Macul, 7820436, Santiago, Chile, marianov@ing.puc.cl

### 1 - A decomposition approach for solving the maximal covering location problem with an m/m/1 queuing system

*Hossein Taghizadeh Kakhki*, Mathematics, Ferdowsi Univ. of Mashhad, Mashhad, Iran, 91775-1159, Mashhad, Iran, Islamic Republic Of, taghizad@math.um.ac.ir, *Foroogh Moeen Moghadas*

We consider the maximal covering location problem in an M/M/1 queuing environment, with constrained maximum allowable waiting time, as proposed by Maianov, and Serra (1998) [Probabilistic Maximal Covering Location Allocation Models for Congested Systems, Journal of Regional Science 38(3) 401-424.]. We propose a new solution procedure based on decomposition of the problem into smaller knapsack subproblems. Computational results for existing test problems, as well as for randomly generated problems are presented

### 2 - The fermat-weber problem in a logistic and service network

*Hans Daduna*, Department of Mathematics, University of Hamburg, Bundesstrasse 55, 20146, Hamburg, Germany, daduna@math.uni-hamburg.de, *Vanessa Lange*

We consider the Fermat-Weber problem in a dynamical environment. From a production center goods are delivered to warehouses. Trucks are loaded at the center, drive to one of the warehouses, are unloaded there, return to the central station. We take into consideration travel times, loading and unloading times, waiting delay for loading and unloading. We determine the location for the production center such that system throughput is maximized. We discuss that temporally some warehouses do not need supply from the center. Our approach combines queuing network and location theory.

### 3 - Location of multiple-server immobile facilities operating as m/er/m/n queues

*Vladimir Marianov*, Electrical Engineering, Pontificia Universidad Catolica de Chile, Vicuna Mackenna 4860, 7820436 Macul, 7820436, Santiago, Chile, marianov@ing.puc.cl

Most location models for congested facilities assume exponentially distributed service times. These formulations do not adequately represent actual service time distributions, which often have small variances. We introduce an order  $r$  Erlang distribution for the service time in multiple-server facilities. Extensive analysis is offered on the influence of the parameters of the service time and the capacity of the facilities on the performance of the system.

## ■ MC-15

Monday 12:00-13:20

Einstein

### Real and rich vehicle routing problems

Stream: Vehicle Routing

*Invited session*

Chair: *Giovanni Righini*, D.T.I., Università degli Studi di Milano, Via Bramante 65, 26013, Crema, CR, Italy, righini@dti.unimi.it

#### 1 - An exact algorithm for the discrete split delivery vrp with time windows

*Iliaria Vacca*, Transport and Mobility Laboratory (Transp-OR), École polytechnique fédérale de Lausanne (EPFL), GC B3 435 (Bâtiment GC), Station 18, 1015, Lausanne, Switzerland, [iliana.vacca@epfl.ch](mailto:iliana.vacca@epfl.ch), *Matteo Salani*

The Split Delivery Vehicle Routing Problem (SDVRP) is a variant version of the classical VRP in which each customer can be visited by more than one vehicle which serves a fraction of its demand. The Discrete SDVRP is another variant in which the delivery request of a customer consists of several items which cannot be split further. In this work we consider the DSDVRP with time windows where the service of items combinations imply a corresponding service time. We present a branch-and-price algorithm and discuss the implications of the classical Dantzig Wolfe reformulation.

#### 2 - Maritime distribution of stone products

*Johan Oppen*, Molde University College, P O Box 2110, 6402, Molde, [johan.oppen@hiMolde.no](mailto:johan.oppen@hiMolde.no)

NorStone produces 8 mill tons of stone products a year. The main products are aggregate for concrete and asphalt, railway gravel, materials for road building and for protection of underwater oil and gas pipelines. The products are based both on crushed stone from stone quarries and sand and gravel from sand pits.

We present a problem description and mathematical models. We also discuss possible solution methods to handle the problem, both in terms of exact methods for small problem instances and simplified models, and heuristics to be used in a real-world planning system.

#### 3 - A branch-and-price algorithm for the multi-depot heterogeneous fleet vehicle routing problem with time windows

*Giovanni Righini*, D.T.I., Università degli Studi di Milano, Via Bramante 65, 26013, Crema, CR, Italy, righini@dti.unimi.it, *Andrea Bettinelli*, *Alberto Ceselli*

We address a variation of the vehicle routing problem with time windows (VRPTW) in which the available fleet is made by vehicles with different characteristics (speed, capacity, fixed costs, ...) and the routes can start from different depots. We present a set covering reformulation and a column generation algorithm, where the pricing subproblem is solved via bi-directional dynamic programming and incremental state space relaxation. We report on preliminary experimental results on benchmark instances from the literature.

## ■ MC-16

Monday 12:00-13:20

Koenig

### Cutting and Packing 1

Stream: Cutting and Packing

*Invited session*

Chair: *Horacio Yanasse*, LAC, INPE, Av. dos Astronautas 1758, CP 515 - INPE/CTE, 12227-010, São José dos Campos, SP, Brazil, [horacio@lac.inpe.br](mailto:horacio@lac.inpe.br)

#### 1 - Exact algorithm for one-dimensional cutting stock problem with given number of setups

*Xiang Song*, School of Mathematics, University of Cardiff, Senghennydd Road, CF24 4AG, CARDIFF, Wales, UK, CF24 4AG, Cardiff, Wales, [songx6@cardiff.ac.uk](mailto:songx6@cardiff.ac.uk)

Classical 1D cutting stock problem consists of finding a way of cutting the stock roll into the smaller ones with the minimum material wastage and meet the customer's demand. However, in reality the total production costs associate with not only material wastage but also setup cost. An auxiliary problem is to minimize the number of different cutting patterns that are used. We aim at solving exactly a variant of 1DCSP, called pattern restricted problem to minimize the number of the stock rolls with the given number of different cutting patterns. A variant column generation technique is used.

#### 2 - New lower bounds based on column generation and constraint programming for the pattern minimization problem

*Cláudio Alves*, Departamento de Produção e Sistemas, Universidade do Minho, Campus de Gualtar, 4710-057, Braga, Portugal, [claudio@dps.uminho.pt](mailto:claudio@dps.uminho.pt), *Rita Macedo*, *J. M. Valério de Carvalho*

The Pattern Minimization Problem is a Cutting and Packing problem that consists in finding a cutting plan with the minimum number of different patterns. We explore a different Integer Programming model that can be solved using column generation, describe different strategies to strengthen it, among which are Constraint Programming and new families of valid inequalities, and derive new lower bounds. Our approaches were tested on a set of real instances, and on a set of random instances from the literature, and showed a clear improvement on the quality of the lower bounds.

#### 3 - An integer programming formulation for the minimization of open stacks problem

*Isabel Cristina Lopes*, Dep. Matematica, ESEIG - Instituto Politecnico do Porto, Rua D.Sancho I, 981, 4480-876, Vila do Conde, [tulicreme@netcabo.pt](mailto:tulicreme@netcabo.pt), *J. M. Valério de Carvalho*

In cutting industries, the different items obtained from cutting patterns are piled in stacks around the machine until all items of the same size are cut. It is desirable to find a sequence of patterns that minimizes the number of different items that are being cut. This is known as the Minimization of Opens Stacks Problem (MOSP). We explore an integer programming formulation for the MOSP, by associating each instance with a graph having a vertex for each item stack and an arc if there is a pattern that produces both items.

#### 4 - A heuristic for the problem of minimizing the number of saw machine cycles

*Horacio Yanasse*, LAC, INPE, Av. dos Astronautas 1758, CP 515 - INPE/CTE, 12227-010, São José dos Campos, SP, Brazil, [horacio@lac.inpe.br](mailto:horacio@lac.inpe.br), *Rodolfo Ranck Junior*, *José Carlos Becceneri*

In this work we present a heuristic and an integer linear programming model for the problem of minimizing the number of saw machine cycles. The heuristic uses the idea of generating cutting patterns that can be repeated many times in association with an approximated resolution of an integer programming model. The model is solved using column generation and a rounding method. The results of some computational experiments are presented using randomly generated instances.

## ■ MC-17

Monday 12:00-13:20

Rheinaue

### Resources in machine scheduling

Stream: Scheduling under Resource Constraints

Invited session

Chair: *Joanna Jozefowska*, Institute of Computing Science, Poznań University of Technology, Piotrowo 2, 60-965, Poznań, Wielkopolska, Poland, [jjozefowska@cs.put.poznan.pl](mailto:jjozefowska@cs.put.poznan.pl)

#### 1 - Resource-constrained flowshop scheduling with resource recycling operations included

*Hsiao-Lan Huang*, Institute of Information Management, National Chiao Tung University, 1001, University Road, 300, Hsinchu, Taiwan, [lan0903@gmail.com](mailto:lan0903@gmail.com), *T.C. Edwin Cheng*, *Bertrand Lin*

This paper studies a generalization of the relocation problem which is formulated from a redevelopment project into a resource-constrained project scheduling problem. In the basic relocation problem, the redevelopment of a building is treated as a single job. In this paper, we separate the demolishing process and reconstruction process, each is performed an independent crew. We formulate this setting into a resource-constrained scheduling problem in a two-machine flowshop. Optimality properties will be addressed. We also discuss the complexity status of several special cases.

#### 2 - Exact methods for the hybrid flowshop problem with batching machines

*Adrien Bellanger*, Ecole des mines de Nancy, LORIA - INRIA Nancy Grand est, École des mines de Nancy (INPL) - LORIA, projet ORCHIDS, Parc de Saurupt, CS 14 234, 54042, NANCY CEDEX, France, [adrien.bellanger@loria.fr](mailto:adrien.bellanger@loria.fr), *Ammar Oulamara*

In this abstract, we consider makespan minimization in the two-stage hybrid flowshop. The first stage contains several identical machines and the second stage contains several batching machines. Processing time of each task is given by an interval on batching machines, and tasks of a same batch have to share a common processing time. We present two branch and bound methods to solve this problem. Direct method solves the previous problem, whereas reverse method solves the reversed problem. Several computational experiments will be presented to show the efficiency of our method.

#### 3 - Resource allocation with apportionment methods

*Joanna Jozefowska*, Institute of Computing Science, Poznań University of Technology, Piotrowo 2, 60-965, Poznań, Wielkopolska, Poland, [jjozefowska@cs.put.poznan.pl](mailto:jjozefowska@cs.put.poznan.pl), *Wieslaw Kubiak*, *Lukasz Jozefowski*

Allocation of resources is main task of any scheduling system. From the client point of view fairness is one of the most important issues. This criterion is often considered in the control of IT systems where clients compete for shared resources. The most popular approaches aim at minimization of Relative Fairness Bound (RFB) and Absolute Fairness Bound (AFB). Both problems can be generalized to proportional allocation of any discrete resource. We prove that the optimization of the RFB leads to the Alabama paradox found in the apportionment theory and propose an algorithm to minimize AFB.

#### 4 - A general branch-and-bound algorithm for fair division problems

*Rudolf Vetschera*, Dept. of Business Administration, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, [rudolf.vetschera@univie.ac.at](mailto:rudolf.vetschera@univie.ac.at)

We introduce a branch-and-bound algorithm for solving fair division problems with indivisible items. Unlike similar algorithms, our algorithm is applicable to a wide class of fairness criteria. Computational results show that it exhibits very good performance for a considerable number of problem instances. Main applications of the algorithm are computational studies of fair division problems. In these problems, a relatively small number of items  $s$  considered, so an exact algorithm can be used even though the problem is a generalization of the set partitioning problem, which is NP-complete.

## ■ MC-18

Monday 12:00-13:20

Lenné

### Modern Applications of Mathematical Programming I

Stream: Mathematical Programming

Invited session

Chair: *Diethard Pallaschke*, Statistics and Mathematical Economics, University of Karlsruhe, Kaiserstr. 12, Geb. 11.40, D-76128, Karlsruhe, Germany, [lh09@rz.uni-karlsruhe.de](mailto:lh09@rz.uni-karlsruhe.de)

Chair: *Ryszard Urbanski*, Faculty of Mathematics and Computer Science, Adam Mickiewicz University, Poznan, ul. Umultowska 87, PL-61-614, Poznan, Poland, [rich@amu.edu.pl](mailto:rich@amu.edu.pl)

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, [gweber@metu.edu.tr](mailto:gweber@metu.edu.tr)

#### 1 - Optimization of the investments' distribution by the stages of the joint implementation projects' realisation

*Vlad Kucher*, -, 04111, Kiev, [commastergm@gmail.com](mailto:commastergm@gmail.com)

Some problems of joint implementation project realization (JIP) arising while investments are mobilized for such projects directed toward energy efficiency increase and GG emissions' mitigation with respect to the Kyoto Protocol are considered. Fuzzy-set estimate introduced for JIP allows estimating investment process efficiency. Problem of investments' distribution optimisation with respect to the project stages is solved as a problem of fuzzy mathematical programming. Problem posing supposes optimisation of investment distribution with respect to the project stages aimed in maximal NPV effect under limitations on emissions' normalized Kyoto levels and on the budget of the investor.

#### 2 - On stability of the mpcc feasible set

*Vladimir Shikhman*, Dept. Mathematics, RWTH Aachen University, Templergraben 55, 52056, Aachen,

Germany, shikhman@mathc.rwth-aachen.de, *Hubertus Th. Jongen, Jan-J Ruckmann*

The feasible set of mathematical programs with complementarity constraints (MPCC) is considered. We discuss local stability of the feasible set with respect to perturbations (up to first order) of the defining functions. Here, stability refers to homeomorphy invariance under small perturbations. For stability we propose a kind of Mangasarian-Fromovitz Condition (MFC) and its stronger version (SMFC). We elaborate some links to metric regularity, Morukhovich's extremal principle, subdifferential qualification condition and generalized Mangasarian-Fromovitz Constraint Qualification.

### 3 - Completeness of the minkowski-rådström-hörmander space.

*Hubert Przybycien*, Mathematics, AM University, 61-614, Poznan, Poland, hubert@amu.edu.pl, *Ryszard Urbanski, Jerzy Grzybowski*

We present a proof of completeness (in metric delta-type) of the Minkowski-Rådström-Hörmander space over an abstract convex cone which is metrizable by complete and translation invariant metric.

### 4 - Reduction of finite exhausters

*Ryszard Urbanski*, Faculty of Mathematics and Computer Science, Adam Mickiewicz University, Poznan, ul. Umultowska 87, PL-61-614, Poznan, Poland, rich@amu.edu.pl, *Jerzy Grzybowski, Diethard Pallaschke*

We introduce the notion of shadowing sets which is a generalization of the notion of separating sets. We prove that the intersection of the family of convex sets  $A_i$ ,  $i=1, \dots, n$ , shadows this family if and only if  $A_1 + \dots + A_n$  is equal to the Minkowski sum of the intersection of all  $A_i$  and the convex hull of all sums  $A_1 + \dots + A_{(i-1)} + A_{(i+1)} + \dots + A_n$ . In terms of shadowing sets, we give a criterion for the minimality of finite upper exhausters. Finally, we give an example of two different minimal upper exhausters of the same function, which answers the question posed by V. F. Demyanov.

## ■ MC-19

Monday 12:00-13:20

*Haber*

### Convex Optimization and Variational Inequalities

Stream: Convex Optimization 1

*Invited session*

Chair: *Giovanni Paolo Crespi*, Economics, University of Valle d' Aosta, via Duca degli Abruzzi, 4, 11100, Aosta, Valle d' Aosta, Italy, g.crespi@univda.it

#### 1 - Optimal energy purchase

*Emanuele Borgonovo*, Decision Sciences and ELEUSI Research Center, Bocconi University, Via Roentgen 1, 20135, Milano, Italy, emanuele.borgonovo@unibocconi.it, *Fabrizio Iozzi, Giovanni Paolo Crespi, Francesca Beccacece*

Energy purchase is a crucial step of a company's supply policy. With market liberalization, energy purchasers are offered a wider range of contract types. This research aims to help choosing the optimal contract, based on the decision-maker expectations of the future values of the exogenous variables. We model a contract as a convex pricing rule. We formalize the problem as the minimization of the total purchase cost given a set of convex sub-models for the prediction of the exogenous variable behavior. Numerical results are obtained for an industrial case study.

#### 2 - Minty variational principle for set-valued variational inequalities

*Giovanni Paolo Crespi*, Economics, University of Valle d' Aosta, via Duca degli Abruzzi, 4, 11100, Aosta, Valle d' Aosta, Italy, g.crespi@univda.it, *Matteo Rocca*

We consider variational inequalities of differential type. Under mild continuity assumptions, a solution to a scalar Minty variational inequality is the solution of the primitive optimization problem. When the inequality is solved well-posedness and generalized convexity properties can be deduced on the primitive objective function. It has been proved that similar results can be established for vector optimization, only up to pseudo-convexity. We propose a generalization to the principle to set-valued functions.

## ■ MC-20

Monday 12:00-13:20

*Mann*

### DEA-Financial Assessment: A New Research Area of DEA

Stream: DEA and Performance Measurement

*Invited session*

Chair: *Toshiyuki Sueyoshi*, Management, New Mexico Tech, 801 Leroy Place, 87801, Socorro, NM, United States, toshi@nmt.edu

#### 1 - Bankruptcy analysis and assessment by DEA and dea-da

*Toshiyuki Sueyoshi*, Management, New Mexico Tech, 801 Leroy Place, 87801, Socorro, NM, United States, toshi@nmt.edu, *Mika Goto*

This research compares DEA with DEA-DA in terms of bankruptcy analysis and assessment. Recently, many DEA researchers have proposed a new use of DEA as a quick-and-easy tool to assess corporate bankruptcy. Meanwhile, other DEA researchers have discussed a use of DEA-DA for bankruptcy-based financial analysis. The two groups are very different from the conventional use of DEA. The two research groups open up a new application area for DEA. This study discusses methodological strengths and weaknesses of DEA and DEA-DA from the perspective of bankruptcy analysis and assessment.

#### 2 - Bankruptcy-based performance analysis by dea-da

*Mika Goto*, Socio-economic Research Center, Central Research Institute of Electric Power Industry, 2-11-1, Iwado Kita, 201-8511, Komae, Tokyo, Japan, mika@criepi.denken.or.jp, *Toshiyuki Sueyoshi*

This study describes a practical use of Data Envelopment Analysis-Discrimination Analysis (DEA-DA) for bankruptcy-based performance assessment. DEA-DA is useful for classifying non-default and default firms based upon their financial performance. This study combines DEA-DA with principal component analysis to reduce the computational burden and then alters DEA-DA weights to address both the sample imbalance problem and the location problem. This study also discusses a combined use between DEA-DA and rank-sum tests to examine statistically hypotheses related to bankruptcy assessment.

#### 3 - Bankruptcy prediction using data envelopment analysis

*Angela Tran*, Chemical Engineering and Applied Chemistry, University of Toronto, 200 College Street,

M5S3E5, Toronto, Ontario, Canada,  
angela.tran@utoronto.ca, *Joseph Paradi*

Predicting the probability of bankruptcy of a company is an important timely challenge for creditors and owners in today's global economy. Current mathematical models predict bankruptcy dichotomously with common financial ratios, disregard market and managerial behavioural factors, and lack a strategy for owners to improve their operations when bankruptcy is imminent. The objective is to develop a DEA model to predict the likelihood of failure and suggest preventative measures based on variables derived from financial statements and their notes, literature, and expertise drawn from analysts.

#### 4 - An efficiency decomposition approach to measure the performance of taiwan financial holding companies

*Shiang-Tai Liu*, Graduate School of Business & Management, Vanung University, No. 1, Van Nung road, Chung-Li, 320, Tao-Yuan, stliu@vnu.edu.tw

One type of DEA studies measures the efficiency via a two-stage structure where the first stage uses inputs to generate outputs that then become the inputs to the second stage. The second stage employs these outputs of the first stage as the inputs to produce its own outputs. Different from previous studies, this paper takes the series relationship of the two individual stages into account in measuring the profitability and marketability efficiencies of Taiwan financial holding companies. The results show all the companies need to spur innovation by finding appropriate management activities.

#### 5 - Evolution of bank efficiency in brazil: a DEA approach

*Roberta Staub*, Research Department, Central Bank of Brazil, Setor Bancário Sul (SBS) Quadra 3 Bloco B - Ed. Sede, 70074-900, Brasília, DF, rbstaub@hotmail.com

This paper investigates cost, technical and allocative efficiency for Brazilian banks from 2000 to 2007. We use Data Envelopment Analysis to compute efficiency scores. Brazilian banks were found to have low levels of cost efficiency compared to banks in Europe and in the US. For the high macroeconomic volatility period (2000-2002), cost inefficiency in Brazilian banks can be attributed mainly to technical inefficiency rather than the allocative. State owned banks are significantly the most cost efficient. There is no evidence of differences in economic efficiency due to activity and bank size

## ■ MC-21

Monday 12:00-13:20

*Hauptmann*

### Planning and scheduling

Stream: Health Care Management

*Invited session*

Chair: *Jan Vissers*, Institute of Health Policy and Management, Erasmus University Medical Centre, Burg. Oudlaan 50, 3062 PA, Rotterdam, Netherlands, j.m.h.vissers@erasmusmc.nl

#### 1 - Midterm scheduling for physicians with flexible shifts using branch-and-price

*Jens Brunner*, TUM Business School, Technische Universität München, Arcisstr. 21, 80333, München, Germany, jens.brunner@wi.tum.de, *Rainer Kolisch*, *Jonathan F. Bard*

We present a new methodology to solve the flexible shift scheduling problem of physicians. The formulation of the problem allows shifts to be generated implicitly rather than employing a predefined set of shift types. Our objective is to minimize the total cost of the assignments given the general labor restrictions. To find high quality assignments, a branch-and-price algorithm is developed that uses several branching rules. The master problem is formulated as a set covering problem whereas the subproblems are mixed integer programs.

#### 2 - Planning elective surgeries — analysis and comparison in a real case

*Inês Marques*, DEIO - CIO, Faculdade de Ciências da Universidade de Lisboa, Campo Grande - Ed. C6 - 4<sup>o</sup> Piso, 1749-016, Lisbon, Portugal, ines.marques@fc.ul.pt, *Maria Eugénia Captivo*, *Margarida Pato*

This work emerges from an urgent need to rationalize resources in health care as well as to reduce waiting lists for surgery in Portugal. An integer linear programming model is presented to schedule elective surgeries. Model solutions were obtained using an exact solver. We compare a real week plane of a hospital in Lisbon with the results obtained from the application of the model developed, considering real data of the same hospital.

#### 3 - Operational research to support the development of triage protocols for use in determining access to paediatric intensive care in the context of pandemic influenza.

*Martin Utley*, Clinical Operational Research Unit, University College London, Gower Street, WC1E 6BT, London, United Kingdom, m.utley@ucl.ac.uk

The threat of an influenza pandemic remains a concern within the UK. At the peak of a pandemic, there would be no access to paediatric intensive care units. However, it is anticipated that there would be periods when paediatric intensive care units are operational and demand is significantly greater than capacity. This presentation will concern analysis being conducted to support the development of protocols to determine access to and continuance of intensive care in this context.

## ■ MC-22

Monday 12:00-13:20

*Arndt*

### Innovations in Railway Logistics Operations

Stream: OR Applications in Industry

*Invited session*

Chair: *Jo van Nunen*, Department Decision and Information Sciences, RSM Erasmus University, Burgemeester Oudlaan 50, 3062 PA, Rotterdam, Netherlands, jnunen@rsm.nl

Chair: *Bjarni Kristjánsson*, Maximal Software, Ltd., Boundary House, Boston Road, W7 2QE, London, Iceland, bjarni@maximalsoftware.com

#### 1 - Impact of introducing crew scheduling support at netherlands railways

*Erwin Abbink*, Department of Logistics, NS Dutch Railways, NL-3500 HA, Utrecht, Netherlands, Erwin.Abbink@ns.nl

We present the impact of introducing decision support for the large-scale crew scheduling problems arising at the Dutch railway operator, Netherlands Railways (NS). NS operates about 30,000 trains a week. These trains need a driver and a certain number of conductors, resulting in crew duties for about 6000 train crew employees. The corresponding planning process is supported by advanced Operations Research techniques. We will focus both on improvements to the planning process and in the product. We show the positive impact on efficiency, punctuality, and on job satisfaction of the train crew.

## 2 - How can the railway system benefit from OR tools? some preliminary observations from sncf

*David De Almeida*, Innovation & Research  
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Railways undertakings and infrastructure manager must focus on customer expectations and manage their scarce resources more efficiently and in a more agile way. The railway production system relies on a heavy planning process where OR tools can be very valuable to enhance current practices, for example by the production of optimized engines circulations or through the investigation of many more production scenarios with the help of computerized OR models. However, such tools require a proper integration with the existing information systems and the end users in order to deliver their promises.

## 3 - Impact of or-tools at prorail network development

*Dick Middelkoop*, Netherlands,  
d.middelkoop@railned.nl

ProRail, the Dutch rail infrastructure manager, is responsible for the safe and optimal use of the rail network. To ensure this we try to look into the future to determine how to solve potential bottlenecks in the network given the demand forecast. This toolbox has a number of tools that support activities in the field of passenger and freight forecasts, optimisation of train services, timetable design and simulation, capacity analysis and traffic management systems. With this toolbox ProRail improves the quality and the throughput times of the network design and the decision making process.

## MC-23

Monday 12:00-13:20

Planck

### ANP I

Stream: Analytic Hierarchy Processes, Analytic Network Processes

*Invited session*

Chair: *Monica Garcia-Melon*, Engineering Projects,  
Universidad Politecnica de Valencia, Camino de Vera s/n,  
46022, Valencia, Spain, mgarciam@dpi.upv.es

Chair: *Pablo Aragonés-Beltrán*, Engineering Projects,  
Universidad Politecnica de Valencia, Camino de Vera s/n,  
46022, VALENCIA, VALENCIA, Spain,  
aragonés@dpi.upv.es

## 1 - A project strategic index proposal for portfolio selection based on the analytic network process

*Monica Garcia-Melon*, Engineering Projects,  
Universidad Politecnica de Valencia, Camino de Vera  
s/n, 46022, Valencia, Spain, mgarciam@dpi.upv.es,  
*Rocio Poveda-Bautista*, *Juan P. Pastor-Ferrando*

A new approach to prioritize project portfolio in an efficient and reliable way is presented. It introduces a rigorous procedure, based on ANP and the strategic objectives of the company, with acceptable complexity which seeks to assist managers of a big Electrical Company of Venezuela to distribute the annual budget among the possible improvement actions to be conducted on the electrical network of Caracas. A total of 15 network improvement actions grouped into three clusters according to the strategic objectives of the company have been analyzed using the Project Strategic Index proposed.

## 2 - Location of a municipal solid waste management plant in the metropolitan area of valencia (spain) using an analytic network process model.

*Pablo Aragonés-Beltrán*, Engineering Projects,  
Universidad Politecnica de Valencia, Camino de Vera  
s/n, 46022, VALENCIA, VALENCIA, Spain,  
aragonés@dpi.upv.es, *Juan P. Pastor-Ferrando*,  
*Fernando García-García*, *Amadeo Pascual-Agulló*

In this work ANP is applied to select the best location for the construction of a municipal solid waste (MSW) plant in the Metropolitan area of Valencia (Spain). This is a complex multicriteria decision-making problem that requires an extensive evaluation process of the potential MSW plant locations and other economic, technical, legal, social or environmental issues. The decision-making process includes the identification of six candidate MSW plant sites and 21 criteria grouped into clusters. The influences between the elements of the network were identified and analyzed using the ANP.

## 3 - Comparison of two apparel retailer companies: a multiple criteria evaluation of retail locations

*Y. Ilker Topcu*, Industrial Engineering, Istanbul  
Technical University, Istanbul Teknik Universitesi,  
Isletme Fakultesi, Macka, 34367, Istanbul, Turkey,  
ilker.topcu@itu.edu.tr, *Sebnem Burnaz*

This study proposes an ANP based evaluation of retail locations by using the judgments of professionals from two retailer companies operating mainly in apparel sector: a major global retailer with over 840 stores in more than 30 countries around the world versus a local industry-leading retail store chain with more than 200 stores in 50 cities of Turkey. As a result of the process; the retail location evaluation criteria were identified, the relations among the criteria were assessed, and the relative importance of the criteria with respect to two companies was revealed.

## 4 - Projects prioritization in higher education institutions using the analytic network process

*Nina Begicevic*, University of Zagreb, Faculty of  
Organization and Informatics, 99999, Varaždin,  
Croatia, begicevic@foi.hr, *Blazenka Divjak*, *Tihomir Hunjak*

In this paper we deal with prioritization of projects in higher education institutions. The first scenario is a need to prepare an action plan for activities that will result in the implementation of a portfolio of projects at the institutional level. The second scenario is making a decision on whether to start a new project application in a situation where project teams have several project ideas and limited resources. The purpose of the paper is to show how to include corporate strategy in the decision-making process and use the Analytic Network Process in solving project selection problems.

## ■ MC-24

Monday 12:00-13:20

GSI - S 20

### Linear Semi-Infinite Optimization I

Stream: Semi-Infinite Optimization

*Invited session*

Chair: *Ralf Werner*, Risk Methodology, Hypo Real Estate / TU München, Unsöldstr. 2, 80538, München, Germany, [werner\\_ralf@gmx.net](mailto:werner_ralf@gmx.net)

#### 1 - Bounds on basket options by linear semi-infinite programming

*Ralf Werner*, Risk Methodology, Hypo Real Estate / TU München, Unsöldstr. 2, 80538, München, Germany, [werner\\_ralf@gmx.net](mailto:werner_ralf@gmx.net)

In 2005, Laurence and Wang introduced two linear SIPs for lower and upper bounds on the prices of basket options. Although the upper bound problem has an analytic solution, the lower bound problem needs numerical solution. In this talk we investigate the performance of a discretization method (with a DC algorithm for the inner global optimization problem) and compare it to the exact solution derived by an ordinary LP. Based on these observations we highlight a surprising strong dependence of the performance on a discriminant parameter, which will be interpreted in a financial context.

#### 2 - Qualification, optimality conditions, and subdifferentials of optimal values functions for dc infinite and semi-infinite programs

*Dinh Nguyen*, Department of Mathematics, International University - VNUHCM, Hochiminh city, Vietnam, Quarter 6, Linh Trung ward., Thu Duc district. Ho Chi Minh city, 84, Ho Chi Minh, [ndinh@hcmiu.edu.vn](mailto:ndinh@hcmiu.edu.vn)

The report is devoted to the study of a class of DC problems with infinitely many convex inequality constraints in locally convex spaces. We first introduce a qualification condition under which necessary and sufficient optimality conditions for such a class of problems are obtained. The results are employed to establish upper estimates of certain subdifferentials of value functions in parametric DC infinite programs. In turn, these results are used to study the bilevel finite and infinite programs with convex data on both lower and upper level of hierarchical optimization

#### 3 - Evenly convex functions

*Margarita Rodríguez Álvarez*, Dpto. Estadística e Investigación Operativa, Universidad de Alicante, Ctra. Alicante-San Vicente s/n, 03690, San Vicente del Raspeig, Alicante, Spain, [marga.rodriguez@ua.es](mailto:marga.rodriguez@ua.es), *José Vicente Pérez*

A set is evenly convex if it is the intersection of some family of open halfspaces. This class of convex sets was introduced by Fenchel in order to extend the polarity theory to nonclosed convex sets. In the eighties, it was started to use evenly convex sets in quasiconvex programming dening the evenly quasiconvex functions as those having evenly convex sublevel sets. In this work, we consider functions with evenly convex epigraphs, the evenly convex functions, and study the main properties of this class of functions containing the important class of lower semicontinuous convex functions.

## ■ MC-25

Monday 12:00-13:20

GSI - S 25

### Operations Research Games

Stream: Cooperative Game Theory

*Invited session*

Chair: *Gustavo Bergantinos*, Statistics and O. R., University of Vigo, Facultade de Económicas, Universidade de Vigo, 36310, Vigo, Pontevedra, Spain, [gbergant@uvigo.es](mailto:gbergant@uvigo.es)

#### 1 - On obligation rules

*Gustavo Bergantinos*, Statistics and O. R., University of Vigo, Facultade de Económicas, Universidade de Vigo, 36310, Vigo, Pontevedra, Spain, [gbergant@uvigo.es](mailto:gbergant@uvigo.es), *Anirban Kar*

Tijs et al (2006) introduce the family of obligation rules in minimum cost spanning tree problems. We prove that obligation rules are closely related with the marginalistic values of the irreducible game. We prove that random order values are obligation rules. Moreover, obligation rules are marginalistic values. We also provide axiomatic characterization of obligation rules with two basic monotonicity properties, namely population monotonicity and strong cost monotonicity.

#### 2 - A characterization of the proportional rule in multi-issue allocation situations

*Silvia Lorenzo-Freire*, Department of Mathematics, Universidade da Coruña, Campus de Elviña, 15071, A Coruña, Spain, [slorenzo@udc.es](mailto:slorenzo@udc.es), *Gustavo Bergantinos*, *Leticia Lorenzo*

Multi-issue allocation situations study problems where we have to divide an estate among a group of agents. The claim of each agent is a vector specifying the amount claimed by each agent on each issue. We present an axiomatic characterization of the proportional rule.

#### 3 - New characterizations of the constrained equal awards rule in multi-issue allocation situations

*Leticia Lorenzo*, Statistics and Operations Research, University of Vigo, Facultad de Economía, Lagoas-Marcosende s/n, 36310, Vigo, Pontevedra, Spain, [leticiaap@uvigo.es](mailto:leticiaap@uvigo.es), *Gustavo Bergantinos*, *Silvia Lorenzo-Freire*

Multi-issue allocation situations study problems where we have to divide an estate among a group of agents. The claim of each agent is a vector specifying the amount claimed by each agent on each issue. We present several axiomatic characterizations of the constrained equal awards (or losses) rule generalizing some characterizations of these rules in bankruptcy situations.

#### 4 - Sharing a polluted river through environmental taxes

*Gómez-Rúa María*, Estadística e Investigación Operativa, Universidade de Vigo, Facultade de CC. Económicas e Empresariais. Lagoas-Marcosende, s/n, 36310, Vigo, [mariarua@uvigo.es](mailto:mariarua@uvigo.es)

We consider a river divided into  $n$  segments. There are  $n$  agents located along the river who generate residues. The river requires cleansing and it entails some cost. We propose several rules to distribute the total pollutant-cleaning cost among all the agents. For each rule we provide an axiomatic characterization using properties based in water taxes. Moreover, we prove that one of the rules coincides with the weighted Shapley value of a game associated with the problem.

## ■ MC-26

Monday 12:00-13:20

GSI - S 35

### Graphs and Networks II

Stream: Discrete Optimization

*Contributed session*

Chair: *Kiyoshi Sawada*, Department of Information and Management Science, University of Marketing and Distribution Sciences, 3-1, Gakuen-nishi-machi, Nishi-ku, 651-2188, Kobe, [Kiyoshi\\_Sawada@red.umds.ac.jp](mailto:Kiyoshi_Sawada@red.umds.ac.jp)

#### 1 - Adding edges to multi-levels of a complete k-ary tree minimizing total distance

*Kiyoshi Sawada*, Department of Information and Management Science, University of Marketing and Distribution Sciences, 3-1, Gakuen-nishi-machi, Nishi-ku, 651-2188, Kobe,  
[Kiyoshi\\_Sawada@red.umds.ac.jp](mailto:Kiyoshi_Sawada@red.umds.ac.jp), *Kazuyuki Amano*

This study proposes a model of adding relations in multi-levels to an organization structure which is a complete K-ary tree such that the communication of information between every member in the organization becomes the most efficient. When edges between every pair of nodes at each of L levels are added to a complete K-ary tree of height H, an optimal set of depths of L levels is obtained by minimizing the total distance which is the sum of the number of edges in shortest paths between every pair of all nodes in the complete K-ary tree.

#### 2 - Finding Hamiltonian contour with minimal acceptable risk weight

*Mirko Vujosevic*, Laboratory for Operational Research, Faculty of Organizational Sciences, Jove Ilica 154, 11000, Belgrade, Serbia, [mirkov@fon.rs](mailto:mirkov@fon.rs), *Djokovic Aleksandar*

The weight of the Hamiltonian contour ( $H_c$ ) is supposed to be normally distributed random variable with mean and variance calculated as the sums of the corresponding means and variances of its edges. The  $H_c$  weight of the acceptable risk is defined as the value for which the probability of realization of weights greater than this value is less than given risk probability. The problem is to find  $H_c$  with the minimal acceptable risk weight for given risk probability. An algorithm for its solving and some preliminary results are presented.

#### 3 - Mathematical modeling and solving the metric dimension and related problems

*Mirjana Cangalovic*, Department for Mathematics, Statistics and Operational Research, Faculty of Organizational Sciences, University of Belgrade, Jove Ilica 154, Belgrade, Serbia, [canga@fon.rs](mailto:canga@fon.rs),  
*Jozef Kratica*, *Vera Kovacevic Vujcic*

The paper considers three NP-hard optimization problems on graphs: the metric dimension, the strong metric dimension and the minimal doubly resolving set problems. We present the corresponding integer linear programming models. Numerical experiments are performed on several classes of graphs, including hypergraphs and Hamming graphs, as well as on crew scheduling and graph coloring ORLIB instances. Problems of smaller dimensions are solved exactly, while large scale problems are treated by genetic algorithms.

#### 4 - A greedy algorithm for obtaining global information from local informations in a Markov network

*Edith Kovacs*, Department of Mathematics, Budapest College of Management, Villanyi ut 11-13, 1114,

Budapest, Hungary, [edith\\_kovacs@yahoo.com](mailto:edith_kovacs@yahoo.com), *Tamas Szantai*

In order to approximate a joint probability distribution we have introduced a special kind of junction tree, called t-cherry junction tree in our earlier work. This approach is based on the t-cherry tree and t-hypercherry tree. We developed a greedy algorithm that can derive from the local information contents an optimal t-cherry junction tree (a special spanning hypertree) which encodes the information of the joint probability distribution. In the last part we highlight some possible applications of our theory in data mining problems such as classification and pattern recognition.

## ■ MC-27

Monday 12:00-13:20

GSI - S 21

### Berth and Crane Operations Planning

Stream: Container Terminal Operations

*Invited session*

Chair: *Frank Meisel*, Martin-Luther-University Halle-Wittenberg, Gr. Steinstr. 73, 06108, Halle, Germany, [frank.meisel@wiwi.uni-halle.de](mailto:frank.meisel@wiwi.uni-halle.de)

#### 1 - The quay cranes scheduling problem with time windows

*Frank Meisel*, Martin-Luther-University Halle-Wittenberg, Gr. Steinstr. 73, 06108, Halle, Germany, [frank.meisel@wiwi.uni-halle.de](mailto:frank.meisel@wiwi.uni-halle.de), *Christian Bierwirth*

We consider the problem of scheduling quay cranes that serve container vessels in a seaport. In previous studies of this problem it is assumed that the number of cranes serving a vessel is not changed within the service process. In practice, however, cranes are often re-assigned to vessels of higher priority. In such a situation, the availability of cranes at a vessel is restricted to time windows. In the talk, we present a mathematical model for the quay crane scheduling problem with time windows. A heuristic is proposed that delivers reasonably good solutions for a set of test instances.

#### 2 - Accelerating quay crane operations through double cycling and reshuffling

*Christian Bierwirth*, Martin-Luther-University Halle-Wittenberg, 06108, Halle, Germany, [christian.bierwirth@wiwi.uni-halle.de](mailto:christian.bierwirth@wiwi.uni-halle.de), *Frank Meisel*

Recent studies indicate that the handling of vessels is significantly accelerated by quay crane double cycling. This paper suggests a strategy to further accelerate the service process by internally reshuffling containers in a bay in combination with double cycling. Reshuffle containers are no export containers and must be moved to access other containers for unloading. We develop a MIP model and provide a fast heuristic for building crane schedules. Computational results show that internal reshuffling can reduce the vessel service time considerably stronger than crane double cycling alone.

#### 3 - Robust optimal control of vessel processing in container terminals

*Johannes Paefgen*, Institute for Operations Research, ETH Zurich, Steinwiesstr. 4, 8032, Zurich, Switzerland, [johannes.paefgen@gmail.com](mailto:johannes.paefgen@gmail.com), *Marco Laumanns*

We consider a container terminal where vessels arrive randomly within an arrival window given by a fixed periodic schedule. Vessel processing requires an assignment of quay cranes and berth sections, and is required to be completed within a contractually agreed service time. This can be formulated as a stochastic dynamic resource allocation problem. A Markov decision process model is proposed, and algorithms for derivation of its optimal control policy are given for different cost criteria. The resulting closed-loop system is analyzed with respect to robustness for non-modeled disturbances.

## ■ MC-28

Monday 12:00-13:20

GSI - S 1

### Financial Optimization 2

Stream: Financial Optimization

*Invited session*

Chair: *Diana Barro*, Dept. of Applied Mathematics, University of Venice, Dorsoduro 3825/E, 30123, Venezia, Italy, [d.barro@unive.it](mailto:d.barro@unive.it)

#### 1 - Skewness-aware asset allocation: empirical evidence

*Dessislava Pachamanova*, Mathematics and Sciences, Babson College, 319 Babson Hall, 02457, Babson Park, MA, United States, [dpachamanova@babson.edu](mailto:dpachamanova@babson.edu), *Melvyn Sim*, *Cheekiat Low*

We introduce a measure of portfolio skewness that can be linked to tail risk measures such as Value-at-Risk, and generalize the idea of variance and covariance in the new skewness-aware asset pricing and allocation framework. We show via computational experiments that the proposed approach results in improved and intuitively appealing asset allocation when returns follow real-world or simulated skewed distributions. We also suggest a skewness-aware equivalent of the classical CAPM beta, and study its consistency with the observed behavior of the stocks traded at the NYSE between 1963 and 2006.

#### 2 - Stochastic portfolio optimization with market frictions

*Miguel Lejeune*, Decision Sciences, George Washington University, 2201 G Street, NW, 20052, Washington, DC, [mlejeune@gwu.edu](mailto:mlejeune@gwu.edu)

We propose probabilistic asset allocation models that account for market frictions and for the estimation risk pertaining to asset returns. Exact solution methods are developed and their computational results are compared. The application of the model and solution approach for the construction of funds traded on major market places will be discussed.

#### 3 - Application of interactive surrogate constraint method to financial optimization problems

*Yuji Nakagawa*, Faculty of Informatics, Kansai University, 2-1-1 Ryozzenji-Cho Takatsuki-City, 569-1095, Osaka, Japan, [nakagawa@res.kutc.kansai-u.ac.jp](mailto:nakagawa@res.kutc.kansai-u.ac.jp), *Yuriko Isada*, *Nobuko Igaki*, *Chanaka Edirisinghe*

Large-scale separable nonlinear integer programming problems with multiple constraints can be solved optimally by using the improved surrogate constraints (ISC) method. We developed an interactive optimization solver based on the ISC method to solve a non-separable and non-convex optimization problem. The interactive optimization solver is applied to the financial optimization problems; e.g., mean-variance model and the index-plus-alpha-funds optimization model. The models are applied to the Tokyo Stock Market and computational results are reported.

#### 4 - The effect of shorting in optimal tracking error portfolios

*Diana Barro*, Dept. of Applied Mathematics, University of Venice, Dorsoduro 3825/E, 30123, Venezia, Italy, [d.barro@unive.it](mailto:d.barro@unive.it), *Gautam Mitra*, *Diana Roman*

In this paper we analyze the effect of using long short portfolio to track an index. The main objectives of this contribution are to point out the effect of shorting mainly in a bearish market and to analyze the effect of shorting both in a symmetric and asymmetric tracking error cases in presence of extreme event scenarios. We are interested in analyzing the increased flexibility in the tracking strategies granted by the introduction of short selling in terms of tracking performance in normal market conditions and in presence of extreme events.

## ■ MC-29

Monday 12:00-13:20

GSI - S 2

### Risk and Uncertainty in Energy Models

Stream: Energy and Emission Markets

*Invited session*

Chair: *Christoph Weber*, Universität Essen, Universitätsstr. 11, 45117, Essen, Germany, [Christoph\\_Weber@uni-duisburg-essen.de](mailto:Christoph_Weber@uni-duisburg-essen.de)

Chair: *Dominik Möst*, Universität Karlsruhe, Institut für Industrial Production (IIP), Hertzstraße 16, 76131, Karlsruhe, Germany, [Dominik.Moest@kit.edu](mailto:Dominik.Moest@kit.edu)

#### 1 - Power plant dispatch and portfolio management under uncertain fuel and electricity prices

*Dominik Möst*, Universität Karlsruhe, Institut für Industrial Production (IIP), Hertzstraße 16, 76131, Karlsruhe, Germany, [Dominik.Moest@kit.edu](mailto:Dominik.Moest@kit.edu), *Dogan Keles*, *Wolf Fichtner*

In liberalised energy markets energy utilities are facing several uncertainties. The short-term plant dispatch is mainly affected by uncertain fuel and electricity prices. In this contribution these uncertainties are modelled with time series models such as ARMA-processes. The simulated price paths are used in a stochastic model based on a recombining tree approach, to optimize the plant dispatch and the electricity trade on the wholesale market. Results of the stochastic model are compared with a deterministic calculation, to point out the impact of stochastic parameters.

#### 2 - Advantages of a stochastic optimization in mid-term generation and trading planning

*Bernd Tersteegen*, Institute of Power Systems and Power Economics (RWTH Aachen University), Schinkelstr. 6, 52056, Aachen, [bt@iaew.rwth-aachen.de](mailto:bt@iaew.rwth-aachen.de), *Tobias Mirbach*, *Gerd Hinueber*

Within the scope of this work a stochastic optimization method for power generation and trading planning is presented. The investigations focus on the influence of price uncertainties for unit commitment of thermal power plants under consideration of fuel constraints. In particular, the difference between a deterministic Monte Carlo simulation and a stochastic optimization by means of scenario analysis using scenario trees will be investigated with respect to a robust optimization result. Therefore, the scheduling of power plants as well as the contribution margin will be analyzed.

### 3 - Valuation of a flexible gas fired unit under uncertain prices

Marc Hasenbeck, F&E, price[it] GmbH, Breite Str. 32a, 06108, Halle, Sachsen-Anhalt, hasenbeck@price-it.eu

We present a modelling approach for a flexible gas fired unit for the purpose of valuation and controlling facing uncertainty in prices for gas and electricity. Especially it is taken care of a realistic modelling of prices and the embedding of important restrictions like minimum uptimes and downtimes, ramp up costs and lead times for commitment decision. The path-dependent problem is solved with Stochastic Dynamic Programming in a Quasi-Monte-Carlo environment. Finally we discuss the value of flexibility as part of real options theory and hedging strategies.

## ■ MC-30

Monday 12:00-13:20

GSI - S 26

### Dynamic Programming I

Stream: Dynamic Programming

Invited session

Chair: Lidija Zadnik Stirn, Biotechnical Faculty, University of Ljubljana, Vecna pot 83, 1000, Ljubljana, Slovenia, lidija.zadnik@bf.uni-lj.si

#### 1 - The dynamic lot size problem with minimum order quantities and capacity constraints

Irena Okhrin, Juniorprofessur in Information & Operations Management, European University Viadrina, Grosse Scharrnstrasse 59, 15230, Frankfurt (Oder), Germany, irena.okhrin@euv-frankfurt-o.de, Knut Richter

The paper continues the analysis of a capacitated single item lot sizing problem where a minimum order quantity restriction, instead of the setup cost, guarantees a certain level of production lots. We work out the necessary and sufficient solvability conditions and apply the dynamic programming technique to develop a solution algorithm that is based on the concept of minimal sub-problems. An investigation of the properties of the optimal solution structure allowed us to reduce the complexity of the algorithm. Computational tests confirm the efficiency of the solution algorithm developed here.

#### 2 - Multi-level hierarchic Markov process as a tool for optimization of beef heifer management decisions

Anna Stygar, Department of Cattle Breeding, University of Agriculture in Krakow, al. Mickiewicza 24/28, 30-059, Crakow, rwira@wp.pl, Anders Kristensen

Economic efficiency of beef herd is highly influenced by the decisions on heifer management. The identification of the optimal decisions can be supported by means of mathematical modeling and programming. The objective of this study was to develop the model to optimize the strategy of beef heifer rearing and mating concerning economic output at single-animal level. Optimization was performed using dynamic programming method with multi-level hierarchic Markov approach. The model was created as a plug-in of MLHMP software.

#### 3 - A unifying approximate dynamic programming model for the economic lot scheduling problem

Christiane Barz, Booth School of Business, University of Chicago, 5807 S Woodlawn Ave, 606037, Chicago,

IL, United States, cbarz@chicagoGSB.edu, Dan Adelman

We formulate the economic lot scheduling problem with sequence-dependent setups as a semi-MDP. An affine approximation of the bias function gives a semi-infinite LP determining a lower bound for the minimum average cost rate. Under a mild condition, we can reduce this problem to a small convex quadratically constrained linear problem, which is equivalent to the lower bound problems derived by Dobson (1992) and Bomberger (1966). We thus provide a framework that unifies previous work, and opens new paths for future research on tighter lower bounds and dynamic heuristics.

#### 4 - Optimal dispatch planning of security guards counter to an arriving suicide bomber

Toru Komiya, Dept. of Computer Science, Japan National Defense Academy, Hashirimizu 1-10-20, 2398686, Yokosuka, kanagawa, Japan, komiya@nda.ac.jp, Methee Pholphphan, Ryusuke Hohzaki

We propose a method to decide the number of dispatching security guards optimally to Arena where many citizens come and go through. Through some successive planned mission periods, some guards are dispatched to Arena to patrol and search for an emerging suicide bomber. When they perceive a suspect, then communicate with each other and try to neutralize him. In each period, the numbers of dispatching guard are decided to maximize the expected number of living guards and citizens. We concluded that the optimal numbers depends on the detection capabilities of each guard mainly.

## ■ MC-31

Monday 12:00-13:20

GSI - S 34

### Data Mining Applications in Quality Improvement

Stream: Data Mining in Quality Improvement

Invited session

Chair: Gulser Koksak, Industrial Engineering, Middle East Technical University, 6531, Ankara, Turkey, koksak@ie.metu.edu.tr

#### 1 - Exploring the emotions of internet newspaper reader's by kansei engineering

Ezgi Aktar Demirtas, Industrial Engineering, Eskisehir Osmangazi University, Eskisehir Osmangazi University Department of IE, 26140 Meselik ESKISEHIR/TURKIYE, 26140, ESKISEHIR, Turkey, eaktar@ogu.edu.tr, Berna Ulutas

By the development of internet applications and changes in the reader's habits, internet newspapers are becoming more popular in these days. This study proposes a Kansei Engineering approach to explore the emotions of internet newspaper readers. A group of representative readers have been asked to evaluate different newspaper designs by using a semantic differential scale for the kansei words that specific to internet newspapers. Then, the kansei words that can influence reader's preferences are investigated by Ordinal Logistic Regression which is superior to traditional methods.

#### 2 - Comparison of data mining algorithms for classification and prediction in quality improvement

Gulser Koksak, Industrial Engineering, Middle East Technical University, 6531, Ankara, Turkey, koksak@ie.metu.edu.tr, Zeynep Anakli, Inci Batmaz,

*Fatma Yerlikaya Ozkurt, Murat Caner Testik, Elcin Kartal, Sinan Kayaligil, Berna Bakir, Esra Karasakal*

Classification and Prediction are frequently used data mining (DM) functions in many areas including quality improvement. Several DM methods can be used for these purposes. Previous studies on comparison of performance of these methods may not be valid for the quality data. In this study, DM methods such as decision trees, neural networks and regression are prioritized according to several criteria using Analytical Network Process. In this comparison performance of the methods on two data sets used for classification and prediction of quality, and expert opinion are taken into consideration.

### 3 - A re-sampling approach and its applications for mts classification based on imbalanced data

*Berna Bakir*, Information System, Middle East Technical University, METU Informatics Institute, Balgat, 06531, Ankara, [berna@ii.metu.edu.tr](mailto:berna@ii.metu.edu.tr), *Dilber Ayhan*, *Baris Yenidunya*, *Gulser Koksak*

Learning from imbalanced datasets is a major challenge for classifiers. Resampling is commonly used solution for imbalanced datasets. In this study, a SMOTE-based resampling approach was used to determine optimal resampling parameters. 10 imbalanced datasets were resized with undersampling or oversampling based on the search space of class ratio, sample size and number of neighbors. Datasets were modeled with MTS classifier. Decision tree was applied to the results to generate rules that relate datasets characteristics and resampling parameters to the performance of the classifier.

### 4 - Nonsmooth optimization of desirability functions by msg algorithm

*Basak Akteke-Ozturk*, Institute of Applied Mathematics, Middle East Technical University, Scientific Computing, 06531, Ankara, Turkey, [bozturk@metu.edu.tr](mailto:bozturk@metu.edu.tr), *Gulser Koksak*, *Gerhard-Wilhelm Weber*

We concentrate on the optimization problems of the desirability functions which are very common in solving quality problems depending on several quality characteristics in industrial processes and products but they contain nondifferentiable points. Castillo et al. (1996) and later Ch'ng et al. (2005) presented new approaches to avoid the nondifferentiabilities based on smoothening and changing the formula of the functions, respectively. We use Modified Sub-gradient Algorithm given by Gasimov (2002) and analyze the zero duality gap properties of the algorithm on our specific example.

## MC-32

Monday 12:00-13:20

GSI - S 4

### Financial Markets

Stream: Financial Modelling

*Contributed session*

Chair: *Gabriela Fernández Barberis*, Métodos Cuantitativos para Economía, Universidad San Pablo-CEU. Fac. CC. Económicas y Empresariales, Julián Romea 23, 28003, Madrid, Madrid, Spain, [ferbar@ceu.es](mailto:ferbar@ceu.es)

### 1 - Equilibrium pricing of contingent claims in tradable permit markets

*Katsumasa Nishide*, Interdisciplinary Research Center, Yokohama National University, 79-3 Tokiwadai, Hodogaya-ku, 2408501, Yokohama, Japan, [knishide@ynu.ac.jp](mailto:knishide@ynu.ac.jp)

In this paper, we construct a permit market model to derive a pricing formula of contingent claims traded in the market in a general equilibrium framework. It is shown that prices of contingent claims exhibit significantly different properties from those in the ordinary financial markets. In particular, if the social cost function kinks at some level of abatement, the forward price as well as the spot price can be subject to the so-called price spike. However, this price-spike phenomenon can be weakened if the system of banking and borrowing is properly introduced.

### 2 - On lazy \$-game and its behavior

*Jun Kiniwa*, Applied Economics, University of Hyogo, 8-2-1 Gakuen nishi-machi, 651-2197, Kobe, Hyogo, Japan, [kiniwa@econ.u-hyogo.ac.jp](mailto:kiniwa@econ.u-hyogo.ac.jp), *Takeshi Koide*, *Hiroaki Sandoh*

To increase the market similarity of a minority game, a \$-game was presented. However, since it is defined as an offline game, it is difficult to simulate it. We propose a new online version of the \$-game, called a lazy \$-game. First we reveal the condition of a bubble phenomenon in the lazy \$-game. Next we investigate the price behavior in the lazy \$-game and show that there are some upper/lower bounds of price as long as both buyers and sellers are nonempty. Then we consider the similarity between the lazy \$-game and the \$-game. Finally we present simulation results.

### 3 - An investor/entrepreneur dynamic model of start-up firms

*Edgar Possani*, Department of Mathematics, Instituto Tecnológico Autónomo de México, Río Hondo No.1, Col. Progreso Tizapan, C.P. 01080, Mexico City, D.F. - Mexico, Mexico, [epossani@itam.mx](mailto:epossani@itam.mx), *Thomas Archibald*, *Lyn Thomas*

Start-up firms are important drivers of modern economies, not only as a source of innovation but also in the generation of new jobs. We examine how different objectives for investors and entrepreneurs affect the characteristics of the investment contracts and operating policies used by start-up firms. Using Markov decision models we address financial and operating decision under different economic environments, and give conditions under which optimal policies change for both parties.

## MC-33

Monday 12:00-13:20

GSI - S 7

### global optimization in locating in space

Stream: Global Optimization

*Invited session*

Chair: *Oleg Burdakov*, Department of Mathematics, Linköping University, Campus Valla, 58183, Linköping, Sweden, [olbur@mai.liu.se](mailto:olbur@mai.liu.se)

### 1 - Nash equilibria in locational analysis

*Elena Saiz*, Strategy, Radboud Universiteit Nijmegen, Thomas van Aquinostraat 3.1.04, 6525GD, Nijmegen, Netherlands, [e.saiz@fm.ru.nl](mailto:e.saiz@fm.ru.nl), *Eligius M.T. Hendrix*, *Blas Pelegrin*

The location decision of a facility for two competing chains in a new planar market is described by a Huff-like attraction model. This means that the market share capture is given by a gravity model. The profit that can be reached depends on the actions of the competitor. The main question is what are the possible Nash equilibria in such a situation, how are they characterised and by which computational methods could they be determined.

## 2 - Competitive facility location and design model with reaction of competitors in the plane

*Saidani Nasreddine*, ICD, CNRS 2848 Université de Technologie de Troyes, France, 12, rue Marie Curie - BP 2060, 10010, TROYES, France, nasreddine.saidani@utt.fr, *Chu Feng, Chen Haoxun*

This work investigates the location and design of a single new facility in a competitive market. The demand is split probabilistically over all facilities proportionally to the attraction of each facility. The attraction is determined by a gravitational type model. We develop a new technique with two stages by combining the techniques of operations research and those of game theory. We use the global optimization to determine the location that maximizes the profit and the Nash equilibrium to determine the quality of the new facility and those in the market that guarantee the equilibrium.

## 3 - Optimal placement of communications relay nodes

*Oleg Burdakov*, Department of Mathematics, Linköping University, Campus Valla, 58183, Linköping, Sweden, olbur@mai.liu.se, *Patrick Doherty, Kaj Holmberg, Per-Magnus Olsson*

We consider optimal 3D placement of communications relay nodes (unmanned vehicles, UVs) in the presence of obstacles. It is a difficult multi-extremal problem with typically disjoint feasible set. A spatial discretization and a reduction to a shortest path problem allows efficient finding a good approximation to a global minimum. Restricted number of available UVs is also considered. We introduce two label correcting algorithms for the hop-restricted shortest path problem. The algorithms produce a Pareto solution to the two-objective problem of minimizing the path cost and the number of hops.

## 4 - On the convex hull of Huffman codes

*Thanh Hai Nguyen*, Computer Fundamental Laboratory of Marseille, University of the Mediterranean sea, Faculté des Sciences de Luminy, 163, av. de Luminy, F-13288, Marseille cedex 9,, France, thanh.hai.nguyen@lif.univ-mrs.fr, *Jean François Maurras, Viet Hung Nguyen*

In this paper, we give a partial description of convex hull of Huffman codes. That is defined from a finite set of rooted binary tree of  $n$  leaves, there are Huffman trees of  $n$  characters. To each of possible Huffman codes, which are built following the frequency distribution of each character on the text, we associate a point in  $Q_n$  with the coordinates are the number of edges of the unique path from the root to each leaf of the tree. We describe several facet-defining inequality families, in particular, we show that the coefficients of one of these families form a Fibonacci sequence.

## ■ MC-34

Monday 12:00-13:20

GSI - S 8

### Fuzzy Optimization and Decision Analysis 1

Stream: Fuzzy Systems, Neural Networks & Artificial Intelligence

*Invited session*

Chair: *Masahiro Inuiguchi*, Department of Systems Innovation, Osaka University, 1-3 Machikaneyama, 560-8531, Toyonaka, Osaka, Japan, inuiguti@sys.es.osaka-u.ac.jp

## 1 - The use of interval valued probability measures in fuzzy linear programming

*Phantipa Thipwivatpotjana*, University of Colorado Denver, 80202, Denver, United States, phantipa.thip@ucdenver.edu, *Weldon Lodwick*

This paper uses a constraint set approach to linear programming problems with equality constraints whose coefficients and/or right-hand side values could be uncertain. We consider three types of uncertainty: probabilistic, fuzzy/possibilistic and interval. The constraint set is ill-defined and difficult to generate. Our approach computes an inner constraint set and an outer constraint set. Optimization is then carried out using these two sets using interval valued probability approaches. We discuss the requisite associated semantics.

Co-Author: Phantipa Thipwivatpotjana

## 2 - Production and transportation planning — a fuzzy approach for minimizing the total cost

*Heinrich Rommelfanger*, Economics and Business Administration, Goethe University, Niebergallweg 16, 65824, Schwalbach a. Ts., Hessen, Germany, Rommelfanger@wiwi.uni-frankfurt.de

The target of this paper is to determine a production and transportation plan that minimize the total cost of a manufacturer that has production facilities and central stores in several sites in Europe. For working in a realistic environment we assume that the production capacities and the demand in the sales bases are not known exactly but can be described in form of fuzzy numbers. We demonstrate that this problem can adequately be solved without using computation-intensive integer programming algorithms. An numerical example illustrates the efficiency of the proposed inter-active procedure.

## 3 - Construction of a poset using families of strong cuts

*Dragan Stojic*, Quantitative methods in Economics, Faculty of Economics, Dr Sime Milosevica 16, 21000, Novi Sad, Serbia, stojicd@eccf.su.ac.yu, *Dragan Vugdelija*

Fuzzy sets in this paper are viewed in the most generalized setting, as mappings from a non empty set  $X$  to a poset. In the investigation of fuzzy structures, collection of cut sets are one of the most important tools. Fuzzy sets are mappings generalizing the characteristic function and also they can be characterized by collections of crisp subsets of the domain-cut sets. We present two algorithms on constructing a partially ordered set  $P$  and a fuzzy set  $\mu$  such that the family of strong cuts of  $\mu$  coincide with a given family of finite sets,  $F$ .

## ■ MC-35

Monday 12:00-13:20

GSI - S 9

### Facilitated Problem Structuring I

Stream: Facilitated Modelling Interventions

*Invited session*

Chair: *Etiënne Rouwette*, Thomas van Aquinostraat 1.2.33, PO Box 9108, 6500 HK, Nijmegen, E.Rouwette@fm.ru.nl

## 1 - Improving operations management by synthesizing participant knowledge and system data

*Etiënne Rouwette*, Thomas van Aquinostraat 1.2.33, PO Box 9108, 6500 HK, Nijmegen, E.Rouwette@fm.ru.nl, *Andreas Gröbler*

Enterprise Resource Planning systems may overwhelm managers with data to such an extent that it becomes difficult to structure information and improve operations. Group model building integrates system data and participant knowledge and is used to jointly identify improvements in work processes. We describe three group model building projects in ERP contexts, addressing effects in terms of end products, quality of solutions, results as judged by the clients (including commitment and implementation) and outcomes of system changes.

### 2 - Improving team effectiveness in strategic workshops: developing question sets to enhance the facilitators understanding of group dynamics in a live workshop environment.

Ashley Carreras, Leicester Business School, De Montfort University, Marketing, The Gateway, LE19BH, Leicester, United Kingdom, [acarreras@dmu.ac.uk](mailto:acarreras@dmu.ac.uk)

This presentation will examine the authors use of a process of question set development to improve the facilitators understanding of the impact of group dynamics during strategy workshops. Based upon a series of workshops, where this process has been refined, the authors create a series of workshop specific questionnaires that are monitored during the event to improve the team effectiveness dimension of a workshop. The monitoring process allows the facilitators to gain an immediate understanding of the concerns of the individuals during the workshop rather than relying on post event analysis.

### 3 - Facilitated modelling in operational research

Gilberto Montibeller, Dept. of Management (OR Group), London School of Economics, Houghton Street, WC2A 2AE, London, United Kingdom, [g.montibeller@lse.ac.uk](mailto:g.montibeller@lse.ac.uk), L. Alberto Franco

This paper discusses a particular mode of operational research intervention: facilitated modelling. Drawing on research scattered across a range of publications and domains, the review presented here provides a formal definition of facilitated modelling, together with a general framework that allows the conceptualisation of a wide variety of facilitated modelling approaches to organisational intervention. Design issues in facilitated modelling and their practical implication are discussed, and directions for future research identified.

## ■ MC-36

Monday 12:00-13:20

GSI - S 11

### Stochastic Control in Insurance

Stream: Optimal Control in Finance and Insurance

Invited session

Chair: Nicole Baeuerle, Institute for Mathematical Stochastics, University of Karlsruhe, Englerstr. 2, 76128, Karlsruhe, Germany, [baeuerle@stoch.uni-karlsruhe.de](mailto:baeuerle@stoch.uni-karlsruhe.de)

### 1 - Compactness of the space of non-randomized policies in countable-state sequential decision processes

Eugene Feinberg, Department of Applied Mathematics, Stony Brook University, and Statistics, 11794-3600, Stony Brook, NY, United States, [eugene.feinberg@sunysb.edu](mailto:eugene.feinberg@sunysb.edu)

For sequential decision processes with countable state spaces and compact action spaces, we prove compactness of the set of strategic measures corresponding to nonrandomized policies. It is known that for the Borel state case this set may not be compact in spite of compactness of the set of all strategic measures. We use the compactness result from this paper to show the existence of optimal policies for countable-state constrained optimization of expected discounted and nonpositive rewards, when the optimality is considered within the class of nonrandomized policies.

### 2 - Optimal control and dependence modeling of portfolios with Lévy dynamics

Anja Blatter, Institute for Stochastics, University of Karlsruhe (TH), Kaiserstraße 89, 76133, Karlsruhe, [blatter@stoch.uni-karlsruhe.de](mailto:blatter@stoch.uni-karlsruhe.de), Nicole Baeuerle

We are interested in optimizing proportional reinsurance policies in a multidimensional Lévy-driven insurance model. A special feature of our construction is to allow for dependent claim occurrences in different business lines modeling dependence via an Archimedean Lévy copula.

Solving the HJB equation yields that the optimal retention level keeps a constant amount of claims. Based on this we identify structure conditions with respect to the Archimedean Lévy copula under which an insurance company reinsures a larger fraction of claims from one business line than from another.

### 3 - On dividends charged by transaction costs in the compound Poisson risk model

Stefan Thonhauser, Institut de sciences actuarielles (ISA), University of Lausanne, Université de Lausanne Quartier UNIL-Dorigny, Bâtiment Extranef, 1015, Lausanne, [stefan.thonhauser@unil.ch](mailto:stefan.thonhauser@unil.ch)

We consider the compound Poisson risk model extended by the possibility of dividend payments (charged by both fixed and proportional transaction costs). The performance of an admissible dividend strategy is measured by its total expected discounted utility. We characterize the value function of the related optimization problem as a fixed point to a certain optimal stopping operator and as a solution to the associated quasi-variational inequalities. We will present a numerical method for solving the problem in general and some special cases which admit an explicit solution.

## ■ MC-37

Monday 12:00-13:20

GSI - S 12

### Innovative Models in Revenue Management

Stream: Revenue Management

Invited session

Chair: Joern Meissner, Dept of Management Science, Lancaster University Management School, Room A48, LA14YX, Lancaster, United Kingdom, [j.meissner@lancaster.ac.uk](mailto:j.meissner@lancaster.ac.uk)

### 1 - Risk considerations in revenue management

Matthias Koenig, Department of Management Science, Lancaster University Management School, LA1 4YX, Lancaster, United Kingdom, [m.koenig@lancaster.ac.uk](mailto:m.koenig@lancaster.ac.uk), Joern Meissner

Risk consideration has become an important issue in revenue management. We present current approaches how to deal with risk in dynamic pricing and dynamic capacity control. We analyze the effect of different policies regarding downside risk and volatility.

## 2 - Incorporating competition in dynamic pricing models

*Christine Currie*, School of Mathematics, University of Southampton, Highfield, SO17 1BJ, Southampton, United Kingdom, [christine.currie@soton.ac.uk](mailto:christine.currie@soton.ac.uk)

Competition has been acknowledged as being an important missing element in dynamic pricing models but has received relatively little attention in the literature. We will focus on price competition in this talk and make the assumption that all of the products on sale are identical and perish on the same day. An analytical model will be used to characterise the optimal prices for the different players in the market. The effects of varying the number of competitors and the amount of inventory available in the market on the optimal prices will also be examined using a simulation model.

## 3 - Strategic business planning and its evaluation

*Tsutomu Mishina*, Systems Science and Technology, Akita Perfectural University, 84-4 Tsuchia-Ebinokuchi, 015-0055, Akita, Japan, [mishina@akita-pu.ac.jp](mailto:mishina@akita-pu.ac.jp), *Alejandra Gomez\_Padilla*

Any business plan should be fairly evaluated soon after its operation. However, unlike an evaluation based on the exact number of sales such as car sales, an effective performance-based evaluation for its general accomplishment is difficult to pursue due to its qualitative data and unclear set of goals. This paper presents a planning-evaluation method which constructs a tree of multiple purpose levels of operations. Looking from the lower levels up towards the higher levels shows the ultimate goal of the plan. An example provided shows government policy making and its evaluation.

## 4 - Choice-based network revenue management under weak market segmentation

*Arne Karsten Strauss*, Management Science, Lancaster University Management School, Lancaster, LA1 4YX, Lancaster, United Kingdom, [a.strauss@lancaster.ac.uk](mailto:a.strauss@lancaster.ac.uk), *Joern Meissner*

We present a network revenue management method where customers choose according to the MNL choice model. Weak market segmentation is reflected by allowing the sets of considered products of the different customer segments to overlap. We replace the value function of the intractable dynamic program by a time- and inventory-sensitive approximation and compute the latter via solution of a large-scale linear program. We employ column generation and propose heuristics for the NP-hard subproblems. Numerical results indicate improved policy performance in particular under weak market segmentation.

## ■ MC-38

Monday 12:00-13:20

GSI - S 13

### Optimization problems with vanishing constraints

Stream: Variational Inequalities and Bi-Level Problems

*Invited session*

Chair: *Christian Kanzow*, University of Wuerzburg, Institute of Mathematics, Am Hubland, 97074, Wuerzburg, [kanzow@mathematik.uni-wuerzburg.de](mailto:kanzow@mathematik.uni-wuerzburg.de)

#### 1 - Mathematical programs with vanishing constraints

*Tim Hoheisel*, Institute of Mathematics, University of Würzburg, Am Hubland, 97074, Würzburg,

[hoheisel@mathematik.uni-wuerzburg.de](mailto:hoheisel@mathematik.uni-wuerzburg.de), *Christian Kanzow*, *Wolfgang Achtziger*

We consider a new class of constrained optimization problems called "mathematical programs with vanishing constraints" (MPVCs), which have important applications, e.g., in the field of topology optimization. One of the major difficulties of these problems arises from the fact that, most of the prominent constraint qualifications do not hold and hence, the Karush-Kuhn-Tucker conditions no longer provide necessary optimality conditions, and standard NLP solvers are likely to fail. Thus, new CQs, stationarity concepts and numerical algorithms are investigated.

#### 2 - Topology optimization of mechanical structures subject to stress constraints

*Wolfgang Achtziger*, Department of Mathematics, Technische Universität Dortmund, Vogelpothsweg 87, 44221, Dortmund, Germany, [wolfgang.achtziger@tu-dortmund.de](mailto:wolfgang.achtziger@tu-dortmund.de), *Tim Hoheisel*, *Christian Kanzow*

Topology optimization became a promising approach to design optimization of mechanical structures. A challenge is the correct formulation and treatment of local stress constraints. Discontinuous stresses can be avoided by mixed formulations in design and state variables. The price is the violation of constraint qualifications and the failure of standard optimization methods. These problem formulations belong to the class of "Mathematical Programs with Vanishing Constraints". As a cure some perturbation techniques have been proposed. We compare these techniques in view of topology problems.

#### 3 - On some new aspects of the implicit programming approach in a class of mathematical programs with equilibrium constraints

*Michal Cervinka*, MTR, UTIA AV CR., Pod Vodarenskou vezi 4, 18208, Praha, Czech Republic, [cervinka@utia.cas.cz](mailto:cervinka@utia.cas.cz), *Jiri Outrata*

We analyze the influence of implicit programming hypothesis and presence of state constraints on first order optimality conditions to mathematical programs with equilibrium constraints. In absence of state constraints, we derive strong stationarity conditions provided the strong regularity condition holds. In the second part of the paper we suggest an exact penalization of state constraints and test the behavior of standard bundle trust region algorithm on academic examples.

## ■ MC-39

Monday 12:00-13:20

GSI - S 14

### Game Theory 2

Stream: Game Theory

*Contributed session*

Chair: *Ilya Katsev*, St. Petersburg Institute for Economics and Mathematics, Russian Academy of Sciences, Tchaikovsky st. 1, 191187 St. Petersburg, Russia, 195067, Saint-Petersburg, Russian Federation, [katsev@yandex.ru](mailto:katsev@yandex.ru)

#### 1 - Price of anarchy (poa) in the markovian single server

*Gail Gilboa-Freedman*, Mathematics, Tel Aviv University, TAU, P.O Box 39040, Tel Aviv, 69978, Tel Aviv, Israel, [email2gail@gmail.com](mailto:email2gail@gmail.com), *Rafi Hassin*, *Yoav Kerner*

Price of Anarchy is the ratio of optimal and equilibrium social welfare. We investigate the PoA in the most fundamental queueing model involving customers' decisions. It has an odd behavior.

## 2 - On the ordinal equivalence of values in cooperative games

Josep Freixas, Applied Mathematics 3, Technical University of Catalonia, Av. Bases de Manresa, 61-73, E-08242 MANRESA. Spain, 08242, Manresa, Spain, josep.freixas@upc.edu, Montserrat Pons

We consider the ordinal equivalence of the Shapley and Banzhaf values for transferable utility cooperative games with a fixed set of players, i.e., cooperative games for which the preorderings on the set of players induced by these two values coincide. To this end we consider several solution concepts within semivalues and introduce three subclasses of games. A characterization theorem in terms of the ordinal equivalence of some semivalues is given for each of these three classes of cooperative games. We extend the proposed problem to other values.

## 3 - Between the prekernel and the prenucleolus

Ilya Katsev, St. Petersburg Institute for Economics and Mathematics, Russian Academy of Sciences, Tchaikovsky st. 1, 191187 St. Petersburg, Russia, 195067, Saint-Petersburg, Russian Federation, katsev@yandex.ru, Elena Yanovskaya

A collection of TU games solutions intermediate between the prekernel and the prenucleolus is considered. All these solutions are Davis-Maschler consistent, symmetric and covariant. Each solution from the collection is parametrized by a positive integer  $k$  such that for all games with the number of players not more than  $k$  the solution for parameter  $k$  coincides with the prenucleolus, and for games with more than  $k$  players it is maximal, i.e. it satisfies the "k-converse consistency". The properties of solutions are described and their characterization by balancedness is given.

## MC-40

Monday 12:00-13:20

GSI - S 27

### Models and Implementation of Operational Systems for Development

Stream: OR for Development and Developing Countries

Invited session

Chair: Chandra Sekhar Pedomallu, Bioinformatics, New England BioLabs, 240 County Road, 01938, Ipswich, MA, United States, pcs.murali@gmail.com

## 1 - Dss platform for integrated assessment of cities occupation dynamics. case study, medellín metropolitan area-colombia

Claudia Rave, Energy Institute, National University of Colombia, AA 1027, crr 80 No 65 - 223, BL M2 of 112, 57, Medellín, Colombia, claudia.rave@gmail.com, Gloria Patricia Jaramillo, Y Olaya

An integrated platform for urban prospective planning, based on the analysis of city occupation models as a dynamic and defining process of the impacts and feedbacks between the citizen choices, land policy and mobility patterns has been designed and developed as a working model and supporting planning tool for decision making. The platform is based in the combination of different OR methodologies and a detailed spatially disaggregated application it's being implemented for the metropolitan area of Aburrá valley (Colombia)

## 2 - Greek regional development: examining the convergence hypothesis and identifying development patterns through multivariate approaches.

Yorgos Goletsis, Dept. of Economics, University of Ioannina, University campus, GR 45110, Ioannina, Greece, goletsis@cc.uoi.gr, Michael Chletsos

Although several studies indicate that there is evidence for EU convergence in country level this is not always true at regional level. In this work, we propose a methodology to analyse regional disparities and regional development patterns. Our methodology is composed of the development of a composite matrix aiming at capturing multiple dimensions of development and cluster analysis for the identification of development patterns. Factor analysis is applied for building the composite index and for the clustering. The methodology is applied to the case of the Greek regions.

## 3 - Exploring the relationship between public space intervention and homicides in bogota: case study

Juan Camilo Bohórquez, Industrial Engineering, Universidad de Los Andes, Calle 19 A #, 37 Este Edificio ML, Oficina 333, 57-1, Bogota, Colombia, jua-boho@uniandes.edu.co, Juan Pablo Calderón, Olga Lucia Sarmiento, Roberto Zarama Urdaneta

The CICLOVIA program in Bogotá, Colombia is a weekly program where more than 121 km of main roads are closed to cars and open to the non-motorized vehicles and recreation. The system has evolved as a network of parks and resources. This network has joined the city and transformed the dynamics of Sunday mornings from 7am to 2pm. As part of a broader study by CEiBA-COMPLEXITY we study the relationship between the CICLOVIA as a complex-social-system and the rate and distribution of homicides from 1977 to 2004.

## 4 - The evolution of the ciclovía as an adaptive network.

Juan Pablo Calderón, Industrial Engineering, Universidad de Los Andes, 57, Bogota, Colombia, ju-cald1@uniandes.edu.co, Juan Camilo Bohórquez, Olga Lucia Sarmiento, Roberto Zarama Urdaneta

CICLOVIA is a weekly event that takes place in Bogotá, Colombia. It holds approximately one million people per week in 121 kilometers of roads being open to the public for recreation. We study the evolution of the CICLOVIA as an organism growing, adapting and coevolving with the city. The CICLOVIA connects parks spread throughout the city becoming a park 121 km long every Sunday from 7am to 2pm. We study the evolution of the organization as an adaptive network and as a growing network of parks.

## MC-41

Monday 12:00-13:20

GSI - S 28

### Forest Management I

Stream: OR in Agriculture and Forest Management

Invited session

Chair: Manfred Gronalt, Department of Economics and Social Sciences, Production and Logistics, University of Natural Resources and Applied Life Sciences, Vienna, Feistmantelstrasse 4, 1180, Vienna, Austria, manfred.gronalt@boku.ac.at

## 1 - Forest sustainability assessment from the representation of personal preferences on environmental comparisons

Susana Martin-Fernandez, Forest economy and management, Technical University of Madrid, Ciudad Universitaria sn, 28040, Madrid, Spain,

susana.martin@upm.es, *Eugenio Martinez-Falero,*  
*Concepcion Gonzalez*

We have developed a participatory system for assessing the ecological sustainability at each point of a forest. For each individual, we obtain a representation of her/his environmental preferences from a comparison of the sustainability between different pairs of alternatives. We also identify the nature of the discrimination threshold. Then, we infer: sustainability on each spatial point; the analytical expression of the value function and type of rationality in the decisions. Finally, web2.0 resources are applied to aggregate individual preferences into communities with similar preferences.

## 2 - Optimizing pinus pinaster stand management scheduling, under the risk of fire

*Liliana Ferreira,* Rua do Convívio, nº 156 Telheiro - Barreira, 2410-333, Leiria,  
liliana.ferreira@estg.ipleiria.pt

FERREIRA, L., CONSTANTINO, M., BORGES, J. We present a management scheduling model for pinus pinaster stands that take into account fuel treatments and the risk of fire. Stochastic dynamic programming is used to determine the expected financial value of the optimal prescription. Fire occurrence and damage probabilities are introduced in the model to analyze the impact of the risk of fire and alternative fire occurrence scenarios were considered at each stage. Results obtained by a test case show that the maximum stand expected financial value decreases when the risk of fire is considered.

## 3 - Analysis of the efficiency in a multiobjective forest management problem solved via a metaheuristic procedure.

*Monica Hernandez,* Applied Economics (Mathematics), University of Malaga, Faculty of Economics, Campus El Ejido s/n, 29071, Malaga, Spain, m\_huelin@uma.es, *Trinidad Gomez, Julian Molina, Maria Amparo Leon, Rafael Caballero*

In this work, a forest harvesting planning problem is solved via a non linear multiobjective programming model where the economic factor of timber production is considered and also aspects related to environmental protection (as carbon captured). We also incorporate spatial constraints. The model proposed is applied to a timber production plantation in Cuba with a highly unbalanced age distribution, so, we also try to rebalance age distribution by the end of the planning horizon. The result is a highly complex problem that is solved by applying a metaheuristic method based on Scatter Search.

## 4 - Integrated empty container management and vehicle routing in timber transport

*Jan Zazgornik,* Feistmantelstrasse 4, 1180, Vienna, jan.zazgornik@boku.ac.at, *Manfred Gronalt, Patrick Hirsch*

In this study foldable containers are used to transport wood products from forests to industrial sites and further on to customers. Therefore, a vehicle routing and container scheduling system is developed and formulated as a Mixed Integer Programming Model. The problem is state-dependent during execution and integrates empty container management and full truck routing. Larger problem instances are solved by a modified nearest neighbor insertion heuristic and improved by a metaheuristic called dynamic Tabu Search with Alternating Strategy, where neighborhoods are changed dynamically.

## MC-42

Monday 12:00-13:20

GSI - S 3

### Health Care I

Stream: Health Care

*Contributed session*

Chair: *Marie Persson,* Department of Software and Systems Engineering, Blekinge Institute of Technology, Box 520, 372 25, Ronneby, Sweden, map@bth.se

#### 1 - Optimal consumption, health expenditures and retirement

*Gustav Feichtinger,* Operations Research and Nonlinear Dynamical Systems, Vienna University of Technology, Argentinierstr. 8 / Inst. 105-4, A-1040, Vienna, Austria, or@server.eos.tuwien.ac.at, *Stefan Wrzaczek, Alexia Prskawetz, Michael Kuhn*

We propose a multi-stage optimal control life-cycle model that focuses on both optimal health expenditure and retirement age. When the individual retires, wage payments are replaced by a pension payment over the remaining lifespan. The pension payment depends on the length of the working period and the discounted average remaining life expectancy. We derive explicit expressions for the time paths of consumption and health expenditures and an implicit one for the optimal retirement age. All of them have interesting economic interpretations. Numerically we are able to compare various scenarios.

#### 2 - An approximate hypercube queuing model embedded into straightforward optimization methods to analyze large emergency medical systems on highways

*Ana Iannoni,* Laboratoire Genie Industrielle, Ecole Centrale Paris, P 676, 92295, Chatenay Malabry, France, iannoni93@hotmail.com, *Reinaldo Morabito, Cem Saydam*

In an effort to address larger problems, the present study explores the benefits of using fast approximate hypercube algorithms embedded into simple greedy heuristics. We consider two different problems separately: determining the location, and the districting of ambulances along the highway. The approaches are based on single- and multi-start greedy heuristics and utilize an approximate partial backup hypercube queuing model. Computational results are presented by applying the present approach to a case study as well as to larger problem instances of up to 100 ambulances.

#### 3 - Heuristic algorithm for optimization of beam orientation in intensity-modulated radiation therapy planning

*Ahmad-Saher Azizi-Sultan,* TU Dresden, Germany, sultansaher@hotmail.com

Planning beam orientations in intensity-modulated radiation therapy (IMRT) is an important but large-scale optimization problem with impractical excessive time complexity. Selecting suitable beam directions in IMRT is still a time consuming manual trial-and-error search procedure that depends on intuition and empirical knowledge. This work shows that the problem of beam orientations is NP-hard and presents a non-brute force heuristic algorithm that works in clinically practical time and aims at determining an appropriate set of beam orientations for IMRT.

## ■ MC-43

Monday 12:00-13:20

GSI - S 10

### Forest Investments 1

Stream: Long Term Financial Decisions

*Invited session*

Chair: *Bernhard Moehring*, Fakultät für Forstwissenschaften und Waldökologie, Universitaet Goettingen, 37077, Goettingen, Germany, bmoehri@gwdg.de

#### 1 - Forest as an investment

*Thomas Knoke*, Technische Universität München, 85354, Freising, Germany, knoke@forst.wzw.tum.de

Forests experience an increasing attention as economic assets. Starting with a tendency to include forests in portfolios of assets to stabilize their return in the USA, this philosophy spreads nowadays also in Germany. My paper gives an overview on financial characteristics of forest investments. Besides profitability I will particularly address aspects of risk. Finally, I will draw conclusions for the financial attractiveness of forest investments.

#### 2 - Adaption to uncertainty: sustainable forest management and intergenerational justice

*Andreas Hahn*, TU München, 85354, Freising, Germany, andreas.hahn@forst.wzw.tum.de

Managers in forestry need to deal with long time horizons and intergenerational aspects. But current approaches seek to achieve sustainability mainly by taking into account today's needs in combination with biologically based indicators. Although the integration of risks has been picked as topic in forest science in the last years, studies mainly focused on the enhancement of the resistance against disturbances. Flexibility as other side of the coin will be analyzed in the current project.

#### 3 - Finding the optimal rotation age under risk by means of survival probability

*Bernhard Moehring*, Fakultät für Forstwissenschaften und Waldökologie, Universitaet Goettingen, 37077, Goettingen, Germany, bmoehri@gwdg.de, *Kai Staupendahl*

Against the background of climate change, the frequency and intensity of natural disturbances (storm, insects, etc.) on the silvicultural production is expected to change. We present a model which tries to support decisions in forest production under these conditions. Risk is integrated by an age dependent survival function, which describes the probability that a forest stand of a given age survives a time interval of certain length. Furthermore, price reductions and cost additions caused by calamities are considered. Practical implications are demonstrated for various parameter settings.

## ■ MC-44

Monday 12:00-13:20

GSI - S 16

### Parametric Optimization II

Stream: Parametric Optimization

*Invited session*

Chair: *Georg Still*, Mathematics, University of Twente, P.O.Box 217, 7500 AE, Enschede, Netherlands, g.still@math.utwente.nl

#### 1 - High-order optimality conditions for nonlinear programming problems

*Helmut Gfrerer*, Institute for Computational Mathematics, Johannes Kepler University Linz, Altenbergerstr 69, A-4040, Linz, Austria, gfrerer@numa.uni-linz.ac.at

We consider optimality conditions of Fritz-John type for mathematical programs with both equality and inequality constraints. We present so called no-gap necessary and sufficient conditions of arbitrary order. Similarly to the well-known cases of first and second-order conditions, a regularity condition on the equality constraints is required in order that the necessary conditions are meaningful. Surprisingly the amount of regularity requirements on the equality constraints decreases with the order of the conditions.

#### 2 - Solving generalized fractional programming problems with approximation

*S. Ilker Birbil*, Manufacturing Systems/Industrial Engineering, Sabanci University, Orhanli, 34956, Tuzla, Istanbul, Turkey, sibirbil@sabanciuniv.edu, *J.b.g. Frenk, Shuzhong Zhang*

We propose a new approach to solve generalized fractional programming problems with approximation. Capitalizing on two alternatives, we review the Dinkelbach-type methods and set forth the main difficulty in applying these methods. To cope with this difficulty, we propose an approximation approach that can be controlled by a predetermined parameter. The proposed approach is promising particularly when it is acceptable to find an effective, but near-optimal value in an efficient manner. Finally, we support our discussion through numerical experiments.

#### 3 - Increasing the demand in traffic equilibrium flows.

*Georg Still*, Mathematics, University of Twente, P.O.Box 217, 7500 AE, Enschede, Netherlands, g.still@math.utwente.nl

The classical Wardrop traffic equilibrium concept is considered. We review the well-known sensitivity results of Hall for variable traffic demand. Then the equilibrium concept is generalized to the case of discontinuous cost functions. Characterizations and existence results for equilibria are extended to this general setting. We distinguish between strong and weak equilibria and show that the monotonicity results of Hall are no longer valid for the weak equilibria.

## ■ MC-45

Monday 12:00-13:20

GSI - S 33

### Analysis of Deterministic and Stochastic Discrete Systems 2

Stream: Discrete Optimal Control

*Invited session*

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

Chair: *Vladimir Zubov*, Mechanics of continuum media, Dorodnicyn Computing Centre of Russian Academy of Sciences, Vavilova 40, 119333, Moscow, Russian Federation, zubov@ccas.ru

#### 1 - Algorithms for solving discrete control problems with deterministic and random states transactions of dynamical system

*Dmitrii Lozovanu*, Institute of Mathematics and Computer Science, Academy of Sciences of Moldova,

Academiei 5, IMI, MD-2020, Chisinau, Moldova,  
Moldova, Republic Of, lozovanu@math.md

We consider the time-discrete systems with finite set of states and study the stochastic versions of classical discrete optimal control problems. We show that such kind of problems in general form can be formulated and studied on stochastic networks and new approaches for their solving based on concept of Markov's processes and dynamic programming can be proposed. We present some new results concerning determining optimal solution of the problems on networks with deterministic and random states transaction of dynamical system.

## Monday 13:35-14:55

### ■ MD-01

Monday 13:35-14:55

Beethoven

### Non-linear combinatorial optimization problems

Stream: Combinatorial Optimization

*Invited session*

Chair: *Adam Letchford*, Department of Management Science, Lancaster University, Management School, LA1 4YX, Lancaster, United Kingdom,  
A.N.Letchford@lancaster.ac.uk

#### 1 - A new linearization technique and its application to train platforming problems

*Laura Galli*, DEIS, University of Bologna, Viale Risorgimento, 2, 40136, Bologna, Italy,  
l.galli@unibo.it, *Alberto Caprara*, *Sebastian Stiller*,  
*Paolo Toth*

In this paper we study a general formulation of the train platforming problem and the corresponding robust counterpart. Motivated by our case study, we consider a general quadratic objective function, and propose a new way to linearize it by using a small number of new variables along with a set of constraints that can be separated efficiently by solving an appropriate linear program. The robust counterpart presents a non-linear link with the deterministic model that can be handled in a similar fashion.

#### 2 - Knapsack-based cutting planes for the max-cut problem

*Konstantinos Kaparis*, School of Mathematics, University of Southampton, Highfield, Southampton, SO17 1BJ, Southampton, United Kingdom,  
k.kaparis@soton.ac.uk, *Adam Letchford*

We present a new procedure for generating cutting planes for the max-cut problem. The procedure consists of three steps. First, the minimum eigenvalue of a certain matrix is computed. Second, the associated eigenvector is used to construct a knapsack relaxation of the max-cut problem. Third, knapsack-based cutting planes are generated using existing techniques from the literature. Although the resulting cutting planes typically do not define facets of the cut polytope, they are still rather strong in practice.

#### 3 - Convex reformulations for binary quadratic programs

*Amélie Lambert*, CEDRIC, CNAM, 292 rue saint martin, 75141, paris, france, amelie.lambert@cnam.fr,  
*Alain Billionnet*, *Sourour Elloumi*

Let (QP) be a binary quadratic program that consists in minimizing a quadratic function subject to linear constraints. To solve (QP) we reformulate it into an equivalent program with a convex objective function. Our reformulation, that we call EQCR (Extended Quadratic Convex Reformulation), is optimal from the continuous relaxation bound point of view. We show that this best reformulation can be deduced from the solution of a semidefinite relaxation of (QP) and that EQCR outperforms QCR. We present computational experiments on Max-Cut and on the k-cluster problem.

## ■ MD-02

Monday 13:35-14:55

Schumann

### Extended Vehicle Routing and Scheduling

Stream: Transportation Planning

*Invited session*

Chair: *Stefan Irnich*, Deutsche Post Endowed Chair of Optimization of Distribution Networks, RWTH Aachen University, Templergraben 64, 52062, Aachen, Germany, [sirnich@or.rwth-aachen.de](mailto:sirnich@or.rwth-aachen.de)

#### 1 - Combining vehicle routing with forwarding

*Xin Wang*, Business Studies & Economics, University of Bremen, Chair of Logistics, Wilhelm-Herbst-Straße 5, 28359, Bremen, Bremen, Germany, [gongyiche@hotmail.com](mailto:gongyiche@hotmail.com), *Herbert Kopfer*

Efficiency of transportation request fulfilment can be increased by subcontracting requests to outside carriers. This problem extension transforms usual vehicle routing problems to the more general integrated operational transportation problems. In this contribution the Vehicle Routing Problem is extended with diverse sub-contraction types. The problem is formalized as a mixed integer linear programming model and solved by CPLEX. Results show tremendous cost savings even for small problem instances by allowing subcontracting. Optimal fleet size for own and hired vehicles are also analyzed.

#### 2 - Minimization of the manufacturer's distribution costs in the supply chain — a case study

*Pawel Hanczar*, Department of Logistics, University of Economics, ul. Komandorska 118/122, 54-608, Wroclaw, [pawel.hanczar@ae.wroc.pl](mailto:pawel.hanczar@ae.wroc.pl)

In the paper, the situation where a manufacturer orders transportation services from an external company is taken into consideration. In the first part of the paper, basic definitions are introduced. Then possible models for a solution to the problem presented are discussed. In order to solve this issue, two linear programming formulations based on the set partitioning model and on the vehicle routing problem have been developed. The last part of the paper describes the application of this model to planning routes. Additionally, the integration with the R3 system is discussed in detail.

#### 3 - Pickup and delivery with dynamic freight consolidation: a near real-time optimization problem

*Curt Nowak*, Betriebswirtschaft und Wirtschaftsinformatik, Stiftung Universität Hildesheim, Samelsonplatz 1, 31141, Hildesheim, Germany, [cnowak@bwl.uni-hildesheim.de](mailto:cnowak@bwl.uni-hildesheim.de), *Felix Hahne*, *Klaus Ambrosi*

Large scale pickup and delivery providers continuously face very complex dynamic Vehicle Routing Problems (VRPPD). When orders are submitted within short intervals, new transportation plans must be calculated very quickly preventing the use of conventional search strategies for optimal solutions. Yet, if time windows allow for reloads the shipping volume and overall travel distance can be improved by combining freights on vehicles. This paper demonstrates a fast strategy for dynamic freight consolidation applicable to large scale VRPPD. Test results based on real life data will be presented.

## ■ MD-03

Monday 13:35-14:55

Reger

### Case Studies for Transportation Planning I

Stream: Transportation Planning

*Invited session*

Chair: *Herbert Kopfer*, Department of Business Studies & Economics, Chair of Logistics, University of Bremen, Wilhelm-Herbst-Strasse 5, 28359, Bremen, Germany, [kopfer@uni-bremen.de](mailto:kopfer@uni-bremen.de)

#### 1 - Vehicle routing problem: a case study in local government

*Azmin Azliza Aziz*, Warwick Business School, University of Warwick, Warwick Business School, The University of Warwick, CV4 7AL, Coventry, [A.A.Aziz@warwick.ac.uk](mailto:A.A.Aziz@warwick.ac.uk)

The Vehicle Routing Problem is defined as the problem of designing optimal delivery routes in order to minimize a cost function. While the literature shows that the study on VRP has received considerable attention from researchers and practitioners, their presence and importance in the application to real-world problems are relatively under-researched. This paper aims to tackle this imbalance by studying the case of all routing-related services at Coventry City Council (CCC). This study discusses and describes all the sub-services in detail and identifies the common nature underlying them.

#### 2 - Web and GIS based computational solution to vehicle routing problems

*Emre Dağlı*, Institute of Applied Math. Scientific Computation, METU - TURKEY, 1879/3 sokak No:14 Daire:3 Karsiyaka, IZMIR/TURKEY, 35530, IZMIR, Turkey, [emre.dagli@gmail.com](mailto:emre.dagli@gmail.com), *Osman Özgür*, *Burak Ozdemir*

This paper presents a computational implementation of Vehicle Routing Problems (VRP). We will present comparison results generated by our web based VRP solver software, which has several types of VRP algorithms built-in (Users can also upload their algorithms). Moreover, types of VRPs and their classification methods based on a survey will be presented briefly. Additionally, the software used in this work will also be presented. The results depend on real geographic locations of vehicles, delivery/pickup points on the Google Map, and distances are obtained from a GIS service.

#### 3 - A truck loading algorithm for renauld's supply chain system

*Jean-philippe Brenaut*, RENAULT SAS, API EQV NOV 354 , 13 Avenue Paul Langevin, 92359, LE PLESSIS ROBINSON, [jean-philippe.brenaut@renault.com](mailto:jean-philippe.brenaut@renault.com)

In order to improve the efficiency of its supply chain, Renault has developed a truck loading system. This system first creates piles of containers, then places these piles in the truck. This last issue is a classical rectangles placement problem. A specific algorithm has been developed to solve this problem, based on a partial branch and bound method and using a variable depth. The objective is to optimize the compacity of the placement. Alternative methods have been tested, such as Constraint Programming or Mixed Integer Programming, but revealed to be much less efficient.

#### 4 - A complexity indicator for renauld's vehicle documentation

*Alain Nguyen*, IT, RENAULT, 13 ave Paul Langevin, (API : EQV NOV 3 54), 92359, Le Plessis Robinson Cedex, [alain.nguyen@renault.com](mailto:alain.nguyen@renault.com), *Herve Bricard*

Renault's Vehicle Documentation is built upon version and options. Options are linked by constraints within a model, e.g. SR (sunroof)  $\implies$  ABS. These constraints are forming a graph. The complexity indicator for a graph is its number of circuits. We used Tarjan's algorithm to build it. For most models it runs within 15 minutes. The complexity of Tarjan's algorithm is  $O(nm(C+1))$ , where  $n$  is the number of nodes,  $m$  the number of arcs, and  $C$  is the number of elementary circuits. Tiernan has proved that  $C$  has an upper bound which is proportional to the integral from 0 to  $n$  of the Gamma function.

## ■ MD-04

Monday 13:35-14:55

Liszt

### Scheduling in Health Care

Stream: Scheduling

Invited session

Chair: *Dobrila Petrovic*, Faculty of Engineering and Computing, Coventry University, Priory Street, CV1 5FB, Coventry, United Kingdom, [D.Petrovic@coventry.ac.uk](mailto:D.Petrovic@coventry.ac.uk)

#### 1 - Multiobjective scheduling of radiotherapy cancer patients

*Mohammad Sarwar Morshed*, Control Theory and Applications Centre, Faculty of Engineering and Computing, Coventry University, Priory Street, CV1 5FB, Coventry, United Kingdom, [m.morshed@coventry.ac.uk](mailto:m.morshed@coventry.ac.uk), *Dobrila Petrovic*, *Sanja Petrovic*

This research concerns a multiobjective scheduling of radiotherapy cancer patients in Arden Cancer Centre, University Hospitals Coventry and Warwickshire, UK. Genetic Algorithms (GA) based model has been developed and implemented. Two objectives are defined: minimisation of Average patient's waiting time and minimisation of Average tardiness of the patients' first fraction. The developed GA incorporates a domain specific knowledge in creating initial solutions and in the genetic operators. The schedules generated by the GA using real data collected from the Cancer Centre have good performance.

#### 2 - A mathematical programming model for the radiotherapy pre-treatment scheduling problem

*Elkin Castro*, School of Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, [edc@cs.nott.ac.uk](mailto:edc@cs.nott.ac.uk), *Sanja Petrovic*

Demand for radiotherapy treatment services has increased due to aging population, higher cancer incidence, and a larger number of prescribed radiotherapy fractions. This higher demand can in turn produce longer waiting times which negatively impact the health of patients. This research work is concerned with the radiotherapy pre-treatment scheduling problem present in the Nottingham City Hospital, Nottingham University Hospitals NHS trust. A mathematical programming formulation of this problem is given, and valuable insights into future developments are provided through experimental tests.

#### 3 - Optimization based approaches for the planning and the management of week-hospital services

*Rosita Guido*, University of Calabria, 87036, Rende, Italy, [rguido@deis.unical.it](mailto:rguido@deis.unical.it), *Marco Matucci Cerenic*, *Domenico Conforti*, *Maria Letizia Conforti*, *Francesca Guerriero*

The Week Hospital is a new inpatient health care delivery organization, which consists in delivering hospital medical services on week-time basis for selected group of patients. The most important problem is to effectively and efficiently plan and manage all the relevant hospital resources, ensuring the optimal clinical management of the admitted patients. We propose innovative optimization models to address the problem under study and we evaluate their performance by considering both randomly generated instances and real data coming from General Hospital Careggi, Florence, Italy

#### 4 - An optimal scheduling tool for emergency departments

*Mel Diefenbach*, School of Mathematical Sciences, Queensland University of Technology, 2 George St, 4000, Brisbane, QLD, Australia, [m.diefenbach@qut.edu.au](mailto:m.diefenbach@qut.edu.au), *Erhan Kozan*

An overview of the Emergency Department (ED), its complexities, processes, resources, demands and performance measures are explored in this paper. The complexity of the system is increased by the stochastic nature of the problem. The ED is modelled as a dual resource job shop problem to handle this complexity. The beds and doctors are assumed as the machine resources and the patients are assumed synonymous with the jobs. The model aims to optimise the multi-criteria objectives. Objectives include waiting time performance, access block, bed utilisation, doctor utilisation and tardiness.

## ■ MD-05

Monday 13:35-14:55

Haydn

### Bioinformatics I

Stream: Computational Biology, Bioinformatics and Medicine

Invited session

Chair: *Ceyda Oguz*, Department of Industrial Engineering, Koc University, Rumeli Feneri Yolu, Sariyer, 34450, Istanbul, Turkey, [coguz@ku.edu.tr](mailto:coguz@ku.edu.tr)

#### 1 - Isothermic sequencing by hybridization with additional information available

*Piotr Formanowicz*, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, [piotr@cs.put.poznan.pl](mailto:piotr@cs.put.poznan.pl)

Sequencing by hybridization (SBH) is one of the methods of reading DNA sequences. It is composed of biochemical and computational stages. Since its classical version is very sensitive for errors some variants of the basic approach are being developed. Isothermic SBH with additional information is one of them. In this variant of the method in the biochemical stage an isothermic DNA chip is used and moreover, the resulting spectrum contains partial information about repeated subsequences. This leads to a formulation of new combinatorial problems which must be solved in the computational stage.

#### 2 - An mdp approach for the optimal issuing policy of a blood product

*René Haijema*, Operations Research and Logistics, Wageningen University and Research center, Hollandseweg 1, 6706 KN, Wageningen, Netherlands, [rene.haijema@wur.nl](mailto:rene.haijema@wur.nl)

Medicines strongly prefer to get the youngest platelet pools available. To reduce outdated one carefully has to choose which pools to issue from stock. Through a (fictitious) cost structure one may specify the preference for young pools, and assign costs for outdated and shortages. When only the short term demand is known, one is interested which pools to issue from stock to minimize the long-run average cost of the issuing policy. We have formulated the issuing problem as a Markov decision problem (MDP). The approach has the potential to contribute to a better transfusion practice.

### 3 - Exact crossing minimization in general tanglegrams

*Frauke Liers*, Institut fuer Informatik, Universitaet zu Koeln, Pohligstrasse 1, 50969, Koeln, Germany, [liers@informatik.uni-koeln.de](mailto:liers@informatik.uni-koeln.de), *Frank Baumann*, *Christoph Buchheim*

A tanglegram consists of a pair of general trees where additional tangle edges may connect their leaves. The task is to draw it with a minimum number of tangle edge crossings, without inducing a crossing within a tree. Applications exist in computational biology. We model the task as a quadratic linear ordering problem QLO with side constraints. As QLO is a face of some cut polytope and the constraints maintain this property, any polyhedral approach to maximize can be used. We present results using linear and semidefinite programming, showing that our approach is fast in practice.

### 4 - Gevadss - system for development and standardized evaluation of novel genetic vaccines

*Piotr Lukasiak*, Institute of Computing Science, Poznan University of Technology, ul.Piotrowo 2, 60-965, Poznan, Poland, [Piotr.Lukasiak@cs.put.poznan.pl](mailto:Piotr.Lukasiak@cs.put.poznan.pl), *Jacek Blazewicz*, *Pawel Wojciechowski*, *Marcin Borowski*, *Pawel Kedziora*

Recombinant viral vectors and virus-like particles are considered the most promising vehicles to deliver antigens in prophylactic and therapeutic vaccines against infectious diseases and cancer. Several potential vaccine designs exist but their cost-effective development crucially lacks a standardized evaluation system. GeVaDSs (Genetic Vaccine Decision Support system) will contain standardized data related to defined gold standard antigens and methods used to assess immune responses as well as algorithms allowing the intelligent comparison of new vectors to previously analyzed ones.

## ■ MD-06

Monday 13:35-14:55

Koch

### Global logistics modeling

Stream: OR and Real Implementations

*Invited session*

Chair: *Hokey Min*, College of Business Administration, Bowling Green State University, 43404, Bowling Green, OH, United States, [hmin@bgsu.edu](mailto:hmin@bgsu.edu)

#### 1 - Supply chain risk modeling from global logistics perspectives

*Hokey Min*, College of Business Administration, Bowling Green State University, 43404, Bowling Green, OH, United States, [hmin@bgsu.edu](mailto:hmin@bgsu.edu)

Due to increased complexity and uncertainty, a global supply chain is often characterized by various risks. Indeed, the recent McKinsey report indicates that nearly a quarter of surveyed company executives did not have any formal risk assessment tools and nearly half of them never formulated company-wide strategies to mitigate supply chain risks. To better cope with challenges of global supply chain operations, I would bring up fruitful research agenda that address open research questions regarding risk profiling, risk analysis, risk sharing, risk tuning, and risk-related change management.

#### 2 - Transshipment port selection using the hybrid dea/ahp methodology

*Byung-In Park*, Department of Logistics, Chonnam National University, San 96-1, Dundeok-dong, 550-749, Yeosu, Chonnam, Korea, Republic Of, [bipark@chonnam.ac.kr](mailto:bipark@chonnam.ac.kr), *Hokey Min*

The accelerated globalization of logistics activities over the last several decades spurred a rapid expansion of ports all cross the world. However, the recent slowdown of international trade created the on-going glut of ports throughout the world. Although the abundance of ports provides more transshipment options for carriers, it makes the port selection decision more complex. To cope with this complexity, this paper proposes a hybrid DEA/AHP model that is designed to identify factors influencing port selection, evaluate the relative efficiency of ports, and then select the best port.

#### 3 - A game-theoretic volume discount model in global maritime logistics

*Byung-In Park*, Department of Logistics, Chonnam National University, San 96-1, Dundeok-dong, 550-749, Yeosu, Chonnam, Korea, Republic Of, [bipark@chonnam.ac.kr](mailto:bipark@chonnam.ac.kr), *Souk-Kyung Sung*, *Hokey Min*

Maritime logistics firms impose port service charges on their customers. To continually attract their customers, these firms need to develop a viable port service charge structure. Nevertheless, the volume discount or incentive structure in the marine logistics industry was operated by a simple rule-of-thumb. As a viable alternative such a rule of thumb, this paper proposes a cooperative game-theoretical approach that is designed to handle the volume discount based on the customer's cargo volume or the number of calling ships.

#### 4 - Modeling techniques and solution approaches for maximizing fleet availability of mission aircraft subject to flight and maintenance requirements

*Andreas Gavranis*, Mechanical & Industrial Engineering, University of Thessaly, Leoforos Athinon, Pedion Areos, 38334, Volos, Magnisia, Greece, [agavranis@gmail.com](mailto:agavranis@gmail.com), *George Kozanidis*

Flight and Maintenance Planning (FMP) addresses the question of which available aircraft to fly and for how long, and which grounded aircraft to perform maintenance operations on, in a group of aircraft that comprise a unit.

We compare several modeling techniques for the FMP problem. We report our computational experience with heuristic approaches, we elaborate on their computational complexity, and we discuss the effect of different design decisions on their performance. We also propose an exact solution procedure that can handle multiobjective FMP instances quite efficiently.

## ■ MD-07

Monday 13:35-14:55

GSI - S 29

### Railway Disruption Management

Stream: Optimization in Public Transport

*Invited session*

Chair: *Dennis Huisman*, Econometric Institute, Erasmus University, Rotterdam, Netherlands, [huisman@few.eur.nl](mailto:huisman@few.eur.nl)

#### 1 - Dispatching support system for a main station area

*Martin Fuchsberger*, D-Math, Insitute for Operations Research, ETH Zurich, Raemistrasse 101, 8092, Zurich, Zurich, Switzerland,

fumartin@ifor.math.ethz.ch, Jörg Priewasser, Holger Flier, Gabrio Curzio Caimi, Marc Nunkesser, Marco Laumanns

We address the problem of conflict-free dispatching of trains in main station areas. Our model is based on an integer multi-commodity flow formulation that incorporates the detailed railway topology, dynamics and delays of the trains as well as connection requirements. Our mixed objective considers minimizing delay propagation and broken connections. The resulting integer program is solved with a commercial solver. Tests with data from Berne, Switzerland show that with this model it is possible to find feasible solutions in appropriate time.

## 2 - Capacity oriented rolling stock rescheduling in passenger railways

Lars Nielsen, Department of Decision and Information Sciences, Rotterdam School of Management, Erasmus University Rotterdam, Burgemeester Oudlaan 50, Room T09-24, 3062 PA, Rotterdam, Netherlands, ln Nielsen@rsm.nl, Leo Kroon, Gabor Maroti

The rolling stock planning at the major Dutch passenger railway operator NS is based on the expected number of passengers on the timetabled trains. These come from observations of passenger traveling patterns on similar days in previous years. In case of disruptions or serious delays the flow of passengers changes as some passengers change their route or choose other means of transportation. We present a model for rolling stock rescheduling that considers the flow of passengers in the time expanded railway network combined with the rolling stock units assigned to the timetable services.

## 3 - Railway crew rescheduling under uncertainty

Daniel Potthoff, Econometric Institute, Erasmus University Rotterdam, P.O. Box 1738, 3000 DR, Rotterdam, Netherlands, potthoff@ese.eur.nl, Dennis Huisman

The Dutch railway network experiences about three large disruptions per day on average. Algorithms for crew rescheduling usually assume that the duration of the disruption is known. In reality however, disruptions sometimes last longer than expected. In this talk, we will discuss how a column generation based rescheduling algorithm can be extended in order to deal with this uncertainty. We will present results for real-life instances and compare our method with a wait-and-see approach.

## ■ MD-08

Monday 13:35-14:55

GSI - S 30

### Vehicle Routing Applications in Taiwan

Stream: Optimization in Public Transport

Invited session

Chair: Yuh-Jen Cho, Department of Transportation Technology and Logistics Management, Chung Hua University, No. 707, Sec. 2, WuFu Rd., 30012, HsinChu, Taiwan, Taiwan, yjcho@chu.edu.tw

Chair: Huey-Kuo Chen, Civil Engineering, National Central University, No. 300, Jung-Da Road, 320, Chung-Li City, Taoyuan, Taiwan, ncutone@ncu.edu.tw

## 1 - The vehicle routing problem with variable virtual depots

Huey-Kuo Chen, Civil Engineering, National Central University, No. 300, Jung-Da Road, 320, Chung-Li

City, Taoyuan, Taiwan, ncutone@ncu.edu.tw, Huey-Wen Chou, Che-Fu Hsueh, Chia-Yun Hsu

This paper addresses the vehicle routing problem with variable virtual depots. The goal of the operation minimizes the total travel and waiting cost for all vehicles while balanced workload among drivers is also considered. In this problem, a large vehicle departs from a physical depot (PD), services all virtual depots (VDs), and then returns to the PD. A set of smaller vehicles positioned at the PD deliver services to ordinary customers within given time constraints and, if necessary, reloads the commodity en route from either the PD or from the larger vehicle at a VD before continuing work.

## 2 - Investigation of multi-period inventory routing management strategies with stochastic demands using simulation

Chao-Hua Chen, Department of Transportation Technology and Logistics Management, Chung Hua University, 707, Sec.2, WuFu Road., 300, Hsinchu, Taiwan, erchen@chu.edu.tw

The inventory routing problem involves with the coordination decisions of at what time and with what quantities, as well as by how many trucks and what routes in carrying out replenishment works within a supplier-customer system under a preferred level of customer service. This study proposes new replenishment strategies and investigates their effects on the related costs and the trade-off effect between inventory and transportation cost for a multi-period IRP with stochastic demands. Simulation along with linear programming method is used to perform the modeling and analysis.

## 3 - Application of hybrid meta-heuristic method on the multi-temperature co-delivery routing

Yuh-Jen Cho, Department of Transportation Technology and Logistics Management, Chung Hua University, No. 707, Sec. 2, WuFu Rd., 30012, HsinChu, Taiwan, Taiwan, yjcho@chu.edu.tw, Yu-Ning Tseng

This study proposed a model named as the Hybrid Multi-Temperature Co-delivery Vehicle Routing Problem (HMCVRP), and designed a RASTA (Ranked Ant System with Threshold Accepting) procedure that combined the neighborhood search methods with threshold accepting algorithm into a scheme of the ASrank algorithm to solve the HMCVRP. In order to identify the feasibility of RASTA, a bank of 30 instances was generated and five experiments were conducted to analyze the computational performance. Computational results shown that the proposed RASTA can solve the HMCVRP effectively.

## 4 - Mixed hub-and-spoke intra-network routes design for the fixed-route trucking carriers

Chien-Yen Chang, Department of Transportation Technology and Logistics Management, Chung Hua University, No. 707, Sec. 2, WuFu Rd., 300, Hsin Chu, Taiwan, Taiwan, axle@chu.edu.tw, Yuh-Jen Cho, Chia-Chun Wu

The intra-network of a fixed-route trucking carrier can be transferred into a hub-and-spoke network. The purpose of this study is to propose a model of routes design for the intra-network, named as the Mixed Hub-and-Spoke Network Routing Problem (MHSNRP). A heuristic method is developed to solve the MHSNRP. In order to evaluate the MHSNRP and the heuristic method, we generate a set of 72 MHSNRP instances and code a computer program in C# language to conduct the experimental tests. Results show that the proposed MHSNRP is full of potential to the intra-network routes design.

## ■ MD-09

Monday 13:35-14:55

GSI - S 5

### Strategic Design

Stream: Supply Chain Management

*Invited session*

Chair: *Agnieszka Ponikierska*, Institute of Management Engineering, Poznan University of Technology, ul. Strzelecka 11, 60 - 965 , Poznan, Poland, Agnieszka.Ponikierska@gmail.com

#### 1 - Strategic design of competing supply chain networks with foresight

*Shabnam Rezapour*, Amirkabir university, Amirkabir university, Tehran, Iran., ITSR, Tehran, Iran., 12345, Tehran, Iran, Islamic Republic Of, s\_rezapoor@aut.ac.ir, *Reza Zanjirani Farahani*

We consider a model for duopolistic competitive supply chain network designing with sequential acting and variable delivered prices. The model designs a multi-tier chain operating in markets under deterministic price-dependent demands and with a rival chain present. The existing chain tends to open some new retailers to recapture some income in a near future. The chains' structures are assumed to be set "once and for all" in a sequential manner but further price adjustments are possible. This problem is modeled by a linear binary bi-level program and solved by a combinatorial meta-heuristic.

#### 2 - Multi-echelon logistics network design with fuzzy bi-level programming

*Umut Rifat Tuzkaya*, Industrial Engineering, Yildiz Technical University, YTU, Department of Industrial Engineering,, Yildiz, Besiktas, 34349, Istanbul, Turkey, tuzkaya@yildiz.edu.tr, *Semih Onut*

This study considers a multi-echelon logistics network and deals for optimizing bi-level structured objectives simultaneously. The objective of the first level is related with the overall network and the objectives of the lower level consider the echelons of the network separately. The developed bi-level multi-objective 0-1 integer linear programming model is formed to determine the amount of each product, which should be shipped among the locations, during a planning horizon. A numerical example is given to show the applicability of the model and it is solved by fuzzy programming approach.

#### 3 - Empirical-based scenario analysis of strategic impact factors

*Tobias Klatt*, Chair of Management Accounting and Control, University of Goettingen, Platz der Göttinger Sieben 3, 37079, Göttingen, Germany, Tobias.Klatt@wiwi.uni-goettingen.de

Strategic planning still lacks an empirical foundation while accessible data is mostly used only for descriptive purposes. To fill this gap an empirical quantitative approach for strategic scenario planning is developed that applies time-series data for management decision support. The employment of vectorautoregressive models on the case of the German construction industry supplies evidence on time-displaced impacts of external factors as well as on outcomes of alternative developments in these trends. This environmental scanning reveals needs for action concerning the strategic positioning.

#### 4 - Reengineering of the information and materials flow systems in the supply chain

*Agnieszka Ponikierska*, Institute of Management Engineering, Poznan University of Technology, ul. Strzelecka 11, 60 - 965 , Poznan, Poland,

Agnieszka.Ponikierska@gmail.com, Katarzyna Grzybowska

Currently observed global trends and economic transformations influence the activities and changes in supply chain in a radical way. In this way is necessary to search a new organisation solutions and new concepts of management which would allow to lower the costs of the activity and as a result would grow the competitiveness on the market. The implementation of Just in Time, Quick Response, Vendor Management Inventory systems and outsourcing process in the supply chain should lead to the reengineering in an integrated supply chain and to achieving the intended effect of chain functioning.

## ■ MD-10

Monday 13:35-14:55

GSI - S 6

### Evolutionary Multiobjective Optimization III

Stream: Evolutionary Multi Objective Optimization

*Invited session*

Chair: *Sanaz Mostaghim*, Universität Karlsruhe, 76128 , Karlsruhe, Germany, smo@aifb.uni-karlsruhe.de

#### 1 - An interactive evolutionary algorithm for the multi-objective vehicle routing problem

*Martin Josef Geiger*, Department of Business and Economics, University of Southern Denmark, Campusvej 55, 5230, Odense, Denmark, mjj@sam.sdu.dk

We present an interactive evolutionary algorithm with an application to vehicle routing problems under multiple objectives. The overall solution concept is based on a two-stage approach in which a first approximation of the Pareto-set is computed and shown to the decision maker. Then, a refined search in preferred regions of the outcome space follows, allowing the decision maker to state one or several reference points that further guide the search. Experiments are carried out for benchmark instances taken from the literature and results are reported.

#### 2 - Multi-objective particle swarm optimization

*Sanaz Mostaghim*, Universität Karlsruhe, 76128 , Karlsruhe, Germany, smo@aifb.uni-karlsruhe.de

Multi-objective Particle Swarm Optimization (MOPSO) approximates a set of optimal solutions through cooperation and competition among the potential solutions. As an iterative method, MOPSO consists of a population of particles searching the parameter space by moving with certain velocities toward the best found solutions (guides). In MOPSO, selecting the guides is very difficult yet an important issue for attaining convergence and diversity of solutions. This paper gives an overview on the existing techniques in MOPSO and many-objective PSO.

## ■ MD-11

Monday 13:35-14:55

GSI - S 17

### The Decision Deck project

Stream: Multiple Criteria Decision Analysis

*Invited session*

Chair: *Raymond Bisdorff*, CSC/ILIAS, University of Luxembourg, 6, rue Richard Coudenhove-Kalergi, L-1359, Luxembourg, Luxembourg, raymond.bisdorff@uni.lu

Chair: *Patrick Meyer*, LUSI, Telecom Bretagne, Technopole Brest-Iroise CS 83818, 29238 Brest Cedex 3, 29238, Brest, France, patrick.meyer@telecom-bretagne.eu

#### 1 - News and perspectives from the decision deck project

*Vincent Mousseau*, LGI, Ecole Centrale Paris, Grande voie des vignes, 92 295, Chatenay Malabry, France, vincent.mousseau@ecp.fr, *Marc Pirlot*, *Raymond Bisdorff*

The Decision Deck project aims at collaboratively developing software tools implementing Multiple Criteria Decision Aid. Its purpose is to provide effective tools for three types of "users": - practitioners who use MCDA tools to support actual decision makers involved in real world decision problems, - teachers who present MCDA methods in courses, for didactic purposes, - researchers who want to test and compare methods or to develop new ones. The aim of this presentation is to detail the latest developments of the Decision Deck project.

#### 2 - Xmcda: a standard xml encoding of MCDA data

*Raymond Bisdorff*, CSC/ILIAS, University of Luxembourg, 6, rue Richard Coudenhove-Kalergi, L-1359, Luxembourg, Luxembourg, raymond.bisdorff@uni.lu, *Patrick Meyer*, *Thomas Veneziano*

XMCDA is a structured XML proposal to represent objects and data issued from the field of MCDA. Its main objectives are to allow different MCDA algorithms to interact and to be easily callable from a common platform like Decision Deck diviz. We present this standardised XML structure and detail the underlying data types via examples speaking for themselves.

#### 3 - Diviz: an MCDA components workflow execution engine

*Thomas Veneziano*, CSC, University of Luxembourg, Université du Luxembourg, FSTC, 6, rue Richard Coudenhove-Kalergi, 1359, Luxembourg, Luxembourg, thomas.veneziano@uni.lu, *Sebastien Bigaret*, *Patrick Meyer*

diviz is a software platform, derived from the open source Bio-side software, which aims at helping researchers to build MCDA workflows based on elementary algorithmic components available as web services. We focus on the use of components originating from kappalab, an R library, which can be used for Choquet integral based MCDA.

## ■ MD-12

Monday 13:35-14:55

GSI - S 18

### Stochastic Mixed Integer Programming Algorithms and Applications

Stream: Stochastic Programming

*Invited session*

Chair: *Laureano Fernando Escudero*, Dept. de Estadística e Investigación Operativa, Universidad Rey Juan Carlos, c/Tulipan, S/n, 28933, Mostoles (Madrid), Spain, laureano.escudero@urjc.es

#### 1 - Branch-and-fix coordination approach for the mixed 0-1 multistage environment: a set of strategies

*María Merino*, Matemática Aplicada, Estadística e Investigación Operativa, Facultad de Ciencia y Tecnología. Universidad del País Vasco, Barrio Sarriena s/n, 48940, Leioa, Vizcaya, Spain, maria.merino@ehu.es, *Laureano Fernando Escudero*, *M. Araceli Garín*, *Gloria Pérez*

We present a specialization of the Branch-and-Fix Coordination approach for multistage mixed 0-1 stochastic problems where the 0-1 and continuous variables appear at any stage. It uses the Twin Node Family (TNF) concept and is designed for coordinating and reinforcing the branching nodes and variable selections at each Branch-and-Fix tree. Some blocks of additional strategies (related to the cluster partitioning, the TNF branching selection and bounding, the starting branching and branching order) are proposed to increase the efficiency of the approach. Computational experience is reported.

#### 2 - On the performance of the bfc-tsmip algorithm

*Maria Araceli Garin*, Economía Aplicada III, Universidad del País Vasco, Lehendakari Aguirre 83, 48015, Bilbao, Spain, Spain, mariaaraceli.garin@ehu.es, *Laureano Fernando Escudero*, *María Merino*, *Gloria Pérez*

In the Branch-and-Fix Coordination scheme for solving large scale two-stage stochastic problems, we consider two classes of mixed 0-1 problems: with 0-1 and continuous variables in the two stages, and with continuous variables in the second stage. The approach uses the Twin Node Family concept in order to satisfy the non-anticipativity constraints for the 0-1 first-stage variables. For satisfying the nonanticipativity constraints also on the first-stage continuous variables, we need to solve two submodels of the DEM, for the given TNF integer set. Computational experience is reported.

#### 3 - On the air traffic flow management problem. a stochastic integer programming approach,

*Alba Agustin*, Statistic and Operational Research, Rey Juan Carlos University, c/ Maestro Navas, 10, 4B, 28011, Madrid, Spain, alba.agustin@urjc.es, *Pablo Olaso*, *Antonio Alonso-Ayuso*

We present a tight stochastic 0-1 programming model for the air traffic flow management problem on a short term policy. The problem consists of deciding, for each aircraft, how to develop the route to follow and cancellation, if any, according to company priorities. We consider the uncertainty in the capacity of the departures and arrivals at airports and the number of aircrafts that may fly on a sector, at a given time. We create an air network whose links describe all given possible routes, such that alternative routes to the main one are allowed. Some computational experience is reported.

## ■ MD-13

Monday 13:35-14:55

GSI - S 31

### Stochastic programming II.

Stream: Stochastic Programming

*Invited session*

Chair: *Michael Bussieck*, GAMS Software GmbH,  
Eupener Str 135-137, 59033, Cologne, Germany,  
MBussieck@gams.com

#### 1 - A progressive hedging algorithm for a stochastic lot sizing and pricing problem

*Hongyan Li*, Department of Business Studies, Aarhus School of Business, 8210, Aarhus, hojl@asb.dk

We address a capacitated lot sizing and pricing problem for a single product firm. The firm makes production and price decisions under stochastic and price dependent demands. Fixed and variable unit production costs are considered. The inventory holding cost or backlogging cost will be charged for excess production or demand. We model the problem as a stochastic MIP model, and a heuristic algorithm is developed. The study accommodates the complexity of time varying cost and market uncertainty, and incorporates pricing decisions with traditional production and inventory planning process.

#### 2 - Capacity planning and capital expenditure for participation in collaborative provision of advanced mobile data services

*Paolo Pisciella*, Norwegian University of Science and Technology, 7491, Trondheim, Norway,  
paolo.pisciella@iot.ntnu.no, *Alexei Gaivoronski*, *Josip Zoric*

This paper considers a bilevel single-leader/multi-follower model underlying the collaborative provision of advanced mobile data services when facing a stochastic demand level. The bilevel structure is exploited by considering, in the lower level, a set of service providers taking decisions concerning the initial capacity, while in the upper level the leader decides on how to share the revenues to make the service provision feasible, while considering a stochastic demand level for the service. This results in a stochastic programming problem for each component provider.

#### 3 - Stochastic optimization: recent enhancements in algebraic modeling systems

*Michael Bussieck*, GAMS Software GmbH, Eupener Str 135-137, 59033, Cologne, Germany,  
MBussieck@gams.com

With all the uncertainty in data there is considerable demand for stochastic optimization in operational, tactical and strategical planning. Nevertheless, there exist a fairly small number of commercial applications building on stochastic optimization techniques. After a decade without much progress on the software side, modeling system providers have recently entered the second round of making it easier to go from a deterministic model to a stochastic version of such a model. We will review the different concepts emphasizing on recent enhancements in the GAMS system.

## ■ MD-14

Monday 13:35-14:55

GSI - S 32

### Districting problems

Stream: Location Analysis

*Invited session*

Chair: *Cesar Beltran-Royo*, Estadística e Investigación Operativa, Universidad Rey Juan Carlos, Calle Tulipán, s/n, 28933, Móstoles, Madrid, Spain, cesar.beltran@urjc.es

#### 1 - Using the simplex method to determine land reallocation in urban land arrangements applications

*Tayfun Cay*, university of selcuk, 42031, konya, Turkey, tcay@selcuk.edu.tr, *Ibrahim Baz*, *Zekai Cevdet Can*, *Fatih Iscan*

All the land in the plan boundaries is either in private or public ownership. By urban land arrangement they are rearranged according to construction plan data with the view to provide technical and social-cultural area productions. Lands needed for these areas are achieved by deduction of some proportion from each parcel arrangement areas for the value increment because of arrangement. In this paper, a method is described as optimum formation for the reallocation of parcels in urban land arrangement; which can easily be programmed for computers based on the principles of linear programming.

#### 2 - The quadratic assignment problem solved by semi-lagrangian relaxation

*Cesar Beltran-Royo*, Estadística e Investigación Operativa, Universidad Rey Juan Carlos, Calle Tulipán, s/n, 28933, Móstoles, Madrid, Spain, cesar.beltran@urjc.es, *Huizhen Zhang*, *Miguel Constantino*

In this work we apply the Semi-Lagrangian Relaxation (SLR) method [1] to solve the Quadratic Assignment Problem. It is well known that, Lagrangian relaxation is used in combinatorial optimization to generate bounds for the optimal cost. The SLR method is a modified Lagrangian relaxation that generates (integer) optimal solutions. [1] C. Beltran, C. Tadonki, and J.-Ph. Vial. Solving the p-median problem with a semi-Lagrangian relaxation. Computational Optimization and Applications, 35(2):239—260, 2006.

## ■ MD-15

Monday 13:35-14:55

Einstein

### Vehicle Routing

Stream: Vehicle Routing

*Invited session*

Chair: *Roberto Baldacci*, DEIS, University of Bologna, Via Venezia, 52, 47023, Cesena, Italy, r.baldacci@unibo.it

#### 1 - An exact algorithm for the period routing problem

*Roberto Baldacci*, DEIS, University of Bologna, Via Venezia, 52, 47023, Cesena, Italy, r.baldacci@unibo.it, *Enrico Bartolini*, *Aristide Mingozzi*

We present an exact algorithm for solving strategic and tactical multi-period vehicle routing problems that can be modeled as Period Vehicle Routing Problems (PVRPs). The paper describes an integer programming formulation of the PVRP that is used to derive different lower bounds and an exact solution method. Computational results on test instances from the literature and on new sets of test instances show the effectiveness of the proposed method.

## 2 - Location of capacitated depots for the vehicle routing problem

*Roberto Wolfler Calvo*, L.O.S.I., Université de Technologie de Troyes, Troyes, France,  
roberto.wolfler@utt.fr, *Roberto Baldacci, Aristide Mingozzi*

We consider the Capacitated Location Routing Problem (CLRP), the problem of opening one or more depots on a given set of a priori defined depot locations and to design for each opened depot a number of routes in order to supply a given set of customers. The objective is to minimize the sum of the fixed costs of the opened depots and of the costs of the routes operated by the depots. We describe an exact method that is based on a Set Partitioning (SP) like formulation of the problem that is a generalization of the SP formulation of the Capacitated VRP and of the Multi-Depot CVRP.

## 3 - The generalized covering salesman problem

*Majid Salari*, DEIS, University of Bologna, Viale risorgimento 2, 40136, Bologna, Italy,  
majid.salari2@unibo.it, *Zahra Naji Azimi, Bruce Golden, S. Raghavan, Paolo Toth*

We define the Generalized Covering Salesman Problem, in which the goal is to identify the minimum length tour of a subset of cities such that each city not on the tour is within a given distance from the visited nodes, and each customer  $i$  needs to be covered at least times. We define three variants of this problem. In the first case, each city can be visited just once, while in the second version visiting a node more than once is possible but without staying overnight. In the last variant, we can visit each city more than once consecutively. Finally we present two heuristics for these problems.

## 4 - The pickup and delivery problem with incompatibility constraints

*Pablo Factorovich*, Computer Science Department, University of Buenos Aires - Science School, Angel Gallardo 555 1° 10, 1405, Buenos Aires, Argentina,  
pfactoro@dc.uba.ar, *Isabel Méndez-Díaz, Paula Zabala*

In the Pickup and Delivery Problem (PDP) a vehicle must accomplish a set of requests, each one related to pickup node preceding a delivery one. In many scenarios, certain goods cannot be on the vehicle simultaneously (e.g. food & detergents). To model them, a variation of PDP can be defined by adding an "incompatibility graph" to be obeyed. This problem (PDPwI) has not been described yet in the literature. In this research we propose four formulations for PDPwI and we algorithmically compare them. One of these models is based on variables that were not previously used in routing literature.

## ■ MD-16

Monday 13:35-14:55

Koenig

### Cutting and Packing 2

Stream: Cutting and Packing

Invited session

Chair: *Gleb Belov*, Numerical Mathematics, TU Dresden, 01062, Dresden, Germany, bg37@gmx.net

## 1 - A just-in-time intelligence framework to the bin packing problem

*Sergey Polyakovskiy*, Department of Computer Science and Robotics, Ufa State Aviation Technical

University, Oktiabrya pr., 45-19, 450058, Ufa, Russian Federation, maxles@yandex.ru, *Rym Mhallah*

We address the Bin Packing Problem under the Just-In-Time condition. Indeed, the items are to be extracted from bins exactly on due dates; otherwise they incur earliness-tardiness penalties. We minimize penalties along with the wastes of bins using an Agent-Based (AB) framework. AB identifies critical areas consisting of clusters of items competing for the same time slot, and assimilates the items and bins to agents. Driven by their parameters, decision rules, and fitness assessment agents collaborate to obtain a solution. AB proves flexibility and offers a stable and robust work environment.

## 2 - Sawmbs: a sufficient-average-weight-minimum-bin-slack heuristic for one-dimensional bin-packing

*Krzysztof Fleszar*, Olayan School of Business, American University of Beirut, P.O. BOX 11-0236, Riad El Solh, 1107 2020, Beirut, Lebanon,  
kfleszar@gmail.com, *Christoforos Charalambous, Khalil Hindi*

A sufficient-average-weight-minimum-bin-slack (SAWMBS) heuristic for the one-dimensional bin-packing problem is presented. It fills bins one at a time, optimising a bicriteria objective, which aims first at achieving average item weight at least as large as the average weight of all currently available items, and secondly at minimising slack. Thus, bin capacity is well utilised without packing too many small items. Reductions are also used to improve solutions and reduce processing time. Computational study attests to the efficiency and effectiveness of SAWMBS.

## 3 - A new lower bound for bin packing problem with general conflicts graph

*Mohamed Maiza*, EMP BP17 Bordj El Bahri, 16111, Alger, Algeria, mohamed.maiza@emn.fr, *Christelle Gueret, Pierre Lemaire, Mohammed Said Radjef*

We propose a new lower bound for the one dimensional bin packing problem with conflicts. The conflicts are represented by a graph whose nodes are the items, and adjacent items cannot be packed into the same bin. The lower bound is based on an iterative search of maximal cliques in the conflict graph using Johnson's heuristic. At each step we delete from the graph the items of the last clique found, together with small items that could eventually be packed with them. The lower bound corresponds to the sum of the bins required at each step.

## ■ MD-17

Monday 13:35-14:55

Rheinaue

### Scheduling and Applications

Stream: Scheduling under Resource Constraints

Invited session

Chair: *Malgorzata Sterna*, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, Malgorzata.Sterna@cs.put.poznan.pl

## 1 - Scheduling tasks in web service for text translation

*Malgorzata Sterna*, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, Malgorzata.Sterna@cs.put.poznan.pl, *Jacek Juraszek*

The research concerns the scheduling tool supporting the web service offering automatic text translation between Polish and 3 other languages. The system consists of a few translation processes dedicated to particular translation directions, running in parallel and sharing hardware resources. After the analysis of historical data obtained for a simple random scheduler, we proposed an on-line scheduling policy based on priority dispatching rules. The new scheduler improved the efficiency of the system, increasing significantly the percentage of orders realized within a given time limit.

## 2 - Agent driven scheduling model in the multi-line production system

Grzegorz Pawlak, Institute of Computing Science, Poznan University of Technology, ul. Piotrowo 2, 60-965, Poznan, Poland, grzegorz.pawlak@cs.put.poznan.pl, Sławomir Walkowski, Tomasz Żurkowski

The variety of possible configurations of the currently used production lines, their structures and control methods make them a natural application field for the agent based scheduling systems. The goal of our research was to model and to analyze production processes in the real factory floor, taking into account the structure of its production lines, in order to work out proper management models and the efficient adaptive control. Particularly, we analyzed the state of the buffer and of the switch where two or more production lines are joined, as well as the velocity of the assembly lines.

## 3 - On scheduling divisible loads with memory constraints

Maciej Drozdowski, Dept. of Computer Science and Management, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, Maciej.Drozdowski@cs.put.poznan.pl, Joanna Berlinska

We consider processing divisible loads on heterogeneous distributed systems with limited memory. Divisible loads are computations which can be divided into parts of arbitrary sizes and can be processed independently on distributed computers. The problem consists in partitioning and distributing the load such that the schedule is as short as possible. We formulate this problem as mathematical programming problem and propose heuristics to solve it. A set of heuristics non-dominated from the point of view of complexity and the quality of the solutions is identified experimentally.

## 4 - The last station problem in assembly lines

Waldemar Grzechca, Faculty of Automatic Control, Electronics and Computer Science, The Silesian University of Technology, Akademicka 2A, 44100, Gliwice, Poland, waldemar.grzechca@polsl.pl

Nowadays, a good balanced assembly line is a very important factor in modern manufacturing companies. Even small differences in assigning of tasks on workstations can cause great profits or losses for producers. The line efficiency, time of the line and smoothness index is the basic measures in estimation of final results. The differences of balance and equalization in assembly line are considered. Author discusses the problem of the last station and a modified smoothness index is presented. As a conclusion, a numerical example will be calculated.

## ■ MD-18

Monday 13:35-14:55

Lenné

## Modern Applications of Mathematical Programming II

Stream: Mathematical Programming

Invited session

Chair: I. Kuban Altinel, Industrial Engineering Dept., Bogaziçi University, Bebek, 34342, Istanbul, Turkey, altinel@boun.edu.tr

### 1 - Topological properties of the solution set of generalized vector equilibrium problems

Kamelia G. Alizadeh, sahand University of technology, 5133351996, Tabriz, Iran, Islamic Republic Of, kamelia\_alizadeh@yahoo.com, Ildar Sadeqi

In this paper, a generalized vector equilibrium problem (GVEP) with set-valued maps on a reflexive Banach space is considered. It is known that the solution set fails to be nonempty and convex in general. Using the recession method, we give conditions under which the solution set is nonempty, convex and weakly compact, then extend it to the strongly generalized vector equilibrium problem (SGVEP). This result in generalizing and modifying various existence theorems. Also we study topological properties of the solution set to the same problems.

### 2 - Multiparametric sensitivity analysis in transportation problems with linear-plus-linear fractional objective function

Sanjeet Singh, Operations Management, Indian Institute of Management Calcutta, D.H. Road, Joka, Kolkata, 700104, Kolkata, West Bengal, sanjeet@iimcal.ac.in, Pankaj Gupta, Milan Vlach

In this paper, we provide the multi-parametric sensitivity analysis of a transportation problem whose objective function is the sum of linear and linear-fractional function. We construct critical region for simultaneous and independent changes in the objective function coefficients treating each parameter at its independent level of sensitivity. A numerical example is given to illustrate the multiparametric sensitivity analysis results. We also extend the sensitivity results to the three index transportation problem with planar constraints as well as axial constraints.

### 3 - When every function evaluation counts: an efficient optimizer for high-dimensional problems and a bootstrap standard error estimation of a psychological behavior model

Thomas Buchsbaum, Dept. of System Analysis, Integrated Assessment, and Modeling (SIAM), Eawag - Swiss Federal Institute of Aquatic Science and Technology, Ueberlandstrasse 133, P.O. Box 611, 8600, Dübendorf, Switzerland, buchsbaum@ieec.org

I present an efficient, almost global optimization approach (EAGO) that aims at finding a reasonably good minimum of disturbed-convex functions with a very small number of function calls. This makes the algorithm a great choice for computationally demanding optimization tasks like the bootstrapped estimation of nonlinear model parameters and their sampling distributions. In a case study, EAGO is used to estimate the parameter variabilities of a social-psychological behavior model and a variance-based global sensitivity analysis and its implications are presented.

### 4 - Mission based component test plans

M. Emre Keskin, Industrial Engineering Department, Bogazici University, Rumelihisarustu Bebek, Istanbul,

34337, Istanbul, Turkey, emre.keskin@boun.edu.tr, I. Kuban Altinel, Suleyman Ozekici, Bora Cekyay, Orhan Feyzioglu

System based component testing idea is applied many times in the literature. However, reliability definition employed in all these studies assumes a fixed time during which the object works without a failure. This reliability definition is invalid for systems designed to perform sequence of missions which are possibly in random order and have possibly random durations. In this study, a new method which we call as mission based component test plans is proposed for determination of the optimum component test plans for series systems and serial connection of redundant subsystems.

## ■ MD-19

Monday 13:35-14:55

Haber

### Quasidifferential Analysis and Generalized Convexity

Stream: Convex Optimization 1

Invited session

Chair: *Ryszard Urbanski*, Faculty of Mathematics and Computer Science, Adam Mickiewicz University, Poznan, ul. Umultowska 87, PL-61-614, Poznan, Poland, rich@amu.edu.pl

Chair: *Diethard Pallaschke*, Statistics and Mathematical Economics, University of Karlsruhe, Kaiserstr. 12, Geb. 11.40, D-76128, Karlsruhe, Germany, lh09@rz.uni-karlsruhe.de

#### 1 - Quasidifferentiable functions and pairs of compact convex sets

*Diethard Pallaschke*, Statistics and Mathematical Economics, University of Karlsruhe, Kaiserstr. 12, Geb. 11.40, D-76128, Karlsruhe, Germany, lh09@rz.uni-karlsruhe.de, *Ryszard Urbanski*

Pairs of compact convex sets arise in the quasidifferential calculus of V.F. Demyanov and A.M. Rubinov as sub- and superdifferentials of quasidifferentiable functions. Of importance are minimal elements. Different criteria for minimality are presented. Algebraic and geometric characterizations of minimality lead to a separation law of convex sets by sets.

The equivalence of the separation law with the order cancellation law will be shown. Within the frame of a commutative ordered semigroups with cancellation law pairs of convex sets lead to a fractional arithmetic for convex sets.

#### 2 - Gradient set splitting in nonconvex nonsmooth numerical optimization

*Enrico Gorgone*, DEIS, University of Calabria, Via Pietro Bucci, CUBO 41c, 87036, RENDE, Italy, egorgone@deis.unical.it

We classify the limit points of gradient sequences, for a locally Lipschitz function, on the basis of the linearization error with respect to a given point. Thus we construct two distinct polyhedral approximations of the objective function, which are used in the definition of two quadratic subproblems. We design a bundle type algorithm based on alternate solution of such subproblems. We prove termination of the algorithm under the hypothesis that the function is weakly semismooth. The results of some numerical experiments are also reported.

#### 3 - Conically equivalent convex sets and applications

*Alberto Zaffaroni*, Dipartimento di Scienze Economiche e Matematico-Statistiche, Universita' di

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Given a l.s.c. sublinear function  $h$  on a normed space  $X$  and a cone  $K$  in  $X$ , two closed, convex sets  $A$  and  $B$  in  $X$  are  $K$ -equivalent if their support functions coincide on  $K$ . We characterize the greatest set in an equivalence class, the equivalence between two sets, and find conditions for the existence and the uniqueness of a minimal set. We give some applications to the study of gauges of convex radiant sets and of cogauges of convex coradiant sets. Moreover we study the minimality of a second order hypodifferential.

#### 4 - Reducing infinite exhausters

*Jerzy Grzybowski*, Faculty of Mathematics and Computer Science, Adam Mickiewicz University, Umultowska 87, 61-614, Poznan, Poland, jgrz@amu.edu.pl, *Ryszard Urbanski*

We present criteria for an infimum of support functions of a family of convex sets to be a difference of support functions of two sets. First criterion is related to the property of translation of the intersection of the family of convex sets. Second criterion is related to convexity of the union of polars of the family of convex sets.

## ■ MD-20

Monday 13:35-14:55

Mann

### DEA Methodology I

Stream: DEA and Performance Measurement

Invited session

Chair: *Luka Neralic*, Faculty of Economics & Business, University of Zagreb, Trg J. F. Kennedy 6, 10000, Zagreb, Croatia, lneralic@efzg.hr

#### 1 - Sensitivity in data envelopment analysis using an approximate inverse matrix

*Luka Neralic*, Faculty of Economics & Business, University of Zagreb, Trg J. F. Kennedy 6, 10000, Zagreb, Croatia, lneralic@efzg.hr, *Richard E. Wendell*

In this paper, sensitivity analysis of the Charnes-Cooper-Rhodes (CCR) model in data envelopment analysis (DEA) is studied for the case of perturbation of all outputs and of all inputs of an efficient decision making unit (DMU). Using an approximate inverse of the perturbed optimal basis matrix, an approximate preservation of efficiency for an efficient DMU under these perturbations is considered. Sufficient conditions for an efficient DMU to preserve its efficiency are obtained in that case. An illustrative example is provided.

#### 2 - Rational inefficiencies of stochastic service productions

*Andreas Kleine*, Institute of Business Administration, University of Hohenheim (510A), D-70593, Stuttgart, Germany, ankleine@uni-hohenheim.de

We analyze service productions which are characterized by a stochastic external factor and choose data envelopment analysis as the basis for our methodology. Preference relations between inputs and outputs are derived from observed production data. Using this information we introduce a modified concept of value efficiency. We illustrate that depending on the assumed probabilities a value inefficient DMU can be stochastically efficient. Hence, a DEA inefficiency is not necessarily contradictory to rational behavior.

#### 3 - Measurement and decomposition of Malmquist productivity index under variable capacity utilization

*Giannis Karagiannis*, economics, university of macedonia, 156 egnatia str., 54006, thessaloniki, Greece, karagian@uom.gr, *Panos Fousekis*

The aim of the paper is to obtain a decomposition of the Malmquist productivity index under variable capacity utilization. This is pursued using DEA and the bottom-up approach, suggested by Balk (2001). By measuring technical efficiency relative to the short-run (variable-returns-to-scale) frontier we develop two alternative decompositions of the Malmquist productivity index based on two alternative notions of technical change: that defined relative to the capacity frontier (benchmark technology) and that defined relative to the best practice frontier.

## ■ MD-21

Monday 13:35-14:55

Hauptmann

### Models for Screening and Medical Decision Making

Stream: Health Care Management

Invited session

Chair: *Elena Rizzato*, Paediatrics, University of Padova, Via Dona' 11, 35129, Padova, Italy, [ele.rizzato@unipd.it](mailto:ele.rizzato@unipd.it)

#### 1 - When to recommend biopsy to women undergoing mammography screening? a Markov decision process (mdp) model

*Oguzhan Alagoz*, Department of Industrial and Systems Engineering, University of Wisconsin-Madison, 1513 University Avenue, 53706, Madison, WI, United States, [alagoz@engr.wisc.edu](mailto:alagoz@engr.wisc.edu), *Jagpreet Chhatwal*, *Elizabeth Burnside*

Early diagnosis through screening mammography is the most effective means of decreasing the death rate from breast cancer. If a mammogram reports a suspicious finding, then a biopsy is required to decide whether an abnormality is in fact a cancer. Breast biopsy delivers a benign result in 55-85% of cases, resulting in extra anxiety for the patients and unnecessary treatments. We use Markov Decision Processes (MDP) to optimize the biopsy decisions for a woman while maximizing her total expected quality-adjusted life-years. Our results show that optimal biopsy decisions should be age-dependent.

#### 2 - Admission control for preventive services

*Derya Kunduzcu*, Koç University Rumelifeneri Yolu SARIYER, 34450, ISTANBUL, Turkey, [dkunduzcu@gmail.com](mailto:dkunduzcu@gmail.com), *E. Lerzan Ormeci*, *Evrin Didem Gunes*

We consider the capacity rationing of colonoscopy within patients coming from different risk groups, the highest risk corresponding to colorectal-cancer patients. The system can exercise admission or scheduling or both controls. Scheduling lower risk patients is the screening process, improving the status of the whole population in the long run. We consider three different models, depending on which of the controls is used. We establish the existence of optimal monotone policies under certain conditions. We study the effects of system parameters on the optimal policy through a numerical study.

#### 3 - Modelling trauma hip fracture hospital activities

*Cheryl Voake*, Cardiff School of Mathematics, CF24 4AG, Cardiff, [voakec@cf.ac.uk](mailto:voakec@cf.ac.uk), *Jeff Griffiths*, *Janet Williams*

Hip fractures are becoming an increasing problem in hospitals due to the ageing population. The effects of a delay to operation on mortality and length of stay are investigated. A simulation model is being built to model the flow of admissions of trauma hip fracture patients through a large teaching hospital. It was an additional requirement of the hospital that they could focus particularly on a patient's journey through theatre. A number of what-if situations are considered. Future ideas are discussed, including the theoretical formulation of the theatre process.

#### 4 - Perinatal assistance network users' behaviour: model and simulation.

*Elena Rizzato*, Paediatrics, University of Padova, Via Dona' 11, 35129, Padova, Italy, [ele.rizzato@unipd.it](mailto:ele.rizzato@unipd.it), *Paola Facchin*, *Anna Ferrante*, *Giorgio Romanin-Jacur*, *Laura Salmaso*

In a region population is distributed in urban nuclei and a three level neonatal assistance network is set. A mother is admitted to the closest birth centre, whose level corresponds to the expected newborn conditions, if places are at disposition. A transfer to the closest upper level centre is effected if newborn severity increases. The model dynamically describes centres' saturation and patients' trouble due to nucleus-centre distance, thus evidencing network insufficiencies and suggesting adaptations. The model was applied to an Italian region but may be extended to other realities.

## ■ MD-22

Monday 13:35-14:55

Arndt

### Optimization Modeling in Practice II

Stream: OR Applications in Industry

Invited session

Chair: *Eleni Pratsini*, IBM Zurich Research Lab, Säeumerstrasse 4, 8803, Zurich, Switzerland, [pra@zurich.ibm.com](mailto:pra@zurich.ibm.com)

Chair: *Bjarni Kristjansson*, Maximal Software, Ltd., Boundary House, Boston Road, W7 2QE, London, Iceland, [bjarni@maximalsoftware.com](mailto:bjarni@maximalsoftware.com)

#### 1 - Practical solutions in network design for dhl

*Hans Schut*, DHL Supply Chain, Bundeskanzlerplatz 2-10 (Bonn Center), 53113, Bonn, Germany, [hans.schut@dhl.com](mailto:hans.schut@dhl.com), *Sander van den Berg*

DHL Supply Chain deals with many challenges in Supply Chain Planning. The scope of the presentation will be on Outbound Distribution. From an OR perspective this can be subdivided in Assignment, Min Cost Flow and Route planning problems and integrality is imposed on the variables. The combination of size and integrality make it difficult to find an optimum and solve the problems in a reasonable time. DHL found practical methods that combine best of both worlds. The presentation includes several real world problems from the technology and automotive industry.

#### 2 - Mathematical programming based strategic and tactical production and operational logistics planning in the automotive industry

*Achim Koberstein*, Decision Support & OR Lab, University of Paderborn, Warburger Str. 100, 33098, Paderborn, Germany, [koberstein@dsor.de](mailto:koberstein@dsor.de), *Leena Suhl*, *Ralf Bihlmaier*, *Thomas Sillekens*, *Jens Peter Kempkes*, *Thomas Sommer-Dittrich*

In this talk we give an overview over three optimisation systems for planning problems faced by the automotive industry, namely, strategic production planning, tactical workforce planning and operational logistics planning. For the strategic problem we developed a two-stage stochastic mixed-integer programming model, which is solved by an accelerated Benders' decomposition method. The workforce and logistics planning problems are modeled as mixed-integer linear programming problems and solved by standard solvers and heuristics.

### 3 - Collaborative production optimization in plantwide production scheduling and planning

*Guido Sand*, Corporate Research Germany, ABB AG, Wallstadter Straße 59, 68526, Ladenburg, Germany, [guido.sand@de.abb.com](mailto:guido.sand@de.abb.com), *Xu Chaojun*

In today's processing industry, various optimization based decision and automation functions are implemented and used in APC (advanced process control), APS (advanced planning and scheduling), energy trading and the like. Often, distinct subsystems of a plant are optimized in a decentralized manner lacking a function for collaborative optimization of the entire plant. Based on a use case from the metals industries, we discuss the potential of collaborative schedule optimization and a generic solution approach.

### 4 - Alignment of replenishment and lateral transshipment decisions in spare parts networks

*Harold Tiemessen*, Mathematical and Computational Sciences, IBM Research, Saueerstrasse 4, CH-8803, Rueschlikon, Switzerland, [hti@zurich.ibm.com](mailto:hti@zurich.ibm.com), *Eleni Pratsini*, *Moritz Fleischmann*

We consider the problem of joint replenishment and lateral transshipment decisions in a single-echelon inventory network. Under a general setting we develop a framework for the alignment of the two decisions and investigate the possible benefits of jointly optimizing them. Furthermore, for a system of service level constraints, we develop a replenishment rule that provides a lowerbound on total inventory holding costs over all possible transshipment policies. We discuss the computational challenges faced and the managerial implications. The work is motivated by IBM's spare parts network.

## ■ MD-23

Monday 13:35-14:55

Planck

### ANP II

Stream: Analytic Hierarchy Processes, Analytic Network Processes

*Invited session*

Chair: *Petr Fiala*, Dept. of Econometrics, University of Economics Prague, W.Churchill Sq. 4, 13067, Prague 3, Czech Republic, [pfiala@vse.cz](mailto:pfiala@vse.cz)

#### 1 - Applying the ANP model for selecting the optimal full-service advertising agency

*Pi-Fang Hsu*, Department of Communications Management, Shih Hsin University, No.1, Lane 17, Mu-Cha Road, Sec.1., 11604, Taipei, Taiwan, [celina9@ms26.hinet.net](mailto:celina9@ms26.hinet.net), *Pei-Ling Hsieh*, *Shang-Ling Wei*

This study develops a model for selecting full-service advertising agencies. The proposed model comprises two parts, with the first part adopting the nominal group technique (NGT) to identify suitable evaluative criteria for selecting advertising agencies, while the second part applies Analytic Network Process (ANP) to calculate and rank the optimal advertising agency. Additionally, the example of a famous Taiwanese food company is used to demonstrate the process of full-service advertising agency selection using this model.

#### 2 - Application of analytic network process (anp) in pilot selection

*Ebru Yazgan*, Anadolu University, Anadolu University, 26190, Eskişehir, [eyazgan@anadolu.edu.tr](mailto:eyazgan@anadolu.edu.tr), *Abdullah Korkut Üstün*

Job of pilots contains high risk because of the dangers in the nature of flights. In addition, training of pilots is very costly and a time consuming process. So, selection of pilots is very important. With the scope of this study pilot selection is considered as a multi criteria decision problem. In this study, Analytic Network Process (ANP) is used to evaluate and determine the criteria and their weights that affect pilot selection.

### 3 - ANP in supply network formation by auctions

*Petr Fiala*, Dept. of Econometrics, University of Economics Prague, W.Churchill Sq. 4, 13067, Prague 3, Czech Republic, [pfiala@vse.cz](mailto:pfiala@vse.cz)

Supply chain management is affected by network and dynamic business environment. Supply network is a decentralized network system of suppliers, manufacturers, distributors, and customers where material, financial, and information dynamic flows connect members. Supplier-customer relations have received considerable attention in business. Auctions are important market mechanisms for the allocation of goods and services. The paper is devoted to using of multiattribute combinatorial auctions in supply network formation processes. Mathematical models and solutions based on the AHP are presented.

## ■ MD-24

Monday 13:35-14:55

GSI - S 20

### Solution Methods for Semi-Infinite Optimization

Stream: Semi-Infinite Optimization

*Invited session*

Chair: *Alexander Mitsos*, Mechanical Engineering, Massachusetts Institute of Technology, 77 Massachusetts Avenue, MIT 3-158, 02139, Cambridge, MA, [mitsos@mit.edu](mailto:mitsos@mit.edu)

#### 1 - Right-hand side restriction for the deterministic global optimization of semi-infinite programs

*Alexander Mitsos*, Mechanical Engineering, Massachusetts Institute of Technology, 77 Massachusetts Avenue, MIT 3-158, 02139, Cambridge, MA, [mitsos@mit.edu](mailto:mitsos@mit.edu)

A deterministic algorithm is proposed for the global solution of SIPs without any convexity/concavity assumptions. The only assumptions are continuity of the functions and existence of an epsilon-optimal SIP Slater point. A converging upper bounding procedure is proposed based on a restriction of the right-hand-side of the constraint and a discretization of the parameter set. The converging lower bound is obtained by successively tighter discretization. The algorithm is extremely simple to implement and yet very efficient compared to existing methods, as demonstrated by numerical examples.

#### 2 - Bi-criteria multi-body design centering in presence of guillotine constraints

*Jan Schwientek*, Optimization, Fraunhofer ITWM, Fraunhofer-Platz 1, 67663, Kaiserslautern, Rhineland-Palatinate, Germany, [Jan.Schwientek@itwm.fraunhofer.de](mailto:Jan.Schwientek@itwm.fraunhofer.de), *Karl-Heinz Küfer*, *Anton Winterfeld*

Multi-body design centering (MBDC) deals with the optimal embedding of several parametrized bodies (the designs) into another body (the container). Naturally, the designs are required to be non-overlapping, but in practice it is often necessary, that they can be separated by a sequence of guillotine cuts. In our problem, two objectives have to be considered, and the guillotine patterns aren't restricted to orthogonal ones. We formulate bi-criteria MBDC problems with guillotine constraints in a semi-infinite way and present first numerical results for a practical problem with few designs.

### 3 - Semi-infinite optimization with implicit functions

Matthew Stuber, Department of Chemical Engineering, MIT, 77 Massachusetts Ave., Bldg 66-363, 02139, Cambridge, MA, United States, stuber@mit.edu, Paul I. Barton

A method for globally solving nonlinear nonconvex semi-infinite optimization problems constrained by implicit functions using interval methods is presented. Implicit functions arise when the infinite inequality constraint in an SIP is dependent not only on the index variables and decision variables, but also on variables that are implicit functions of the index and decision variables. Using interval methods, convex relaxations of the implicit infinite inequality constraint are calculated and refined in the Branch-and-Bound framework allowing for the calculation of global optima.

## ■ MD-25

Monday 13:35-14:55

GSI - S 25

### Ordered Structured in Games and Decision

Stream: Cooperative Game Theory

Invited session

Chair: Michel Grabisch, CES, Université Paris I - Pantheon-Sorbonne, 106-112 Bd de l'Hopital, 75013, Paris, France, michel.grabisch@univ-paris1.fr

#### 1 - Monge extensions and convexity of cooperation structures

Michel Grabisch, CES, Université Paris I - Pantheon-Sorbonne, 106-112 Bd de l'Hopital, 75013, Paris, France, michel.grabisch@univ-paris1.fr, Ulrich Faigle

We study cooperative games defined on a set  $F$  of feasible coalitions, without any assumption on the structure. By considering an activity bound for each player, we define a Monge algorithm which provides an extension of the game, similar to the Lovasz extension. The Monge extension permits to define the core of the game, keeping the essential properties which hold in for classical games. The Monge extension suggests a natural notion of convexity, independent of the combinatorial structure of the set  $F$ . When  $F$  is closed under union, we prove that convexity is characterized by supermodularity.

#### 2 - A matrix approach to tu games with coalition and communication structures

Gerard Hamiache, Mathematiques Economie et Sciences Sociales, Université Lille 3, Maison de la recherche, Domaine universitaire du Pont de Bois, 59653, Villeneuve d'Ascq, France, gerard.hamiache@univ-lille3.fr

The present article offers a technique to construct extensions of the Shapley value for TU games. Only basic matrix algebra is used. We define an efficient Aumann-Dreze value and an efficient Myerson value. We also define two families of values, the first being a convex combination of the efficient Aumann-Dreze value and of the Shapley value and the second a convex combination of the efficient Myerson value and of the Shapley value. We show that the Myerson value, the Aumann-Dreze value, the Shapley value and the four new solutions above are linked by a relationship of "similarity".

### 3 - Moebius inversion of cooperative games involving partitions of players

Giovanni Rossi, Computer Science, University of Bologna, Mura Anteo Zamboni 7, 40126, Bologna, roxyjean@gmail.com

Cooperative games involving partitions of players are (1) games in partition function form PFF, (2) global G games, (3) global coalitional GC games. Moebius inversion is used for analyzing them in terms of both solutions and cooperation restrictions. A solution of any cooperative game, regarded as a function taking real values on an atomic lattice, is defined as a cooperative game of the same type (i.e. taking values on the same lattice elements as the game to be solved) and with Moebius inversion living only on atoms. The implications are discussed for G, GC and PFF games.

## ■ MD-26

Monday 13:35-14:55

GSI - S 35

### Lot Sizing I

Stream: Discrete Optimization

Contributed session

Chair: Horst Tempelmeier, Supply Chain Management and Production, University of Cologne, Albertus-Magnus-Platz, D-50923, Cologne, Germany, tempelmeier@wiso.uni-koeln.de

#### 1 - A comparative study of three fast algorithms for the single item dynamic lot sizing problem

Nadjib Brahimi, Industrial Engineering and Management, University of Sharjah, POBox 27272, Sharjah, United Arab Emirates, POBox 27272, Sharjah, Sharjah, United Arab Emirates, nbrahimi@sharjah.ac.ae, Dali Chen

Three improved algorithms for the uncapacitated single item dynamic lot sizing problem (USILSP) are analyzed and compared. The three algorithms were introduced independently by Aggarwal and Park (1993), Federguen and Tsur (1991) and Wagelmans, Van Hoesel, and Kolen (1992). The three algorithms solve the USILSP in  $O(T \log T)$ , where  $T$  is the number of periods in the planning horizon. The three algorithms are implemented and compared based on their level of simplicity, ease of implementation and integration in other algorithms, their constant computational section and other aspects.

#### 2 - Solution methods for an integrated lot sizing and scheduling problem

Carina Pimentel, Departamento de Produção e Sistemas, Universidade do Minho, Campus de Gualtar, Portugal, 4710-057, Braga, Portugal, carina@dps.uminho.pt, Filipe Alvelos, J. M. Valério de Carvalho, António Duarte

In this talk we present results of an ongoing study, based on a problem of a textile factory. The core problem is an integrated lotsizing and scheduling one, characterized by sets of parallel machines, arbitrary demands and due dates for products, a compatibility matrix between machines and components and release dates of machines. In a solution, the quantities to produce by product/component/size are split among smaller lots, the machines in which those lots will be produced are determined, as well as the order in which they will be done. We present a MIP model and results of a VNS heuristic.

### 3 - Dynamic uncapacitated lot sizing with random demand under a fillrate constraint

*Horst Tempelmeier*, Supply Chain Management and Production, University of Cologne, Albertus-Magnus-Platz, D-50923, Cologne, Germany, tempelmeier@wiso.uni-koeln.de, *Sascha Herpers*

This paper deals with the single-item dynamic uncapacitated lot sizing problem with random demand. We propose a model based on the "static uncertainty" strategy. In contrast to these authors, we use exact expressions for the inventory costs and we apply a fillrate constraint. We present an exact solution method and modify several well-known dynamic lot sizing heuristics such that they can be applied for the case of dynamic stochastic demands. The results of a numerical test of the heuristics are shown.

## ■ MD-27

Monday 13:35-14:55

GSI - S 21

### Improving Container Terminal Performance

Stream: Container Terminal Operations

*Invited session*

Chair: *Kees Jan Roodbergen*, Erasmus University, Rotterdam School of Management, P.O. Box 1738, 3000DR, Rotterdam, Netherlands, kroodbergen@rsm.nl

#### 1 - Efficient dispatching through utilizing twin load capability of vehicles at container terminals

*Roel van Anholt*, Information Systems and Logistics, VU University Amsterdam, De Boelelaan 1105, room 3A-33, 1081 HV, Amsterdam, Netherlands, ranholt@feweb.vu.nl

Self lifting vehicles (e.g. twin load straddle carriers and shuttle carriers) can be deployed to perform the quay-side transport and the stacking operation. Theoretically these vehicles can transport two 20ft containers at once. However, this capability is seldom used in practice due to the lack of an efficient dispatching strategy. We propose a dispatching strategy that utilizes this capability. With extensive simulation experiments and a sensitivity analysis we demonstrate that this newly developed heuristic algorithm outperforms simple heuristics as commonly used in practice.

#### 2 - Dynamic storage yard allocation for a transshipment hub port

*Ek Peng Chew*, Industrial and Systems Engineering, Faculty of Engineering, National University of Singapore, 10 Kent Ridge Crescent, 119260, Singapore, Singapore, isecep@nus.edu.sg, *Loo Hay Lee*

A storage yard management problem in a transshipment hub is considered. A dynamic yard template is proposed to reuse the storage space for different vessels during different shifts in order to make full use of the storage space. In addition, the consignment strategy is used to reduce the number of reshuffles and the high-low workload balancing protocol is used to reduce the traffic congestion of prime movers.

### 3 - Scheduling of container storage and retrieval

*Kees Jan Roodbergen*, Erasmus University, Rotterdam School of Management, P.O. Box 1738, 3000DR, Rotterdam, Netherlands, kroodbergen@rsm.nl

We consider the problem of scheduling the storage and retrieval of containers in the stack. Some arcs in the underlying directed network must be visited; other arcs may - but need not be - visited. We can consider this problem to be a special case of the directed Rural Postman Problem. We show that this problem can be reformulated as an asymmetric Steiner Traveling Salesman Problem which can be efficiently solved to optimality by a combination of optimal assignments in bipartite networks for parts of the problem and dynamic programming for the connections between those parts.

### 4 - Routing multiple automated stacking cranes at container terminals

*Iris F.A. Vis*, Faculty of Economics and Business Administration, Vrije Universiteit Amsterdam, De Boelelaan 1105, 1081 HV, Amsterdam, Netherlands, ivis@feweb.vu.nl, *Hector Carlo*

The significant growth in volumes of containers being transhipped puts a strain on all logistics processes at container terminals, including the stacking processes. This study is concerned with scheduling storage and retrieval requests for two Automated Stacking Cranes operating in the same block. We present a mathematical model to minimize the makespan for both cranes. Both an algorithm to derive a lower bound for the makespan and a simulated annealing based heuristic are proposed to efficiently solve the problem.

## ■ MD-28

Monday 13:35-14:55

GSI - S 1

### Financial Optimization 3

Stream: Financial Optimization

*Invited session*

Chair: *Andrea Consiglio*, Dept. of Statistics and Mathematics, University of Palermo, Facolta' di Economia - Ed. 13, Viale delle Scienze, 90128, Palermo, Italy, consiglio@unipa.it

#### 1 - Scenario reduction for trading in electricity markets

*Miguel Carrion*, Electrical Engineering, University of Castilla - La Mancha, Avda Carlos III, s/n, Campus Fábrica de Armas, 45071, Toledo, miguel.carrion@uclm.es, *Antonio J. Conejo*, *Salvador Pineda*, *Juan Miguel Morales*

To make informed decisions in futures markets of electricity stochastic programming models are commonly used. The number of scenarios to accurately represent the uncertainty involved is generally large, which renders the associated problem hard to solve. Hence, scenario reduction techniques are needed to trim down the number of scenarios while keeping most of the stochastic information embedded in such scenarios. This presentation proposes a scenario reduction procedure that advantageously compares with existing ones for electricity-market problems tackled via two-stage stochastic programming.

#### 2 - The optimal mortgage choice: mix your loans and stay out of trouble

*Kourosh Marjani Rasmussen*, Management, Technical University of Denmark, Produktionstorvet, DTU — Bygning 424, 2800, Lyngby, Denmark,

kmr@imm.dtu.dk, Snorri P. Sigurdsson, Klaus K. Andersen, Jens Clausen

Changes in interest rate have an impact on a household's mortgage payments and house price fluctuations influence the ability to repay the outstanding debt. The household is interested in minimizing the mortgage payments and reduce the probability of insolvency. We introduce stochastic programming models which explicitly account for interest rate and house price risk. We show that a portfolio of a Danish type fixed rate mortgage and a variable rate mortgage offers cheap house financing and hedge against insolvency in markets with the risk of increasing interest rates and falling house prices.

### 3 - Handling second order stochastic dominance through cutting plane representations of cvar

Diana Roman, School of Inf Syst, Computing and Maths, Brunel University, Kingston Lane, Uxbridge, UB8 3PH, Uxbridge, diana.roman@brunel.ac.uk, Csaba I. Fabian, Gautam Mitra

We consider the problem of constructing a portfolio, which is non-dominated with respect to second order stochastic dominance and thus optimal for risk-averse investors. In addition, this portfolio has a return distribution close to a user-specified, target distribution. The model is formulated as a multi-objective CVaR minimization problem and represented as a LP of large size. Further on, a cutting plane representation of CVaR is used. This approach dramatically increases the execution speed and makes the model solvable even for very large number of scenarios.

### 4 - A stochastic programming model for the optimal issuance of government bonds

Andrea Consiglio, Dept. of Statistics and Mathematics, University of Palermo, Facolta' di Economia - Ed. 13, Viale delle Scienze, 90128, Palermo, Italy, consiglio@unipa.it

Sovereign states issue fixed and floating securities to fund the public debt. The value of such portfolios depends on the fluctuations of the term structure of interest rates. We propose a stochastic programming model to select portfolios of bonds, where the aim of the decision maker is to minimize the cost of the decision process. At the same time, we bound the conditional Value-at-Risk, a measure of risk which accounts for the losses of the tail distribution.

## ■ MD-29

Monday 13:35-14:55

GSI - S 2

### Market Design for Emission Trading

Stream: Energy and Emission Markets

Invited session

Chair: Max Fehr, Mathematics (Institute for Operations Research), ETH Zurich, HG G 22.1, Rämistrasse 101, 8092, Zurich, Switzerland, maxfehr@ifor.math.ethz.ch

#### 1 - Dynamic electricity market equilibria: strategic bidding and production constraints

Alexander Rudyk, Institute for Operations Research, ETH Zurich, Raemistrasse 101, 8092, Zurich, Switzerland, ar@rudyk.net

We predict hourly electricity spot prices based on fundamental price drivers such as electricity demand, fuel prices, emission certificates and technical constraints. For given demand, the competitive market equilibrium is stated as solution of a social cost minimization LP across time. This LP includes power plant production constraints such as bounds on the number of startups a plant may perform during a year. Its dual can be modified to determine market prices when plant owners independently place strategic market bids. We present results for Italy and the United Kingdom.

#### 2 - Design of allocation mechanisms for cap and trade schemes

Max Fehr, Mathematics (Institute for Operations Research), ETH Zurich, HG G 22.1, Rämistrasse 101, 8092, Zurich, Switzerland, maxfehr@ifor.math.ethz.ch

Recent price development of carbon allowances in the EU ETS and its impact on European electricity prices exhibits the importance of a clear understanding of such Trading Systems. We propose a stochastic equilibrium model for the price formation of allowances and products, whose production causes pollution. It turns out that for any cap and trade scheme, designed in the spirit of the EU ETS, the consumers' burden exceeds by far the overall reduction costs, giving rise for huge windfall profits. Following this insight we show how to adapt allocation mechanisms to reduce windfall profits.

#### 3 - Technology change and presence of institutional investors in experimental markets for emission permits

Luca Taschini, Swiss Banking Institute, University of Zurich, Plattenstrasse 32, 8032, Zurich, taschini@isb.uzh.ch, Marc Chesney, Mei Wang

This paper reports on the use of experimental methods to investigate behavior with respect to how prices will be determined in a permit market with and without the presence of non-relevant companies. We find that relevant companies learn to change technology as soon as possible and sell the extra permits at a premium. Behavior of relevant companies moves against that predicted by general economic theory. Conversely, financial institutions and NGOs behave as expected. Financial institutions induce a higher price-volatility, and NGOs attempt quite unsuccessfully to create market-scarcity.

#### 4 - Comparison of two strategic energy models on a case study

Guillaume Erbs, Research and Innovation Division, GDF SUEZ, 361 avenue du Président Wilson, 93211, Saint-Denis La Plaine, France, guillaume.erbs@gdfsuez.com, Jean André, Ruud Egging, Steven Gabriel, Franziska Holz

In this presentation, we compare two ways of modelling the natural gas supply chain. In the first approach, the objective is to minimize the overall cost of the supply chain. In the second one, each player is modelled independently and the objective is to find the equilibrium between all the players.

This study analyzes gas markets worldwide for the year 2015 with a particular emphasis on the European and the United Kingdom markets. A disruption to the Interconnector between Belgium and the UK is considered in which no gas is allowed to proceed from the continent to the UK via that route.

## ■ MD-30

Monday 13:35-14:55

GSI - S 26

### Dynamic Programming - Systems

Stream: Dynamic Programming

Invited session

Chair: Lidija Zadnik Stirn, Biotechnical Faculty, University of Ljubljana, Vecna pot 83, 1000, Ljubljana, Slovenia, lidija.zadnik@bf.uni-lj.si

#### 1 - State-independent control of mdp's

D.a. van der Laan, Econometrics & OR, Vrije University Amsterdam, De Boelelaan 1105, 1081 HV, Amsterdam, Netherlands, dalaan@feweb.vu.nl

For controlling a Markov decision process (MDP) it can be useful if control actions do not depend on the current state of the dynamical system. For example if the MDP is too large and complex to obtain an (optimal) state-dependent control policy by established methods like dynamic programming or if it is a burden to observe the current system state. Also a state-independent policy is easier to implement. Both randomized and deterministic state-independent control policies are considered discussing their advantages, disadvantages and methods for optimization.

## 2 - Optimization of power plant investments using approximate dynamic programming

Ansgar Geiger, Optimization, Fraunhofer Institute for Industrial Mathematics, Fraunhofer Platz 1, 67663, Kaiserslautern, Germany,  
ansgar.geiger@itwm.fraunhofer.de, Stefan Nickel

In power generation expansion planning, two decisions must be made: the technology choice and the timing of the investments. These decisions are strongly influenced by uncertain fuel and emission allowances prices. We formulate the investment problem as a stochastic dynamic model. To be able to consider the effects of the new units on the electricity market, the investment model is coupled with a simple electricity market model determining the electricity prices. Two solution approaches are presented and compared: dynamic programming using aggregation and approximate dynamic programming.

## 3 - Inventory rationing and sharing for traveling salesmen

Grigory Pishchulov, Chair of Industrial Management, European University Viadrina, Grosse Scharnstr. 59, 15230, Frankfurt (Oder), Germany,  
pishulov@euv-frankfurt-o.de

The paper focuses on stock control in pre-sell distribution which engages traveling salesmen to reveal customer demands and quote deliveries. A model company is considered whose salesmen may ration the stock when meeting the demand. The optimal rationing problem is stated as a multi-stage stochastic program. The capability of mobile communication is shown to benefit the company by enabling stock sharing between sales territories and information sharing when demands are dependent. Stochastic dynamic programming is utilised to determine control policies and establish their structural properties.

## 4 - Learning and forgetting in setups:

Sunantha Teyarachakul, Operations Management, ESSEC Business School, Avenue Bernard Hirsch B.P. 50105, 95021, Cergy-Pontoise Cedex,  
teyarachakul@essec.fr

We consider the impacts of learning and forgetting in setups on batch-sizing decisions. A dynamic programming algorithm to obtain the optimal production schedule is developed and presented. We have found several properties associated with our model. For example, Zero-Inventory Property satisfies the optimal policy. Our study demonstrates the situation where firms may be better off producing in smaller batches. This is a new insight that provides one more justification for producing in small lots.

## MD-31

Monday 13:35-14:55

GSI - S 34

## Data Mining Algorithms for Quality Improvement

Stream: Data Mining in Quality Improvement

Invited session

Chair: *Inci Batmaz*, Statistics, Middle East Technical University, Middle East Technical University, Department of Statistics, 6531, Ankara, Turkey, [ibatmaz@metu.edu.tr](mailto:ibatmaz@metu.edu.tr)

### 1 - Design parameter optimization using mahalanobis Taguchi system

*Baris Yenidunya*, Eskisehir Yolu 4. Km. 2. Cadde No:63 C Blok Sögütözü, 06520, Ankara, Turkey,  
[barisyenidunya@gmail.com](mailto:barisyenidunya@gmail.com), *Gulser Koksall*

Mahalanobis Taguchi System (MTS) is a classification method developed mainly for diagnosis/ pattern recognition problems. In this study, MTS is used for design parameter optimization problems with binary response. The proposed method is applied on two different cases and the results are compared to optimization results of the corresponding logistic regression models. Advantages and disadvantages of the approach are discussed.

### 2 - A nonparametric improved fuzzy classifier function approach for classification based on customer satisfaction survey data

*Gizem Özer*, Bascavus street No:47/7 Kucukesat, 06660, Ankara, Turkey, [gizem1306@gmail.com](mailto:gizem1306@gmail.com), *Tuna Kilic*, *Elcin Kartal*, *Inci Batmaz*, *Özlem Türker Bayrak*, *Gulser Koksall*, *Burhan Turksen*

Fuzzy Classifier Functions (FCF) and Improved FCF (IFCF) are newly developed methods used for classification problems to capture the effect of fuzzy uncertainty. These methods depend on construction of one classifier for each cluster after partitioning data with fuzzy c-means (FCM) and improved fuzzy clustering (IFC) methods for FCF and IFCF, respectively. To overcome fitting problems in IFC, we propose using a non-parametric method, MARS. In this study, FCF and IFCF are applied for building a classification model based on customer satisfaction survey data and their performances are discussed.

### 3 - On rough-set based multicriteria decision making in quality improvement

*Guvenc Arslan*, Statistics and Computer Science, Baskent University, Baglica Kamp., Faculty of Science and Letters, Eskisehir Yolu 20. Km. 06810, Ankara, Turkey, [guvenca@baskent.edu.tr](mailto:guvenca@baskent.edu.tr), *Ozlem Aydin*

The initial stage is probably one of the most difficult steps in applications of quality improvement problems. Usually it is not known in advance which variables and factors are most important. In such situations the use of data mining approaches are choices of researchers. It is known that rough sets can deal with inconsistencies effectively. Inconsistencies should also be expected in examples and measurements of quality problems. In this study the use of rough sets and MCDM in quality improvement is investigated and the results are discussed.

### 4 - Multi-class mts classification algorithms and their applications

*Dilber Ayhan*, Industrial Engineering Department, Middle East Technical University, Meksika Cad. 386.sok. Kardelen Sit. B lok. No:1, Ümitköy, Ankara, Turkey, [dilber.ayhan@gmail.com](mailto:dilber.ayhan@gmail.com), *Gulser Koksall*

In this study a classification algorithm, Weighted Multi-Class Mahalanobis Taguchi System (WMMTS), is developed. The motivation comes from Wölfel and Ekenel (2005), which relax adding up of Mahalanobis distances for variables equally. This provides representations of noisy variables with weights close to zero. Second, the classical MTS method is extended for multi-class problems, namely MMTS. Third, the approach of Su and Hsiao (2009), feature weighted multi-class MTS (FWMMTS), is also modified. The WMMTS is applied on several datasets, and its performance is compared to those of MMTS and FWMMTS.

## ■ MD-32

Monday 13:35-14:55

GSI - S 4

### Financial Crisis

Stream: Financial Modelling

Contributed session

Chair: *M Shahid Ebrahim*, Business School, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, m.shahid.ebrahim@nottingham.ac.uk

#### 1 - Empirical study on stability of Japanese corporate ratings with artificial neural network

*Katsuaki Tanaka*, Faculty of Business Administration and Information, Setsunan Univ., 17-8 Ikedanakamachi, 572-8508, Neyagawa, Osaka, Japan, k-tanaka@kjo.setsunan.ac.jp, *Motohiro Hagiwara*, *Hideki Katsuda*, *Susumu Saito*

In Japan, investors have begun to use corporate ratings given by 4 major rating agencies as an index to measure the credit risk of each company. Corporate ratings are based on the quantitative data and qualitative information. But investors do not know the evaluation process or structure of rating agencies. In this paper, using artificial neural network, we propose the method to evaluate the determinant structure of corporate ratings given by agencies and their over-time stability. In our analysis, we only make use of the quantitative data of Japanese companies from the year 2001 to 2007.

#### 2 - The reasons us financial secretary pauson gave up lehman brothers from the non-american investors' view

*George Chun Ming Chien*, Ph. D Student of Graduate Institute of Management Sciences, Agricultural Bank of Taiwan Department of Finance, Tamkang University, 151 Ying-Chuan Rd., 25137, Tamsui, Taipei, Taiwan, chingya816@yahoo.com.tw, *Ching Ya Hsiao*, *Hornng Jinh Chang*

The investment banks are the major targets for fail because they do not have the deposit business. The fifth investment bank at US, Bear Stearns, was acquired by JP Morgan at 2007. The fourth investment bank, Lehman Brothers, filed chapter 11 at 2008 when the US government denied the same terms like Bear Stearns to the possible bidders. If the ratio of non-American Lehman Brothers bond holders is bigger than that of Bear Stearns, the article can conclude Paulson shared the loss of US real estate with investors outside American through Lehman Brothers' failure.

#### 3 - With japan experience, this financial crisis will last longer than expected

*Ching Ya Hsiao*, Ph. D Student of Graduate Institute of Management Sciences, Tamkang University, 151 Ying-Chuan Rd, 25137, Tamsui, Taipei, Taiwan, ya816@yahoo.com.tw, *George Chun Ming Chien*, *Hornng Jinh Chang*

Under Basel I requirement, the Japanese banks had to reduce their assets and caused economic slowing down since 1990. Due to the sub-prime crisis, the US financial institutions also met the capital insufficient problem. This article uses Japanese economic slow experience to conclude the US crisis started from 2007 will not end as most expected.

#### 4 - On the efficiency of the upreit organizational form: implications for the subprime crisis and cdos

*M Shahid Ebrahim*, Business School, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, m.shahid.ebrahim@nottingham.ac.uk

This paper studies optimal real estate organizational forms as a means of enhancing real estate values in the ongoing subprime crisis. We model the organizational response to stakeholder conflicts and regulatory changes to show how they adapt to an optimal form and undertake an optimal capital structure to enhance the welfare of investors. This adaptation enhances welfare by mitigating administrative costs, agency costs, bankruptcy costs, illiquidity costs and taxes.

## ■ MD-33

Monday 13:35-14:55

GSI - S 7

### Metaheuristics in Global Optimization

Stream: Global Optimization

Invited session

Chair: *Pilar Ortigosa*, Computer Architecture and Electronics, Universidad de Almería, Ctra. Sacramento s/n, La Cañada de San Urbano, 04120, Almería, Spain, ortigosa@ual.es

#### 1 - Scheduling optimization based on a genetic algorithm under constraints

*Djamila Boukreda*, Laboratoire LIRE, University of Constantine, Route d'Ain El Bey, 25000, Constantine, Algeria, boukreda@hotmail.com, *Rabah Kassa*, *Khaled Sellami*

We focus on the scheduling problem in a virtual enterprise modeled by a autonomous agents whose aim is to improve their profitability while minimizing the customer's service costs. The sales agents have to establish an optimal scheduling of customer's orders. This can be formulated as a constraint satisfaction problem. We suggest an optimization method of the CSP based on the genetic algorithm. This hybridization aim at better taking over of this kind of problem which is defined by a large research space and a complex constraint set and finds solutions of good quality.

#### 2 - Determining optimal batch sizes by means of evolutionary algorithms and queueing network analysis

*Boualem Rabta*, Entreprise Institute, University of Neuchatel, Rue A.L. Breguet 1, 2000, Neuchatel, Switzerland, boualem.rabta@unine.ch

Batch sizes have a considerable impact on performance of a manufacturing process. Determining optimal values for lot sizes helps reducing inventories/costs and leadtimes. We model the manufacturing system as a G/G/1 batch arrivals queueing network. We use a genetic algorithm that searches for the optimal values for lot sizes and uses an approximate queueing network analysis procedure based on decomposition to evaluate the fitness of each population individual. This approach allows taking into account the randomness of different variables and provides fast and good solutions.

**3 - A shared memory programming approach of uego.**

*Juana Lopez-Redondo*, Computer Architecture and Electronics, University of Almeria, Carretera de Sacramento S/N, La Cañada de San Urbano, 04120, Almería, Spain, juani@ace.ual.es, *I. Garcia, Pilar Ortigosa*

In this work, we deal with UEGO, a multimodal evolutionary global optimization algorithm. It has proved its ability at finding a global optimum solution in a variety of problems. Several parallel implementations of UEGO have been designed for distributed memory architectures with successful results. They were based on message-passing mechanisms. However, since new multicore systems are expected to become common as personal computers, it is advisable to adapt UEGO following shared memory programming. We analyze up to which extent UEGO takes advantages of shared memory architectures.

**■ MD-34**

Monday 13:35-14:55

GSI - S 8

**Fuzzy Logic based decision systems**

Stream: Fuzzy Systems, Neural Networks & Artificial Intelligence

*Invited session*

Chair: *Masayuki Kageyama*, The Institute of Statistical Mathematics, 4-6-7 Minami-Azabu, Minato-ku, 106-8569, Tokyo, kageyama@ism.ac.jp

**1 - Fuzzy rule based scenario-management**

*Thomas Spengler*, Department of Economics and Management, Otto-von-Guericke-University Magdeburg, P.O. Box 4120, 39016 Magdeburg, 39016, Magdeburg, thomas.spengler@ovgu.de

Against the background of increasing environmental complexity, contingency and dynamics scenario management is highly important. Due to the corresponding vagueness and fuzziness the current procedures of the scenario toolbox are no appropriate instruments to treat the judgements and opinions of experts. Therefore we recommend the modelling of fuzzy procedures in the scope of influence, consistency and cross-impact analysis. Hence, we get the ability to treat the estimations and evaluations in a realistic manner. The corresponding procedures are based on fuzzy rule systems.

**2 - Does the law of large numbers hold if people estimate the mean of a random variable by observing it for several times? —an example of fuzziness in the responses of people**

*Bodo Vogt*, Fakultät für Wirtschaftswissenschaft, Otto-von-Guericke-Universität Magdeburg, Postfach 4120, 39016, Magdeburg, Germany, bodo.vogt@ww.uni-magdeburg.de, *Thomas Spengler*

According to statistics observing the realizations of a random variable several times enables an individual to estimate the mean of the random variable more precisely. The variance of the estimator should decrease. In an experiment we test this by asking individuals for confidence intervals of their estimates after different numbers of observations. The confidence interval does not decrease after few observations indicating an uncertainty that is not described by the classical statistical model. We use fuzzy theory to describe this phenomenon and connect our model to behavioral economics.

**3 - On the development of a risk-model using credibilistic processes**

*Masayuki Kageyama*, The Institute of Statistical Mathematics, 4-6-7 Minami-Azabu, Minato-ku, 106-8569, Tokyo, kageyama@ism.ac.jp

In a talk we propose a new risk model to find out a threshold credibility measure. The idea of credibility measure, was introduced by Professor Liu in order to measure fuzzy event, which provides a powerful tool for analysis of the real uncertain problem. At first we introduce how to construct credibilistic processes which is our previous work and play a key role in our model and discuss our proposed risk model. Also, we give a numerical example.

**■ MD-35**

Monday 13:35-14:55

GSI - S 9

**Facilitated Strategy Making**

Stream: Facilitated Modelling Interventions

*Invited session*

Chair: *Colin Eden*, University of Strathclyde, United Kingdom, colin@mansci.strath.ac.uk

Chair: *Fran Ackermann*, University of Strathclyde, United Kingdom, fran@mansci.strath.ac.uk

**1 - Anchoring decision analysis in the strategic management toolbox**

*Paul Schulze-Cleven*, Department of Management, London School of Economics, Wolliner Str. 64, 10435, Berlin, Germany, p.j.schulze-cleven@lse.ac.uk, *Gilberto Montibeller, Martin Schilling*

A variety of tools are available to support the generation of strategy. However, decision analyses have not yet been analyzed as a element of strategy developing processes. In this talk I would like to derive a more outcome oriented understanding of Decision Analysis - stressing the claim and ability to impact organizational strategy and performance - and argue for its acknowledgment within strategic management. Departing from the genuine overlaps of the two fields I will map Decision Analysis methods against various established strategic management tools.

**2 - Scriptmap—a tool to facilitate design of strategy workshops**

*David Andersen*, Public Administration and Policy, University at Albany, 1400 Washington Avenue, 12054, Albany, New York, United States, David.Andersen@albany.edu, *Colin Eden, Fran Ackermann, George Richardson*

This paper reports on the development of a tool to facilitate the design of workshops using: system dynamics group model building, and group problem structuring with causal mapping and using a GSS. The paper explains both the genesis and purpose of 'ScriptMap' as a means for articulating an extensive range of steps (scripts) useful when designing model building workshops. The map comprises 'building blocks' allowing a facilitator to construct, with the map's aid, a thoughtful and careful design. The paper will illustrate the ScriptMap's structure through two example scripts

**3 - Modelling competitive advantage**

*Colin Eden*, Management, University of Strathclyde, 199 Cathedral Street, G4 0QU, Glasgow, United Kingdom, colin@gsb.strath.ac.uk, *Fran Ackermann*

Competitive advantage is crucial during a recession and the Resource Based View is a well developed way of understanding differentiation. However, although the notion of bundles of capabilities/competences makes sense to establish competitiveness, the process of detecting bundles (portfolios, feedback loops) is not well developed. Aspects of 'soft OR' have a role to play. This paper discusses the result of an extensive body of action research undertaken over 15 years with 44 top management teams strategy making. A method is presented based upon causal mapping and mapping formalisms.

#### 4 - Modelling the dynamics stakeholder reactions: a process for considering stakeholder responses, reactions and interactions when developing strategy

*Fran Ackermann*, Management Science, Strathclyde University, 40 George Street, G1 1QE, Glasgow, United Kingdom, fran.ackermann@strath.ac.uk, *Colin Eden*, *David Andersen*, *George Richardson*

Understanding the impact of stakeholder reactions to policy decisions is a critical part of ensuring the likelihood of success. The paper discusses a modelling process for eliciting key stakeholders, their interests, and sanctions or support activities. The process draws upon well-established research in stakeholder management, strategy, & systems thinking. The design explicitly considers interactions between stakeholders with a focus on developing dynamics. The outcome can inform the development of a system dynamics model by modelling feedback between the organization and their stakeholders

## ■ MD-36

Monday 13:35-14:55

GSI - S 11

### Stochastic Control in Finance I

Stream: Optimal Control in Finance and Insurance

*Invited session*

Chair: *Ulrich Rieder*, Optimization and Operations Research, University of Ulm, Helmholtzstrasse 18, 89081, Ulm, ulrich.rieder@uni-ulm.de

#### 1 - On asymptotic power utility-based pricing and hedging

*Johannes Muhle-Karbe*, Zentrum Mathematik, TU München, Boltzmannstr. 3, 85748, Garching bei München, Bayern, muhlekarbe@ma.tum.de

Kramkov and Sîrbu (2006, 2007) have shown that in incomplete markets, first-order approximations of utility-based prices and hedging strategies can be computed by solving a mean-variance hedging problem under a specific equivalent martingale measure and relative to a suitable numeraire. To facilitate computations, we propose an alternative representation in terms of the original numeraire. We then discuss how to apply these results in affine models featuring jumps and stochastic volatility. In particular, we present some numerical examples.

#### 2 - A Bayesian approach to incorporate model ambiguity in a dynamic risk measure

*Nicole Baeuerle*, Institute for Mathematical Stochastics, University of Karlsruhe, Englerstr. 2, 76128, Karlsruhe, Germany, baeuerle@stoch.uni-karlsruhe.de

In this talk we consider a dynamic risk measure for discrete-time payment processes. Analogous to the static AVaR, this risk measure can be reformulated in terms of a Markov decision problem. This observation gives a nice recursive computation formula. Then the dynamic risk measure is generalized to a setting with incomplete information about the risk distribution which can be seen as model ambiguity. We choose a parametric approach here. The risk measure is now the solution of a Bayesian decision problem. It is also possible to discuss the effect of model ambiguity on the risk measure.

#### 3 - Portfolio optimization with dynamic risk constraints and partial information

*Jörn Sass*, Fachbereich Mathematik, TU Kaiserslautern, Postfach 3049, 67653, Kaiserslautern, Germany, sass@mathematik.uni-kl.de

An investor wants to maximize expected utility of terminal wealth. Stock returns are modeled as a SDE with non-constant coefficients. If the drift depends on a process independent of the driving Brownian motion, it may not be adapted to the filtration generated by the stock prices and has to be filtered from the observed prices. In such a model with partial information the optimal strategy can be very extreme. To reduce the shortfall risk, we impose dynamic risk constraints on the strategy. These lead to much more stable strategies which can be computed for classical drift models.

#### 4 - Portfolio optimization under uncertain drift

*Christoph Wopperer*, Optimization & Operations Research, Ulm University, Helmholtzstrasse 22, Room E017, 89081, Ulm, wopperer@gmx.de

Classical portfolio optimization problems assume the availability of a fully characterized stochastic model. However, the mean rate of return of the stock price process is extremely difficult to estimate. Therefore it is desirable to take uncertainty about the return process into account. We discuss a worst-case approach to consumption-investment problems under an uncertain drift process. For the HARA utility function and stochastic coefficients of the stock price process we give a characterization of the robust optimal policy and the worst-case drift process by the solution of a linear BSDE.

## ■ MD-37

Monday 13:35-14:55

GSI - S 12

### Pricing and Revenue Management

Stream: Revenue Management

*Invited session*

Chair: *Guillaume Roels*, Anderson School of Management, UCLA, 110 Westwood Plaza, B511, 90095, Los Angeles, CA, groels@anderson.ucla.edu

Chair: *Houyuan Jiang*, Judge Business School, University of Cambridge, Trumpington Street, CB2 1AG, Cambridge, United Kingdom, h.jiang@jbs.cam.ac.uk

#### 1 - Revenue management for resource allocation problem

*Giovanna Miglionico*, DEIS, Università della Calabria, Cubo 41C - Via Pietro Bucci, 87036, Arcavacata di Rende, Italy, gmiglionico@deis.unical.it, *Francesca Guerriero*, *Filomena Olivito*

We consider the problem of managing a fleet of trucks with different capacity to serve the transportation demand of a given quantity of goods from an origin to a destination at a given time. We propose a dynamic programming model. A linear programming version of the problem is also presented and its solution is exploited via revenue management techniques. Policies that incorporate the "truck sharing", i.e. the joint use of the resource between certain customers are developed. Numerical experiment are carried out to compare the different policies.

## 2 - A branch and cut algorithm for the product assortment problem under customer choice behavior

*Juan Jose Miranda Bront*, Computer Science Department, University of Buenos Aires, Av. Cantilo s/n, Pabellon I, Cdad. Universitaria, C1428EGA, Ciudad Autonoma de Buenos Aires, [jmiranda@dc.uba.ar](mailto:jmiranda@dc.uba.ar), *Isabel Méndez-Díaz*, *Gustavo Vulcano*, *Paula Zabala*

We consider a revenue management problem with fixed prices and a general model of market segmentation. Consumers within each segment choose according to a multinomial logit model. The seller has to decide the optimal set of products to offer in order to maximize the instantaneous revenue rate. We formulate the problem as a MIP, and develop a branch-and-cut to solve it effectively. Our numerical experiments provide evidence of the potential of our approach.

## 3 - Robust pricing in the newsvendor model

*Guillaume Roels*, Anderson School of Management, UCLA, 110 Westwood Plaza, B511, 90095, Los Angeles, CA, [groels@anderson.ucla.edu](mailto:groels@anderson.ucla.edu)

It is usually assumed that firms who seek to optimize their prices have full knowledge of the price-demand curve. However, in practice, many firms are unwilling to experiment with price changes. In this talk, we consider the newsvendor model with endogenous pricing and relax the traditional informational assumption about the price-demand curve. We design robust pricing strategies and quantify the value of information about the price-demand curve.

## ■ MD-38

Monday 13:35-14:55  
GSI - S 13

### Lean Accounting Beyond Operations

Stream: Lean Accounting

*Invited session*

Chair: *Thomas Kristensen*, Center for Industrial Production, Aalborg University, Fibigerstraede 16, 9220, Aalborg Ø, [thomas@lean-accounting.org](mailto:thomas@lean-accounting.org)

#### 1 - Cost estimating for lean supply chains

*Marcus Schweitzer*, Fachbereich 5, University of Siegen, Hoelderlinstr. 3, 57076, Siegen, Germany, [maschweitzer.sb@freenet.de](mailto:maschweitzer.sb@freenet.de)

One major topic of lean management is the design of pull-driven supply chains, realized for example in a continuous replenishment system. This raises the questions of how the supply chain should be structured and of adequate performance indicators to control the application of lean supply chain techniques. In the presentation, an approximate approach of a pull-driven supply chain is developed applying GI/GI/1/k-queueing-systems. It allows the evaluation of alternative chain structures by means of transaction cost and provides a framework for the design of a lean performance measurement system.

#### 2 - Adopting bsc as a change management tool in a public transport operator: the stcp case study

*Leandro Carvalho*, Department of Industrial Management, Faculty of Engineering of the University of Porto, Portugal, Rua 4 Caminhos, Vereda2, n72, BL:B, 7Fr, Canidelo, 4400-260, Vila Nova de Gaia, Portugal, [leandromec@yahoo.com.br](mailto:leandromec@yahoo.com.br), *Jorge Freire de Sousa*

This paper describes the case study of an adaptation of the Balanced Scorecard to the particularities of STCP, the main public transport operator in the city of Oporto. It will be used as a change management tool in order to communicating and clarifying the strategy of the company. The study proposes a new perspective, the value creation for the Stakeholder, as the prime strategic objective of the BSC, and based on this proposal, the STCP strategic map was developed. Concluding, the benefits obtained from the introduction of these tools in its strategic management system will be discussed.

#### 3 - Standard costing in a lean organization: enabling OR coercive?

*Thomas Kristensen*, Center for Industrial Production, Aalborg University, Fibigerstraede 16, 9220, Aalborg Ø, [thomas@lean-accounting.org](mailto:thomas@lean-accounting.org)

Using the enabling-coercive dichotomy we find, in our case studies, that Standard Costing can be perceived as enabling by the actors of Lean companies. Hence, an enabling Standard Costing approach is found to fit Lean, thus contradicting that organic control fits Lean. We look into which uses of Standard Costing and variance analysis constitute the content of the four dimensions of enabling, i.e. repair, internal & global transparency and flexibility. These dimensions focus on the use of standard costing and not the technical structure of the costing models.

## ■ MD-39

Monday 13:35-14:55  
GSI - S 14

### Game Theory 3

Stream: Game Theory

*Contributed session*

Chair: *Mariusz Kaleta*, Institute of Control & Computation Engineering, Warsaw University of Technology, Nowowiejska 15/19, 00-665, Warsaw, [mkaleta@ia.pw.edu.pl](mailto:mkaleta@ia.pw.edu.pl)

#### 1 - On optimal organization of government and corporate control

*Alexander Vasin*, Operations Research, Lomonosov Moscow State University, Russia, Moscow, Leninskie Gori, MSU, 2nd educational building, room 648, 119992, Moscow, Russian Federation, [vasin@cs.msu.su](mailto:vasin@cs.msu.su)

We consider several problems of optimal organization for revenue collecting and law enforcement inspections. We study whether it is possible to organize an effective control over 100000 agents and suppress corruption in case when very few reliable persons are available for this purpose. We determine the optimal strategy including selection of agents for the primary audit and revisions, salaries and premiums of inspectors at different levels, the number of levels in the hierarchy. We show that under general assumptions one honest person is enough for efficient inspection.

#### 2 - Fuzzy subjective conflict analysis

*Teruhisa Nakai*, Civil, Environmental and Applied Systems Engineering, Kansai University, 3-3-35

Yamate, 564-8680, Suita, Osaka, Japan,  
nakai@iecs.kansai-u.ac.jp

For an analysis of a noncooperative game we propose a fuzzy subjective conflict analysis which applies a conflict analysis to a fuzzy subjective game reflecting a subjective sense of value of a player and fuzziness and nonadditivity in human judgments. We show that it is desirable for a player to use a strategy indicated by the stable equilibrium point having a maximum realization probability in his fuzzy subjective game. By this method we can explain the variety in selecting a strategy by a player and dispel the gap between the individual rationality and the social rationality.

### 3 - Decisiveness-related generalized class of power values for cooperative games

Dorota Marciniak, Polish Academy of Sciences,  
Warsaw, Poland, Dorofia@gmail.com

In the presentation I will introduce a class of power values for cooperative games with natural interpretation for simple games. This class contains new values with the properties of our interest. In particular new values that behave well for 'oceanic games' considered by Shapley, for which it turns out that some established indices behave strongly counterintuitive. I will mention the property of this class which is more equal power distribution for more 'egalitarian' games.

### 4 - Computing $\alpha$ -efficient cost allocations

Mariusz Kaleta, Institute of Control & Computation  
Engineering, Warsaw University of Technology,  
Nowowiejska 15/19, 00-665, Warsaw,  
mkaleta@ia.pw.edu.pl

If a cooperative game modeling certain allocation problem has an empty core, then achieving an allocation free from subsidies, requires relaxing the condition for budget-balanced. We show, that the  $\alpha$ -efficient allocation can be calculated by solving multicriteria linear programme. We use the concept of equitable rational preference relation to find the nondominated allocation fairly treating game players. However, the model suffers from the exponential number of constraints. To alleviate this drawback we apply the column generation method.

## ■ MD-40

Monday 13:35-14:55  
GSI - S 27

### OR Methods and Their Applications in Healthcare for Development

Stream: OR for Development and Developing Countries

*Invited session*

Chair: *Honora Smith*, School of Mathematics, University of Southampton, Highfield, SO17 1BJ, Southampton, Hampshire, United Kingdom, honora.smith@soton.ac.uk

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

#### 1 - Tackling maternal mortality: a mathematical model to help evaluate the impact of different interventions.

*Christina Pagel*, Clinical Operational Research Unit, University College London, 4 Taviton Street, WC1H 0BT, London, United Kingdom, c.pagel@ucl.ac.uk,  
*Martin Utley*, *Anthony Costello*

Maternal mortality rates in sub-Saharan Africa have changed little since 1990. Two of the most common causes of maternal death are postpartum haemorrhage and puerperal sepsis. We developed a mathematical model to estimate the impact of three different strategies for reducing maternal deaths from haemorrhage or sepsis, using estimates of incidence, case fatality rates, availability and efficacy of treatment, and care utilisation by economic quintile. We found that interventions to improve community access to medications could be a highly effective addition to health facility improvement.

#### 2 - Modeling patient flows in a two-tier health service system

*Evrin Didem Gunes*, Operations and Information Systems, Koc University, Rumeli Feneri Yolu, Sariyer, 34450, Istanbul, Turkey, egunes@ku.edu.tr, *Mehmet Cagri Dedeoglu*

This work is motivated by the introduction of family practice in Turkey. The objective is to understand the expected changes in the behavior of patients and providers with the introduction of a gatekeeping system. System dynamics methodology is used to model patient flows in the health system, and to analyze the effect of introducing a gatekeeping system on the workloads for hospitals and for family doctors. Dynamics of service quality, word-of-mouth, referral rates, doctor's salary contracts and number of available family doctors are investigated in different scenarios.

#### 3 - Modelling the scalability of three different sized hospitals

*Adisak Sakphisal*, Faculty of Engineering and Industrial science, Swinburne University of Technology, 850/18 Soi Thungthong, Thamuang, 71110, Kanchanaburi, asakphisal@yahoo.com

In Thailand, a welfare agenda has been implemented mandating hospitals to treat patients without charge. Increasing demand for services has forced hospitals to grow rapidly without commensurate increase in funding. By decreasing waiting and treatment times, costs can be reduced, while increasing accessibility. To identify contributing factors, operational processes concerning patient flow were studied in hospital of varying size. Physical, information, and human resources relating to tasks performed were identified. The outcome is a planning model for reorganising outpatient departments.

#### 4 - OR for sustainable community health programs in rural areas of developing countries

*Honora Smith*, School of Mathematics, University of Southampton, Highfield, SO17 1BJ, Southampton, Hampshire, United Kingdom, honora.smith@soton.ac.uk

Community health programs may be facilitated in rural regions of developing countries through village health workers (VHWs) or community centres (CCs). A scheme is being piloted in India as a means of providing the services of VHWs to areas where self-help groups (SHGs) are already functioning. The MNS mixed integer programming model finds best locations for a maximum number of VHW bases, depending on the density of SHGs in a target region. Additionally, dynamic growth in usage of a CC is modelled via a trust factor, where knowledge of the facility is spread by word of mouth.

## ■ MD-41

Monday 13:35-14:55

GSI - S 28

### OR in Agriculture and Forest Management II

Stream: OR in Agriculture and Forest Management

*Invited session*

Chair: *Yi-Ying Chen*, 250, Kuo Kuang Rd., Taichung 402, Taiwan R.O.C., 402, Taichung, j75450@yahoo.com.tw

#### 1 - Planning the harvest machinery use in a medium-size czech logging company

*Jitka Janova*, Department of Statistics and Operation Analysis, Mendel University of Agriculture and Forestry in Brno, Zemedelska 1, 61300, Brno, Czech Republic, janova@mendelu.cz

The problem of tree harvesting planning in a medium size logging company in Czech Republic is treated. The mathematical programming model of the optimal utilisation of machine harvesters and manual operators, when minimum total costs are required, is designed based on the real cost characteristics of the machine and human resources. The impact of additional (environmental) restrictions-currently not fully taken into account by logging companies-on the optimisation model is considered and the applicability of the model in the decision making of small and medium logging companies is discussed.

#### 2 - Optimization of the use of biomass residues in the poplar plywood sector

*Ivan Ferretti*, Dipartimento di Ingegneria Meccanica, Università di Brescia, Via Branze 38, 25123, Brescia, Italy, ivan.ferretti@ing.unibs.it, *Luca Zanchi*

This research deals with the optimization of the use of biomass residues in a firm working in the poplar plywood sector. The residues are: bark, chips, swarf and logs. Every residue is characterized by chemical composition, moisture content, lower calorific value and price. Price and moisture content change over time. The residues can be used for energy production, particleboard production and sale, otherwise stocked and subsequently used. The objective is the evaluation of the optimal quantities of biomass residues for the different uses in order to maximize the firm profit.

#### 3 - Evaluating the pay-off of value chain-retailer with agricultural products

*Yi-Ying Chen*, 250, Kuo Kuang Rd., Taichung 402, Taiwan R.O.C., 402, Taichung, j75450@yahoo.com.tw, *Ming-Chih Tsai*

This study aims to establish a decision model for evaluating food chain integration. Three integrations were identified for decision including transaction, partnering and strategic alliance. Customer value, termed as sale price and supply cost, calculated based on transaction cost theory are quantitatively compared. Parameters were calibrated from 105 real products. The results indicate that retailers' deeper integration with suppliers may bring in a better profits, and vice versa. Short lived produce may significantly affect customer value; whereas, safety and stock-out cost affect supply.

## ■ MD-42

Monday 13:35-14:55

GSI - S 3

### Health Care II

Stream: Health Care

*Contributed session*

Chair: *Leonid Churilov*, Statistics and Decision Support, National Stroke Research Institute, Neurosciences Bld, 300 Waterdale Rd, Austin Health, Repat Campus, 3083, Heidelberg Heights, VIC, Australia, leonid.churilov@gmail.com

#### 1 - Fuzzy clustering employing wavelet coefficients for detection of mitral valve disorders

*Necaattin Barisci*, Computer Eng., Kirikkale University, Kirikkale University, Dept of Computer Eng, 71450, Kirikkale, Turkey, nbarisci@hotmail.com

In this work, cardiac Doppler signals recorded from mitral valve of 75 patients were transferred to a personal computer by using a 16 bit sound card. Wavelet analysis was applied to the recorded signal from each patient and obtained wavelet coefficients. Further these coefficients were classified by using Fuzzy clustering algorithm. Our finding demonstrated that 96% correct classification rate was obtained from fuzzy clustering employing wavelet coefficients for classification of mitral valve disorders. Thus, an additional diagnosis tool is developed for the aid of expert medical staff.

#### 2 - Is integrated care a solution to health care problems? on redesigning antenatal care processes with computer simulation.

*Angele Pieters*, Information Management, Tilburg University, Warandelaan 2, 5000 LE, Tilburg, angele.pieters@uvt.nl, *Henk Akkermans*

Costs and performance of the obstetric care system are subject to debate. This design research addresses two research questions: What are the organizational root causes of these problems? And, how can its performance be improved? Dutch obstetric care is organised as a focused factory, but does not perform accordingly. This research tests the concept of integrated care by system dynamic simulation, based on insights from disparate research fields and on insights from action research. This results in innovative insights in the antenatal care system and superior design principles can be defined.

#### 3 - A new challenge: paediatric palliative care planning

*Giorgio Romanin-Jacur*, Management and Engineering, University of Padova, Stradella San Nicola, 3, 36100, Vicenza, Italy, romjac@dei.unipd.it, *Giada Aspergh*, *Paola Facchin*, *Anna Ferrante*, *Laura Visona*, *Dalla Pozza*

A new patient class, recently considered for specific health care, includes small patients suffering for incurable pathologies. The suggested health care plan includes home care, interrupted by short admissions in an acute hospital department or in a specialized structure. The plan activation requires an assistance network based on the integration between specialized hospital resources and territorial generic medical and social ones. Models and simulations have been utilized to give right network dimensioning, with applications to an Italian region, easily extendable to other situations.

#### 4 - Multi-attribute decision support for stroke imaging software selection

*Leonid Churilov*, Statistics and Decision Support, National Stroke Research Institute, Neurosciences Bld, 300 Waterdale Rd, Austin Health, Repat Campus, 3083, Heidelberg Heights, VIC, Australia,

leonid.churilov@gmail.com, *Liu Daniel, Geoffrey  
Donnan*

Stroke is the second most common cause of death in the world. Acute ischemic stroke victims rely on thrombolysis as the only proven immediate intervention that markedly improve their clinical outcomes, while simultaneously presenting serious risks. Brain imaging plays pivotal role in identifying ischemic stroke patients with the potential to benefit most from thrombolysis. In this presentation we apply the Value-Focused Thinking principles and multi-attribute decision making techniques to the problem of selecting the most appropriate software for stroke imaging and patient selection.

## ■ MD-43

Monday 13:35-14:55

GSI - S 10

### Forest Investments 2

Stream: Long Term Financial Decisions

*Invited session*

Chair: *Thomas Knoke*, Technische Universität München, 85354, Freising, Germany, knoke@forst.wzw.tum.de

#### 1 - Financial analysis of andean alder (*alnus acuminata* h.b.k) under different scenarios of production "land use portfolio approach"

*Baltazar Calvas*, Institute of Forest Management, Technische Universität München, Am Hochanger 13, 85354, Freising, Bayern, Germany, calvas@forst.wzw.tum.de

The financial analysis of Andean alder under different scenarios of production will be helpful to find alternatives to maximize the income of farmers through reforestation in tropical "wastelands" in Southern Ecuador, at the surroundings of Podocarpus National Park. Seeking to reconcile the needs of farmer's subsistence with the conservation needs of tropical forest, we investigated with the portfolio concept land use options for farmers.

#### 2 - Loosing admixed tree species: financial consequences

*Christian Clasen*, Fachgebiet fuer Waldinventur und nachhaltige Nutzung, TU Muenchen, Am Hochanger 13, 85354, Freising, Germany, clasen@forst.wzw.tum.de

These days, the goals of forest management advance mixed forests. They seem to be more appropriate for sustainable thinking in many facets: Ecology, welfare and economics. Some aspects like game browsing advance the make-believe financial attractive tree species like spruce. But with including of probability of failure in earning rate of a long term stand life, mixed forests become more important. With the help of modern portfolio approaches, the loss of mixed species can be determined.

#### 3 - Financial evaluation of mixed species plantations in southern chile

*Patrick Hildebrandt*, Fachgebiet für Waldinventur und nachhaltige Nutzung, TU Muenchen, Am Hochanger 13, 85354, Freising, Germany, hildebra@forst.wzw.tum.de

Mixtures of native and exotic tree species are emerging alternatives for afforestation of former agricultural areas in Southern Chile. The selection of optimum tree species proportions can be treated as a long term decision under uncertainty and can be evaluate financially with classical portfolio theory or other approaches. However, the results are quite sensitive to the applied optimization approach and the underlying data set.

#### 4 - The value of expiring credits issued for carbon sequestration projects

*Klaus Wallner*, TU München, 85354, Freising, Germany, klaus.wallner@tum.de

We present a model to value expiring credits taking into account the regulatory constraints of the Kyoto Protocol. After outlining existing valuation models a new approach developed. Using a portfolio of options which duplicates the flow of payments triggered by an expiring credit as well as the immanent risks for buyers shows that future prices are not relevant for determining the price of an issued expiring credit. The value depends only on the current price of a permanent credit, the risk free return rate and the maturity of the expiring credits.

## ■ MD-44

Monday 13:35-14:55

GSI - S 16

### Energy, Environment and System Optimization

Stream: Uncertainty and Environmental Decision Making

*Invited session*

Chair: *Steven Gabriel*, Civil & Env. Engin./ Applied Math and Scientific Computation Program, University of Maryland, 1143 Martin Hall, 20742, College Park, MD, United States, sgabriel@umd.edu

#### 1 - Employing a two-level integer program for evaluating real options for low-carbon project selection under multi-stage competitions

*Jeremy Eckhause*, Civil and Environmental Engineering, University of Maryland, 2000 Corporate Ridge, 22102, McLean, Virginia, United States, jeckhause@lmi.org, *Steven Gabriel*

We formulate selection of low-carbon energy projects using a real options framework. We take the prospective of public-sector agency, whose objective is to determine the optimal funding strategies in order to achieve certain technological milestones. We develop a two-level integer program, where the upper level problem is the budget allocation and the lower level is the optimal funding strategy. We provide both numerical and theoretical results, describing the shape of this two-level problem and some results for efficient solution techniques.

#### 2 - Analyzing energy security in natural gas markets

*Steven Gabriel*, Civil & Env. Engin./ Applied Math and Scientific Computation Program, University of Maryland, 1143 Martin Hall, 20742, College Park, MD, United States, sgabriel@umd.edu, *Ruud Egging*

In this paper, we provide an analysis of the North American natural gas market and by extension, impacts on Europe. We make use of the World Gas Model (WGM), a large-scale complementarity model of global gas markets in which some of the players are depicted as Nash-Cournot agents. WGM uses multiple years, players, and seasons to depict the operational and investment activity for worldwide gas markets. We consider a variety of supply scenarios including: gas from Alaska, additional shale production, LNG imports and competition in the Atlantic and Pacific basins.

#### 3 - A discretely-constrained mathematical program with equilibrium constraints with an application in electric power markets

*Florian Leuthold*, Chair of Energy Economics and Public Management, Technische Universität Dresden,

Münchner Platz 3, Schumann Bau A 404, 01069,  
Dresden, Germany, Florian.Leuthold@tu-dresden.de,  
*Steven Gabriel*

In this paper we present a discretely-constrained mathematical program with equilibrium constraints (DC-MPEC) for European power markets. A Stackelberg leader determines generation levels while taking into account the actions of an Independent System Operator (ISO) and the competitive fringe. Since the overall problem is a bilinear program with complementarity and other constraints, we need to employ several approaches to convert it to a mixed-integer linear program. We provide results for a small three-node example as well as a larger 15-node problem for Western Europe.

## ■ MD-45

Monday 13:35-14:55

GSI - S 33

### Activities for young people in OR

Stream: Young People for System Theory,  
Optimization and Education

*Invited session*

Chair: *Alexis Pasichny*, Students' Science Association,  
National Technical University of Ukraine "Kyiv Politechnic  
Institute", 37, Peremohy av., 03056, Kiev, Ukraine,  
alexis.pasichny@gmail.com

Chair: *Kateryna Pereverza*, Students Science Association,  
National Technical University of Ukraine, Kyiv,  
Revutskogo, 19/1, app. 282, 02091, Kyiv, Ukraine,  
pereverza.kate@gmail.com

#### 1 - Theoretical and practical or problems for developing countries

*Alexander Makarenko*, Institute for Applied System  
Analysis, National Technical University of Ukraine  
"KPI", Prospect Pobedy 37, 03056, Kiev, Ukraine,  
makalex@i.com.ua

In proposed talk we outline the wide spectrum of issues in OR from the general theoretical problems to the practical aspects. The main issues are: I. General OR problems for system of East/West countries II. OR science and practice as the subsystem of East/West system III. Some new OR research problems in considering developing countries IV. Presumable practical implementations of OR in developing countries V. The experience in OR field in Ukraine (AARIMS 2006-2009; EUROSCIENCE, NGO). Some concrete problems will be discussed in other talks of this subsection of conference.

#### 2 - Education from inside: effective teaching methods from students' view point

*Ielyzaveta Korotchenko*, National Technical University  
of Ukraine "Kyiv Politechnic Institute", prospect  
Peremohy 37, 03056, Kyiv, Ukraine,  
Korotchenko.liza@gmail.com, *Kateryna Pereverza*

The results of students' survey held during the Summer school AACIMP are described in the paper. It was conducted to define the most affective, on students' point of view, teaching methods and ways of presenting new material. The research consists of opinion survey among the participants of the Summer school and further analysis of the collected data. According to the results, there have been distinguished several teaching methods which are most accepted by students and ensure effective course learning. These methods can be successfully applied to education improvement in OR area.

## Monday 15:20-16:10

### ■ ME-01

Monday 15:20-16:10

Maritim

#### Plenary 1

Stream: Plenaries

*Plenary session*

Chair: *Benny Moldovanu*, University of Bonn, 53113, Bonn, Germany, mold@uni-bonn.de

#### 1 - Experimental results on the process of goal formation and aspiration adaptation

*Reinhard Selten*, Universität Bonn, 53113, Bonn, Germany, rselten@uni-bonn.de

We experimentally investigate how subjects deal with a multi-period planning and decision problem. The context is a profit maximization task in a computer-simulated monopoly market over fifty time periods. Subjects have to form vectors of goal variables. A goal variable is an arithmetic expression involving short term feedback variables like profit, sales or quality. An aspiration level is a vector of numerical values for the goal variables. The subjects are provided with a computerized planning tool allowing them to check feasibility of any aspiration level. We present results regarding, first, the selection of goal variables and, second, the process of aspiration adaptation. As to the first, we find that goal persistence, a measure of a subject's tendency to stick to the current goal system, is strongly positively correlated with success. As to the second, we find that aspiration levels tend to be changed in strong agreement with basic principles of Aspiration Adaptation Theory (Sauermann and Selten 1962, Selten 1998, 2001). In addition, we find that in many cases the process of aspiration adaptation leads into a nearly stationary situation in which the aspiration level is approximately reproduced by a subject over several periods. Some subjects who reach a nearly stationary situation explore for a more profitable nearly stationary situation. Those subjects who reach a nearly stationary situation tend to be more successful and more goal persistent than those who do not. This is a joint work with Sabine Pittnauer and Martin Hohnisch.

## Monday 16:20-17:10

### ■ MF-01

Monday 16:20-17:10

Maritim

#### Plenary 2

Stream: Plenaries

*Plenary session*

Chair: *Benny Moldovanu*, University of Bonn, 53113, Bonn, Germany, mold@uni-bonn.de

#### 1 - Computing equilibria

*Christos Papadimitriou*, EECS Department, University of California at Berkeley, 94720, Berkeley, CA, United States, christos@cs.berkeley.edu

The existence theorems establishing that certain equilibria, such as the mixed Nash equilibrium and price equilibria, are guaranteed to exist under very general conditions, are some of the most reassuring results in Economics. Developing efficient algorithms for computing these equilibria — that is, rendering these existence theorems constructive — has been over the past decades an important research front, which however has met with very limited success. In recent years, a new kind of complexity theory has been developed and applied to establish that certain of these computational problems are intractable, thus explaining the lack of progress in the development of efficient algorithms for them. These complexity results raise important new questions related to efficient algorithm for computing approximate equilibria, not unlike the way in which the theory of NP-completeness for combinatorial optimization problems in the 1970s led researchers to the exploration of approximation algorithms. In this talk I shall survey these complexity results, as well as a few recent algorithmic advances.

## Monday 17:25-18:45

### ■ MG-01

Monday 17:25-18:45

Beethoven

#### Metaheuristics and MIPs

Stream: Combinatorial Optimization

*Invited session*

Chair: *Said Hanafi*, ISTV2, LAMIH-SIADE, University of Valenciennes, Le Mont Houy, 59313, Valenciennes, said.hanafi@univ-valenciennes.fr

#### 1 - Neighborhood exploration using mip solvers for a tank allocation problem

*Lars Magnus Hvattum*, Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred Getz veg 3, Sentralbygg 1, N-7491 Trondheim, Norway, 7491, Trondheim, lars.m.hvattum@iot.ntnu.no, *Kjetil Fagerholt*, *Vinicius Armentano*

A subproblem in maritime bulk shipping is to allocate the cargos to the tanks of the ship. There are several constraints, such as the capacity of the tanks, hazmat regulations, and stability requirements. Using MIP solvers to find feasible solutions results in unpredictable running times. We examine the use of tabu search to create more robust solution methods. Neighborhoods are modeled as MIPs and explored using a commercial MIP solver. We discuss how various search components can be included in the neighborhood models, and evaluate the efficacy of this approach.

#### 2 - A multi level branching strategy algorithm for the 01mdk

*Michel Vasquez*, LGI2P, Ecole des Mines d'Alès, Parc scientifique Georges Besse, 30035 cedex 1, Nîmes, France, Michel.Vasquez@ema.fr, *Sylvain Boussier*, *Yannick Vimont*, *Said Hanafi*, *Philippe Michelon*

We combine Resolution Search with 2 tree search algorithms to solve the 01MDK. RS enables to explore partially and iteratively hyperplanes with a fixed number of items while keeping completeness. It enhances the diversification of the search and improves the lower bound rapidly. This lb, associated with the ub, enforces the strength of the reduced costs constraint widely used in the second level variables enumeration. Finally, the item cardinality constraint is used to enumerate the lowest reduced cost variables. We prove optimality for all the 10 constraint 500 variable problems of OR-Library

#### 3 - Inequalities and target objectives in metaheuristics for mixed binary program

*Fred Glover*, Leeds School of Business, University of Colorado, UCB 419, 80309-0419, Boulder, Colorado, United States, Fred.Glover@Colorado.edu, *Said Hanafi*

Recent metaheuristics for mixed binary program include inequalities and target objectives to guide the search. These guidance approaches are useful in intensification and diversification strategies and in strategies that use linear programming to generate trial solutions. We propose new inequalities and associated target objectives that create inequalities and trial solutions. We also propose supplementary linear programming models that exploit the new inequalities for intensification and diversification, and introduce inequalities from elite solutions that enlarge the scope of these models.

### ■ MG-02

Monday 17:25-18:45

Schumann

#### Transportation Planning in Postal Logistics

Stream: Transportation Planning

*Invited session*

Chair: *Hans-Jürgen Sebastian*, Deutsche Post Endowed Chair of Optimization of Distribution Networks, RWTH Aachen University, Templergraben 64, 52062, Aachen, Germany, sebastian@or.rwth-aachen.de

#### 1 - Recent advances in local area transportation planning at deutsche post ag

*Jörg Salomon*, Deutsche Post AG, Charles-de-Gaulle-Straße 20, 53113, Bonn, J.Salomon@DeutschePost.de, *Hans-Jürgen Sebastian*, *Dirk Steffensen*, *Gerhard Stüber*

Local Area Transportation Planning at Deutsche Post means the tactical planning of the networks for inbound and outbound mail of a sorting center for letter or parcel mail. We will present recent results of joint projects of the Deutsche Post AG and the Deutsche Post Chair of Optimization of Distribution Networks at RWTH Aachen University which deal with the analysis, the optimization and the integration of such networks for letter and parcel mail. These projects show that cost reduction is possible while keeping the service quality of the local area transportation networks on a high level.

#### 2 - Challenges of complex vehicle routing problems in local postal pickup and delivery

*Tore Grünert*, GTS Systems and Consulting GmbH, Raiffeisenstr. 10, 52134, Herzogenrath, Germany, gruenert@gts-systems.de

Local postal and delivery is concerned with the delivery of mail items from a sorting facility to customers (for inbound mail) and from customers to the sorting facility (outbound). In many cases the corresponding logistics network uses consolidation points to increase vehicle utilization. Moreover, the typical vehicle cost function is based on time and not distance and the sorting capacities of the facilities have to be taken into account for outbound mail. In this talk we classify the difficult practical constraints and discuss how they can be taken into account in corresponding algorithms.

#### 3 - A multi-criteria analysis of service-area allocations for parcel sorting centers at deutsche post

*Christoph Hemsch*, Deutsche Post Endowed Chair of Optimization of Distribution Networks, RWTH Aachen, Templergraben 64, 52062, Aachen, Germany, chrish@or.rwth-aachen.de, *Andreas Marschner*

Today Deutsche Post operates two separate logistics networks for letter and parcel mail in Germany. Yet, synergies are continuously being examined and implemented, e.g., joint transportation and delivery of letters and parcels. We present a strategic multi-criteria analysis of the allocation of postal code areas to parcel sorting centers. The objectives are to minimize transportation cost, to facilitate coordination of letter and parcel transportation planning and to equally utilize sorting centers. Solutions generated by a genetic algorithm dominate the current allocation in all objectives.

## ■ MG-03

Monday 17:25-18:45

Reger

### Case studies for Transportation Planning II

Stream: Transportation Planning

*Invited session*

Chair: *Joern Schoenberger*, Chair of Logistics, University of Bremen, Wilhelm-Herbst-Straße 5, 28359, Bremen, Germany, jsb@uni-bremen.de

#### 1 - The optimization of the fleet composition problem (fcp) in the distribution system

*Piotr Sawicki*, Faculty of Machines and Transportation, Poznan University of Technology, Institute of Machines and Motor Vehicles, 3 Piotrowo street, 60-965, Poznan, POLAND, Poland, piotr.sawicki@put.poznan.pl,  
*Marcin Kicinski, Jacek Zak, Adam Redmer*

The paper presents the bi-criterion optimization of the FCP in the fuel distribution system. The problem is formulated as an assignment of vehicles to incoming orders and expressed in terms of integer, non-linear programming. The solution procedure is composed of two phases. In the first one the Pareto-optimal solutions are generated by the Genetic Algorithms-based for MS Excel-Evolver solver. In the second phase the solutions are reviewed by the Light Beam Search method. The final solution results in the definition of the optimal fleet composition, including the number and type of vehicles.

#### 2 - The simulation based solution of the fleet composition problem (fcp) in the fuel distribution network

*Piotr Sawicki*, Faculty of Machines and Transportation, Poznan University of Technology, Institute of Machines and Motor Vehicles, 3 Piotrowo street, 60-965, Poznan, POLAND, Poland, piotr.sawicki@put.poznan.pl,  
*Hanna Sawicka, Jacek Zak*

The authors solve FCP for a network with a central fuel warehouse and 16 gas stations, distributing different types of fuel. An object oriented simulation model formulated as an assignment of vehicles to incoming orders is constructed. The model includes number and type of tank trucks and fuel chambers with their capacities and other features. In the simulation experiments several scenarios of fuel transport are designed and evaluated by 2 criteria — transportation costs and capacity utilization. The most satisfactory solution of FCP is generated.

#### 3 - Mixed integer models for the inter-islands fuel oil distribution in cape verde

*Alexandrino Delgado*, DECM, Universidade de Cabo Verde, 163, Mindelo, Cape Verde,  
*Alexandrino.Delgado@unicv.edu.cv, Agostinho Agra*

We consider optimization problems arising in the inter-islands fuel oil distribution in Cape Verde, an archipelago with ten islands. Fuel oil products are imported and delivered into specific islands. From these islands (supply ports) fuel oil products are distributed among all the inhabited islands using a small heterogeneous fleet of ships. The optimization problems combine routing, inventory and scheduling. We discuss mixed integer linear formulations considering different issues such as time-windows, safety stocks, etc.. Computational results based on real data are reported.

## ■ MG-04

Monday 17:25-18:45

Liszt

### Parallel and Multiprocessor Task Scheduling Problems

Stream: Scheduling

*Invited session*

Chair: *Mohamed Bendraouche*, Faculty of Sciences, Saad Dahleb University, Route de Soumaa-Blida, Bp 270 Blida, 09000, Blida, Algeria, bendraouche\_mohamed@yahoo.fr

#### 1 - Scheduling multiprocessor tasks of two sizes

*Tamas Kis*, Computer and Automation Research Institute, Kende utca 13-17, 1111, Budapest, Hungary, tamas.kis@sztaki.hu

We will study the following multiprocessor scheduling problems: There are  $m$  identical parallel processors, and  $n$  tasks. Each task  $j$  has unit execution time, a release date  $r(j)$ , a due date  $d(j)$ , and a requires either  $l$  or  $q$  out of the  $m$  processors concurrently. The processors are not dedicated. All the data is part of the input. Each processor can process at most one task at a time and preemption is not allowed. We describe a polynomial time algorithm for minimizing the number of late tasks under the assumption that the release dates and due dates of the  $q$ -processor tasks are agreeable.

#### 2 - Task scheduling on parallel machines by simulated annealing

*Jacek Juraszek*, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, jacek.juraszek@cs.put.poznan.pl,  
*Erwin Pesch, Malgorzata Sterna*

The research concerns the deterministic problem of scheduling tasks on multiply identical parallel machines in order to maximize the revenue. Any task can be dropped from a schedule without any cost, but accepted tasks have to end before their deadlines. Exceeding the task's due date decreases the revenue with the penalty depending on its tardiness. For this problem we proposed the simulated annealing algorithm, which efficiency was compared in computational experiments with the branch and bound method and the list scheduling approach.

#### 3 - Scheduling on parallel processors subject to compatibility constraints

*Mohamed Bendraouche*, Faculty of Sciences, Saad Dahleb University, Route de Soumaa-Blida, Bp 270 Blida, 09000, Blida, Algeria,  
*bendraouche\_mohamed@yahoo.fr, Mourad Boudhar*

We consider the problem in which jobs have to be scheduled non-preemptively on identical parallel processors. We assume that there exists a compatibility relation between the jobs such that two jobs are compatible if they can be scheduled simultaneously in any time interval. This relation is represented by a graph in which compatible jobs are represented by adjacent vertices. The aim is to minimize the makespan. We study the complexity of this problem for arbitrary graphs, bipartite graphs and the complement of bipartite graphs. We propose polynomial heuristics and test their performances.

## ■ MG-05

Monday 17:25-18:45

Haydn

### Bioinformatics II

Stream: Computational Biology, Bioinformatics and Medicine

*Invited session*

Chair: *Jonathan Garibaldi*, Computer Science & IT, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, [jmg@cs.nott.ac.uk](mailto:jmg@cs.nott.ac.uk)

#### 1 - Structure similarity consensus as a measure of quality in protein structure prediction

*Pawel Widera*, School of Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, [pawel.widera@cs.nott.ac.uk](mailto:pawel.widera@cs.nott.ac.uk), *Daniel Barthel*, *Jonathan Garibaldi*, *Natalio Krasnogor*

In protein structure prediction an evaluation of the quality of a predicted model is traditionally done by measuring the structural similarity of the model and the target structure. Several different measures have been in use for a last decade of CASP experiment (RMSD, GDT\_TS, TM-Score, Max-CMO), each with its own individual strengths and drawbacks. In our ProCKSI structure comparison server we implemented a new consensus measure that combines the knowledge derived from the individual measures. Many interesting features emerged when the new measure was applied to the real world decoys.

#### 2 - Cancer profiles by affinity propagation

*Daniele Soria*, IMA, School of Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, [dqs@cs.nott.ac.uk](mailto:dqs@cs.nott.ac.uk), *Federico Ambrogi*, *Patrizia Boracchi*, *Jonathan Garibaldi*, *Elia Biganzoli*

The Affinity Propagation (AP) algorithm is a novel clustering method proposed by Frey and Dueck in 2007, which combines advantages of both affinity-based and model-based clustering. In our work, the Affinity Propagation was applied to various problems of breast cancer and cutaneous melanoma. Results coming from AP were compared to the ones obtained with standard algorithms showing an overall agreement between different approaches. However, AP also provided novel insights with respect to the number of clusters to consider in a couple of data sets analysed, suggesting new possible cancer groups.

#### 3 - A comparison of simulated annealing strategies for consensus clustering of microarray data

*Enrico Glaab*, School of Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, Nottinghamshire, United Kingdom, [egg@cs.nott.ac.uk](mailto:egg@cs.nott.ac.uk), *Natalio Krasnogor*, *Jonathan Garibaldi*

Consensus clustering is a valuable tool in data mining to aggregate multiple clusterings of the same data into a single representative clustering. Although the most common formulation of consensus clustering as an optimization problem, the median partition problem, is NP-complete. Simulated Annealing has been shown to provide good approximations to the solution. We compare the performance of different Simulated Annealing variants on simulated and real-world microarray data sets. The results provide guidance on the choice of the algorithm and the selection of the combined clustering methods.

#### 4 - Case control analysis for snps data

*Linda Fiaschi*, University of Nottingham, Nottingham, NG8 1BB, NG8 1BB, Nottingham, United Kingdom, [lxf@cs.nott.ac.uk](mailto:lxf@cs.nott.ac.uk)

The study of the human genome has become one of the most challenging goals for scientists. Alteration of the DNA chain such as SNPs may affect a person's response to drug therapy and confer a personal susceptibility or resistance to a certain disease. Pre-eclampsia (PE) is one of the disorder which is currently under genetic analysis for any heritable association. Within the different models that have been used by researchers for studying general genotype-phenotype associations, in this presentation I will show a new methodology based on case control analysis and applied to SNPs studies.

## ■ MG-06

Monday 17:25-18:45

Koch

### Real-world Planning and Scheduling Approaches 1

Stream: OR and Real Implementations

*Invited session*

Chair: *Lars Moench*, Chair of Enterprise-wide Software Systems, University of Hagen, 58097, Hagen, Germany, [lars.moench@FernUni-Hagen.de](mailto:lars.moench@FernUni-Hagen.de)

#### 1 - Lot-sizing and scheduling in the soft drink industry

*Bernardo Almada-Lobo*, Industrial Engineering and Management, Faculty of Engineering of Porto University, Rua Dr. Roberto Frias s/n DEIG, 4200-465, Porto, Portugal, [almada.lobo@fe.up.pt](mailto:almada.lobo@fe.up.pt), *Deisemara Ferreira*, *Christian Almeder*

We present a compact lotsizing and scheduling model for a two-stage production process of a soft drink company. We use a model formulation based on the capacitated lotsizing problem with sequence dependent setup times and costs. As opposed to two other reported formulations we are able to consider the general case of M tanks for the soft drink preparation and N production lines for bottling, labelling and packaging within the same model which allows a simultaneous planning of both production steps.

#### 2 - Scheduling inspection operations with regular step cost functions on a single machine

*Boris Detienne*, Centre Microélectronique de Provence - Site Georges Charpak, Ecole Supérieure des Mines de Saint-Etienne, 880, route de Mimet, 13541, Gardanne, [detienne@emse.fr](mailto:detienne@emse.fr), *Stéphane Dauzère-Pérès*, *Claude Yugma*

This presentation deals with a problem in which a set of inspection operations have to be scheduled to optimize the quality of products manufactured in a fixed production schedule. The problem is formalized as a scheduling problem whose objective is to minimize a regular step cost function. A Mixed Integer Linear Programming model is presented, as well as a dedicated exact method for solving the case without release dates on a single machine. Experimental results are reported and discussed to compare the performances of a standard mathematical programming solver and our dedicated method.

#### 3 - Why do scheduling systems tend to fail in (real-world) complex manufacturing systems?

*Lars Moench*, Chair of Enterprise-wide Software Systems, University of Hagen, 58097, Hagen, Germany, [lars.moench@FernUni-Hagen.de](mailto:lars.moench@FernUni-Hagen.de)

In this talk, we describe some efforts to implement scheduling algorithms in real-world wafer fabrication facilities. While scheduling is to a certain extent well understood in theory and efficient algorithms were suggested from academics, many efforts to implement scheduling systems fail in real-world plants. We identify and analyze some pitfalls that await the scheduling system developer and where possible, make tentative recommendations for how these pitfalls can be avoided or rectified.

## ■ MG-07

Monday 17:25-18:45

GSI - S 29

### Optimizing transport and resources in traffic systems

Stream: Optimization in Public Transport

*Invited session*

Chair: *Uwe T. Zimmermann*, Institute of Mathematical Optimization, TU Braunschweig, Pockelsstrasse 14, 38106, Braunschweig, Germany, u.zimmermann@tu-bs.de

#### 1 - Dynamic construction of time-discretized networks for very large scale operational railway planning

*Frank Fischer*, Mathematics, Chemnitz University of Technology, Reichenhainer Str. 39, 09107, Chemnitz, Germany, frank.fischer@mathematik.tu-chemnitz.de, *Christoph Helmberg*, *Jürgen Janßen*, *Boris Krostitz*

For the German railway network we search for a conflict free schedule for trains with given stopping intervals that observes sequence dependent headway times and station capacities. Our model uses time-discretized networks and configuration networks for the headway-constraints. The huge number of variables is handled by dynamic network generation within a combined Lagrangian relaxation and cutting plane approach. This is solved by a bundle method using primal aggregates for separation and rounding. Some promising results towards handling ten percent of the entire network are presented.

#### 2 - Vehicle routing in waste management

*Ronny Hansmann*, Institut für Mathematische Optimierung, TU Braunschweig, Pockelsstraße 14, 38106, Braunschweig, Germany, r.hansmann@tu-bs.de, *Uwe T. Zimmermann*

Planning waste management involves the two major resources collection-vehicles and crews. An ongoing project with two waste disposal companies aims at simultaneously planning the routes of the vehicles and the crews. In this talk we focus on the optimization of the routes. For our particular NP-hard Arc Routing Problem we present optimization approaches for determining efficient routes. Computational results for real-world data sets are shown. We finish the talk with some concluding remarks on future research towards the simultaneous approach for planning routes and crews.

#### 3 - A new model for routing cars in rail freight service

*Henning Homfeld*, Mathematik, Technische Universität Darmstadt, Schlossgartenstr. 7, 64289, Darmstadt, Germany, homfeld@mathematik.tu-darmstadt.de, *Armin Fügenschuh*, *Hanno Schülldorf*

Cars in rail freight services at Deutsche Bahn follow prescribed routes from their origin via intermediate shunting yards to their destination. The goal in designing such routes is to reduce the number of trains and their travel distances. We present a new MILP model for this problem based on Steiner tree packings. Various real-world capacity constraints make the problem difficult to formulate and also to solve. We compare this model and its solutions using real-world data with our previous formulation based on multi-commodity min-cost flows.

#### 4 - A column generation algorithm for the crew scheduling problem in waste management

*Jens Baudach*, Lehrstuhl für Verkehrssysteme und -logistik, Technische Universität Dortmund, Leonhard-Euler-Str. 2, 44227, Dortmund, NRW, Germany, baudach@vsl.mb.tu-dortmund.de, *Annette Chmielewski*

Planning waste management involves the two major resources collection vehicles and corresponding crews. Our paper focuses on the optimization of individual crews for previously generated collection tours. First, we give a brief introduction in the process of waste disposal and discuss all aspects concerning the scheduling of crews. Second, we present a network-based column generation algorithm which uses a set partitioning approach with additional constraints and includes lagrangean relaxation and subgradient optimization. Finally, computational results for real live data sets are shown.

## ■ MG-08

Monday 17:25-18:45

GSI - S 30

### Case studies

Stream: Optimization in Public Transport

*Invited session*

Chair: *Yuh-Jen Cho*, Department of Transportation Technology and Logistics Management, Chung Hua University, No. 707, Sec. 2, WuFu Rd., 30012, HsinChu, Taiwan, Taiwan, yjcho@chu.edu.tw

#### 1 - A study on the linehaul-feeder vehicle routing problem

*Yuh-Jen Cho*, Department of Transportation Technology and Logistics Management, Chung Hua University, No. 707, Sec. 2, WuFu Rd., 30012, HsinChu, Taiwan, Taiwan, yjcho@chu.edu.tw, *Chih-Hsun Lin*

Recently, some carriers used large truck as the virtual depot to replenish small trucks. This study aims to propose a model, Linehaul-Feeder Vehicle Routing Problem (LFVVRP) to deal with the pre-mentioned case. Moreover, a metaheuristic method combining the Backtracking Adaptive Threshold Accepting (BATA) with neighborhood search heuristics is presented to solve the LFVVRP. To identify the performance of BATA, a set of 58 LFVVRP instances is generated to conduct computational experiments. Results indicated that the proposed BATA for solving the LFVVRP is feasible and efficient.

#### 2 - Tourism planning using public transport in taiwan

*Chih-Hung Chang*, 707, Sec.2, WuFu Rd., Hsinchu, Taiwan 300, R.O.C., 300, Hsinchu, Taiwan, d09403022@chu.edu.tw, *Jau-Ming Su*, *Guei- Jih Wang*

The system for personal travel and demand conditions combined with public transport database and tourist attractions database for tourism planning and scheduling analysis. Traveler use web site to investigate tourist attractions. As a result, this study combined with tourism planning system technology and meeting the public transport trip planning methods to build a mass transit-based travel schedule planning system, to provide people traveling on board public transport to get the best travel itinerary planning.

### 3 - Real time scheduling optimization for airport management: a case study

*Ludovica Adacher*, DIA, Roma Tre University, VIA DELLA VASCA NAVALE 79, 00141, ROMA, ITALY, Italy, adacher@dia.uniroma3.it, *Marta Flamini*

The growing gap between air traffic demand and limited airport capacity causes many congestion problems that can be limited by an optimal dynamic allocation of resources. We deal with a multi objective real time problem of scheduling aircrafts movements in Malpensa terminal.

We consider the minimization of the number of tardy flights and the minimization of the total time the aircrafts aeromotor is working, to improve airport performances and to limit air pollution, considering sophisticated safety constraints. We propose an alternative graph model and some heuristics procedures

### 4 - Optimal headway for feeder transit services: a case study in the texas border's colonias

*Luca Quadrioglio*, Civil Engineering, Texas A&M University, CE/TTI Bldg., 77843-3136, College Station, Texas, United States Minor Outlying Islands, lquadrioglio@civil.tamu.edu

Colonias along the US-Mexico border are one of the most rapidly growing areas in Texas. Because of the relatively low income of the residents and an inadequate transportation services, the basic needs cannot be properly met. The objective of this paper is to determine the optimal headway of a potential feeder transit service operating in a representative Colonia (El Cenizo, TX) using real demand data collected through a travel survey. Results showed that the time interval between consecutive departures from the terminal should be around 11-13 minutes for best service quality.

## ■ MG-09

Monday 17:25-18:45

GSI - S 5

### Human Resources Management I

Stream: Supply Chain Management

*Invited session*

Chair: *Ming Liang*, Mechanical Engineering, University of Ottawa, 770 King Edward Ave, K1N 6N5, Ottawa, Ontario, Canada, liang@eng.uottawa.ca

#### 1 - The performance influence elements of dispatched worker at pharmaceutical industry of taiwan

*Ying-Chyi Chou*, Department of Business Administration, Thughai University, 181 Taichung-kang Rd., Sec. 3, Taichung, Taiwan, 407, Taichung, Taiwan, ycchou@mail.thu.edu.tw, *Chien-Hua Hsiao*, *Pao-Long Chang*

For rapid changing environment, enterprises struggle with unstable labor force and expensive human capital. To decrease the labor cost and enhance flexible human capital, enterprises start to hire temporary employees. Enterprises enjoy utilizing temporary employees, but falling into some managerial problems. The research objective is to explore the pros and cons of using temporary employees for the enterprises. From the "relationship marketing" perspective, we design and conduct a study to explore those important factors that may have strong influences on the performance.

#### 2 - A heuristic procedure for recruiting and transition decisions in a hierarchical manpower system

*Pao-Long Chang*, Department of Business Administration, Feng Chia University, 100, Wenhwa

Road, Seatwen, Taichung, Taiwan, R.O.C, 407, Taichung, Taiwan, paolong\_chang@yahoo.com.tw

This model is frequently used as a forecasting model if  $P(t)$  is deterministic and independent of time. It also can be used as an optimization model with  $P(t)$  and  $Y(t)$  as variables to analyze the influence of recruitment and transition behavior on the size and the relative structure of organizations. Some commonly employed objective functions are, for example, to bring the relative personnel structure as near to a goal as possible, or to minimize a quadratic penalty function associated with labor, hiring, firing, etc. these criteria all fall into a quite general class of problems.

### 3 - Developing a temporary workforce transaction mechanism risk sharing perspectives

*Ying-Chyi Chou*, Department of Business Administration, Tunghai University, 181 Taichung-kang Rd., Sec. 3., 407, Taichung, Taiwan, ycchou@thu.edu.tw, *Yen-Chen Lin*

This paper assumes there are two opportunities for contract adjustment. The first adjustment is called "Period Quantity Adjustment": During the time frame from the issuance of the order to right before the execution of the order, the user firm can use the most up-to-date labor force market information to adjust the original per period demand forecast of the various labor forces. Finally, this research will use sensitivity analysis and experimental design methodology to discuss the benefit of period quantity adjustment and total quantity adjustment.

### 4 - Job rotation methodology to cope with boredom at work

*Ming Liang*, Mechanical Engineering, University of Ottawa, 770 King Edward Ave, K1N 6N5, Ottawa, Ontario, Canada, liang@eng.uottawa.ca, *Nader Azizi*, *Saeed Zolfaghari*

Boredom is a common complaint in a repetitive working environment. It has serious consequences affecting both worker health and productivity. Job rotation has been recommended as a remedy for boredom at work. This paper presents a methodology to implement job rotation in manufacturing. For this purpose, several formulations are developed to measure and predict worker's boredom and skill variations as they are transferred from one workstation to another. A mathematical model has been developed to optimize job rotation. The application of this model is illustrated using an example.

## ■ MG-10

Monday 17:25-18:45

GSI - S 6

### Evolutionary Multiobjective Optimization IV - Auctions

Stream: Evolutionary Multi Objective Optimization

*Invited session*

Chair: *Gülşah Karakaya*, Industrial Engineering, Middle East Technical University, Endüstri Mühendisliği Bölümü, Orta Dogu Teknik Üniversitesi, 06531, Ankara, Turkey, gulsah@ie.metu.edu.tr

#### 1 - Collaborative planning in detailed scheduling

*Benedikt Scheckenbach*, Kolbenzeil 15, 69126, Heidelberg, benedikt.scheckenbach@gmail.com

In SCM, the problems of suppliers and manufacturers are typically interdependent - however, the prevailing practice is to solve them independently. That is, the manufacturer optimizes his production first, generating a supply plan for his suppliers who calculate their optimal production plans subsequently. This prioritization of the manufacturer's objectives leads to suboptimal results. To reach a better alignment of objectives we propose a decentral evolutionary algorithm. We explain the main ideas and present several results for real planning scenarios based on the SAP APO PP/DS optimizer.

## 2 - Bi-objective winner determination in trucking contract procurement auctions

Tobias Buer, Dept. of Information Systems,  
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This contribution examines the determination of winning bids in the tendering of trucking contracts. The underlying optimization problem is modeled as a bi-objective extension to the set covering problem. It is solved by two Pareto-optimization heuristics, the first of which is based on GRASP, whereas the second is based on an evolutionary algorithm. The heuristics are tested with the aid of a new set of problem instances. These instances comply with the free disposal property, which is an important assumption specific to trucking contract procurement. Results of this comparison are presented.

## MG-11

Monday 17:25-18:45  
GSI - S 17

### Theoretical advances in MCDA

Stream: Multiple Criteria Decision Analysis

*Invited session*

Chair: *Michel Grabisch*, CES, Université Paris 1 -  
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#### 1 - A characterization of the 2-additive choquet integral by using a cardinal information

Brice Mayag, Thales Research & Technology, Campus  
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Christophe Labreuche

In the context of MCDA, we present necessary and sufficient conditions to obtain a representation of a cardinal information by a Choquet integral w.r.t. a 2-additive capacity. These conditions are based on some complex cycles called balanced cyclones. The cardinal information is the type MACBETH.

#### 2 - Processing additional information in a multiple criteria context with information imperfections: an aggregation procedure including the weak preference relation

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Jean Marc Martel

Any decision situation, particularly any multiple criteria decision aid process, is inevitably confronted with different kinds of information imperfections (uncertainty, imprecision ...) It is then natural to seek additional information to reduce these imperfections. A unified procedure is proposed to allow for processing additional information in such a context. It is based on the Bayesian decision model. It leads to prior and posterior global preference relational systems containing the strict preference, the weak preference, the indifference and the incomparability relations.

#### 3 - Analysing the correspondence between strict and non-strict outranking relations

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Denis Bouyssou

Some outranking methods like ELECTRE yield preference relations that can be described as 'at least as good relations' while others, like TACTIC, yield 'better than' relations. We analyse outranking relations of both types in a conjoint measurement framework and we study the correspondence between them. We stress in particular that a strict outranking relation (with vetoes) cannot be described as the asymmetric part of some non-strict outranking relation and we elaborate on this.

## MG-12

Monday 17:25-18:45  
GSI - S 18

### Emerging Applications of Simulation

Stream: Stochastic Programming

*Invited session*

Chair: *David Munoz*, Industrial & Operations Engineering,  
Instituto Tecnológico Autónomo de México, Rio Hondo #  
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Mexico, davidm@itam.mx

#### 1 - Modeling, simulation and analysis of a securities settlement system

Miguel De Lascurain, Instituto Tecnológico Autónomo  
de México, 01000, Mexico City, Mexico,  
mdelasc@itam.mx, Arturo Palacios, David Munoz,  
Omar Romero

We report the modeling, simulation and analysis of a new Securities Settlement System (SSS) implemented by INDEVAL, the Central Securities Depository of Mexico. The main objective of this research was to use reduced amounts of cash within reasonable periods of time for the settlement of securities using a linear programming model for the clearing of operations. The performance of the new SSS was evaluated by performing experiments using a deterministic simulation model under different operation parameters.

#### 2 - Bayesian forecasting of spare parts using simulation

David Munoz, Industrial & Operations Engineering,  
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Romero

This article illustrates the development and application of a model that was used to forecast the demand for spare parts based on data from a car dealer in Mexico as well as a novel simulation application. The potential of simulation as a powerful tool to represent and solve a complex forecasting model is illustrated in this work.

#### 3 - Algorithms for the generalized weighted frequency assignment problem

Diego Munoz, Instituto Tecnológico Autónomo de  
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dkedmun@gmail.com, David Munoz

We report the performance of 15 construction heuristics to find initial solutions, and 7 search algorithms to solve a frequency assignment problem where the value of an assigned frequency is determined by the site where it is assigned. Our experimental results show that the construction heuristics that consider the weights of the sites perform better. On the other hand, among the 7 search algorithms tested, an algorithm based on stochastic search that uses the concept of cross entropy performed significantly better than the others.

## ■ MG-13

Monday 17:25-18:45

GSI - S 31

### Stochastic programming III.

Stream: Stochastic Programming

*Invited session*

Chair: *Alexei Gaivoronski*, Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred Getz vei 1, 7491, Trondheim, Norway, alexei.gaivoronski@iot.ntnu.no

#### 1 - Goodness-of-fit tests for uniformity and internal and external sorting

*Thomas Morgenstern*, IWI Informatik und Wirtschaftsinformatik, Hochschule Karlsruhe — Technik und Wirtschaft, Moltkestrasse 30, 76133, Karlsruhe, Baden-Württemberg, Germany, thomas.morgenstern@hs-karlsruhe.de

Goodness-of-fit tests like the Kolmogorov-Smirnov and the Chi-Square test involve sorting and classification of random numbers. The application of Bucket Sort and Merge Sort reduces significantly the computation time of tests with many numbers, e.g. empirical tests of random number generators. Controlling the process with a priority queue allows further improvements, like partial sorting only.

Keywords: goodness-of-fit tests, floating point number sorting, MSD radix sort, merge sort, random number generation, stochastic programming (MSC 2000: 68P10, 65C60, 65C10).

#### 2 - A mip approach to dynamic graph reliability with dependencies

*Nicole Nowak*, TU Darmstadt, 64289, Darmstadt, Germany, nowak@mathematik.tu-darmstadt.de

Dynamic graph reliability problems occur in many real world applications. Production planning in mechanical engineering is one of these. For non-dynamic graph reliability problems dynamic programming approaches are known. However, the dynamic problem is PSPACE-hard. Hence, any approach leading to tractable models is of interest. Dependencies between probabilities of edges cause difficulties in finding a suitable model. We approach the problem from a mixed integer programming point of view and will present models and first solution approaches to problem variants and sub-problems.

#### 3 - Stochastic programming models for distribution of scarce resources under uncertainty

*Alexei Gaivoronski*, Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred Getz vei 1, 7491, Trondheim, Norway, alexei.gaivoronski@iot.ntnu.no

We present stochastic programming models for distribution of scarce resources under stochastic demand. Often it is not enough to maximize profit/minimize cost. We aim at striking balance between risk of not meeting demand satisfaction targets and performance in terms of cost and profit, borrowing ideas from financial theory. Two application examples are presented: one from maintenance of service contracts in high tech industry and another from water resource management. Architecture of decision support system is discussed and results of numerical experiments are provided.

## ■ MG-14

Monday 17:25-18:45

GSI - S 32

### Experimental OR

Stream: Experimental Economics and Game Theory

*Invited session*

Chair: *Andreas Novak*, Business Administration, Bruennerstrasse 72, A-1210, Vienna, andreas.novak@univie.ac.at

#### 1 - A differential game related to terrorism: stationary nash and Stackelberg strategies

*Andreas Novak*, Business Administration, Bruennerstrasse 72, A-1210, Vienna, andreas.novak@univie.ac.at, *Gustav Feichtinger*, *George Leitmann*

The question of how best to prosecute the 'war on terror' leads to strategic interaction in an intertemporal setting. We consider a non-zero sum differential game between a government and a terrorist organisation. Due to the stateseparability of the game we are able to determine stationary Nash and Stackelberg solutions in analytic form. Their comparison as well as the sensitivity analysis deliver interesting insight into the design of efficient measures to combat terror.

#### 2 - Defining Stackelberg equilibria on discrete multilayered networks

*Dmitrii Lozovanu*, Institute of Mathematics and Computer Science, Academy of Sciences of Moldova, Academiei 5, IMI, MD-2020, Chisinau, Moldova, Republic Of, lozovanu@math.md, *Stefan Pickl*

The author introduces specific control problems on so-called multilayered networks. These extend classical deterministic control problems. Stackelberg equilibria are defined. Suitable algorithms are derived exploiting the underlying multilayered structure.

#### 3 - Cooperation within a pdg with unknown length

*Ulrike Leopold-Wildburger*, Statistics and Operations Research, Karl-Franzens-University, Universitätsstraße 15/E3, 8010, Graz, Austria, ulrike.leopold@uni-graz.at

The study examines the influence of pre-existing individual differences in social value orientations measured by the outcomes to oneself and others according to the ring measure by McClintock 1978. We run a simulation in the lab to be able to figure out the high percentage of cooperation in a PDG in which the length of the game is unknown to the players and the fact that cooperation is significantly dependent on the type of the subjects. The experiment study found out that prosocial people demonstrated significantly more cooperation than proselfish within a PDG.

#### 4 - System dynamics and experimental design supporting the simulation and the analysis of a complex lotka-volterra system

*Stefan Pickl*, Department for Computer Science, Universität der Bundeswehr München, heisenbergstr.

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 stefan.pickl@unibw.de, *Ulrike Leopold-Wildburger,*  
*Johannes Leitner*

General Lotka Volterra Systems can be used to simulate and analyze cooperative and non-cooperative behaviour within n-players conflict situations. The authors present an approach which applies techniques from System Dynamics to identify certain equilibria solutions. Experimental settings are used to characterize these solutions in such a way that the impact of parameter changings and human behaviour is analyzed for distinguished examples.

## ■ MG-15

Monday 17:25-18:45

*Einstein*

### Optimizing routes

Stream: Vehicle Routing

*Invited session*

Chair: *Juan José Salazar González*, Estadística e Investigación Operativa, Universidad de La Laguna (Tenerife), Av. Astrofísico Francisco Sánchez, s/n, 38271, La Laguna, Tenerife, Spain, [jjsalaza@ull.es](mailto:jjsalaza@ull.es)

#### 1 - Valid inequalities for the cvrp obtained by projecting a capacitated multicommodity flow formulation

*Maria João Lopes*, Departamento de Métodos Quantitativos, ISCTE - IUL, Centro de IO da FCUL, Av. das Forças Armadas, 1649-026, Liboa, Portugal, [mjfl@iscte.pt](mailto:mjfl@iscte.pt), *Luis Gouveia*

We present valid inequalities for the Capacitated Vehicle Routing Problem that are obtained by projecting the set of feasible solutions of the Linear Programming relaxation of a Capacitated Multicommodity Flow formulation into the space of variables involved in a Capacitated Single-Commodity Flow formulation. Other inequalities are obtained by strengthening some of these valid inequalities.

#### 2 - An ilp improvement procedure for the open vehicle routing problem

*Paolo Toth*, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, [paolo.toth@unibo.it](mailto:paolo.toth@unibo.it), *Majid Salari, Andrea Tramontani*

We present a heuristic improvement procedure for the Open Vehicle Routing Problem (OVRP), a variant of the Capacitated and Distance Constrained VRP in which the vehicles are not required to return to the depot after completing their service. Given an initial feasible solution, the method follows a destruct-and-repair paradigm, where the given solution is randomly destroyed and repaired by solving an ILP model. We report computational results on benchmark instances from the literature. For several instances, the proposed algorithm is able to find the new best known solution.

#### 3 - A randomised method for solving the line design problem for connected rapid transit networks

*Laureano Fernando Escudero*, Dept. de Estadística e Investigación Operativa, Universidad Rey Juan Carlos, c/Tulipan, S/n, 28933, Mostoles (Madrid), Spain, [laureano.escudero@urjc.es](mailto:laureano.escudero@urjc.es), *Susana Muñoz*

In this work we tackle a modification of the well-known extended rapid transit network design problem to allow the definition of circular lines and to obtain a connected network. It is assumed that whichever two stations are linked by one line at most. Given the stations and the links between them to be constructed, we propose a randomised greedy heuristic procedure that attempts to minimise the number of transfers that should be done by the users to arrive at their destinations, in such a way that the number of lines that pass through each station is as small as possible.

#### 4 - A branch-and-cut-and-price approach for a bus school problem

*Juan José Salazar González*, Estadística e Investigación Operativa, Universidad de La Laguna (Tenerife), Av. Astrofísico Francisco Sánchez, s/n, 38271, La Laguna, Tenerife, Spain, [jjsalaza@ull.es](mailto:jjsalaza@ull.es), *Jorge Riera-Ledesma*

The problem is designing a set of optimal school bus routes with the purpose of carrying students to their schools. We are given with schools and bus stops. Each bus stop is reachable by some students, possibly going to different schools. The aims are assigning students to stops and finding least-cost trips and choosing a vehicle to serve each trip. We propose an integer linear formulation, and several families of valid inequalities are derived to strengthen the linear relaxation. A branch-and-cut-and-price procedure has been developed, and a extensive computational experience is presented.

## ■ MG-16

Monday 17:25-18:45

*Koenig*

### Cutting and Packing 3

Stream: Cutting and Packing

*Invited session*

Chair: *J. M. Valério de Carvalho*, Departamento de Produção e Sistemas, Universidade do Minho, 4710 053, Braga, Portugal, [vc@dps.uminho.pt](mailto:vc@dps.uminho.pt)

#### 1 - A constructive bin-oriented algorithm for the two-dimensional bin packing problem with guillotine cuts

*Christoforos Charalambous*, Frederick University, 1036, Nicosia, Cyprus, [c.charalambous@frederick.ac.cy](mailto:c.charalambous@frederick.ac.cy), *Khalil Hindi, Krzysztof Fleszar*

A constructive, bin-oriented algorithm addressing the 2DBP1\*IG problem is presented. The algorithm propagates by deciding a set of items to occupy the bin base and subsequently addressing the remaining free subspaces by applying the same algorithm in a recursive fashion. The items that occupy the base are decided by using a first-fit approach on various sorting sequences and adaptively employing a combination of space-utilisation and average-item-area for determining which to apply. Results on benchmark problems show improved performance on all classes in moderate execution times.

#### 2 - Bin packing problem with the constraint longest items at the bottom

*Nazahet Fellah*, Elctrical and electronical engineering department, faculty of engineering, M'hamed BougaraUniversity of Boumerdes, Avenue de l'indépendance, 35000, Boumerdes, Algeria, [nazahet\\_fellah@umbb.dz](mailto:nazahet_fellah@umbb.dz), *Méziiane Aïder*

We deal with one of the NP hard optimization problems: The on-line variable sized bin packing problem requiring that longer items should be placed at the bottom of the shorter ones in bins. Given a list of items each of normalized size and an infinite supply of bins of different sizes less or equal one. Our task is to minimize the global size of the used bins. We study the behaviour of the heuristic Next Fit Using Largest bins only. We propose a new polynomial heuristic named Improved Best Fit which has an upper bound of two for treating two cases: increasing order and decreasing one.

### 3 - Lower bounds with small complexity for the two-dimensional rectangular bin packing problem

*J. M. Valério de Carvalho*, Departamento de Produção e Sistemas, Universidade do Minho, 4710 053, Braga, Portugal, [vc@dps.uminho.pt](mailto:vc@dps.uminho.pt), *Rita Macedo*, *Cláudio Alves*, *Jürgen Rietz*

The two-dimensional Guillotine cutting stock problem is investigated, especially the exact and the inexact case of cutting in two stages.

Lower bounds are obtained with small, polynomial complexity by maximal dual feasible functions.

Computational tests with instances of the literature prove the strength of the bounds.

## MG-17

Monday 17:25-18:45

Rheinaue

### Resource constraints scheduling with real problem characteristics

Stream: Scheduling under Resource Constraints

Invited session

Chair: *Vicente Valls*, Departamento de Estadística e Investigación Operativa, University of Valencia, Dr. Moliner,50, Burjasot, 46100, Valencia, Spain, [Vicente.Valls@uv.es](mailto:Vicente.Valls@uv.es)

#### 1 - Scheduling and routing pallet-picking operations using different types of forklifts and rfid technology

*Francisco Ballestin*, Department of Statistics and OR, Public University of Navarra, Campus Arrosadia, S/N, 31006, Pamplona, Spain, [Francisco.Ballestin@uv.es](mailto:Francisco.Ballestin@uv.es), *M.Pilar Lino*, *M. Angeles Pérez*, *Sacramento Quintanilla*, *Vicente Valls*

The use of Radio Frequency IDentification technology is changing the management of warehouse operations. We consider a multi-parallel-aisle warehouse where different types of forklifts travel to store/retrieve one pallet on each trip. RFID technology (active tags throughout the warehouse, readers in forklifts) indicates, in real time, the position of each forklift. After a storage location assignment problem determines the location of a pallet, we select in real time an adequate forklift for this location, a route and a starting time, with the objective of minimizing the total material handling cost.

#### 2 - Searching for the best modes in the mrcpsp/max

*Francisco Ballestin*, Dpto. Estadística E.I.O., Universidad Publica de Navarra, Pamplona, Spain, [francisco.ballestin@unavarra.es](mailto:francisco.ballestin@unavarra.es), *Vicente Valls*, *Agustín Barrios*

In the multi-mode resource constrained project scheduling problem multiple execution modes are available for the activities, which are connected through time lags. The objective is to determine a mode and a start time for each activity such that the temporal and resource constraints are met and the project duration is minimised. The heuristic is a repetition of two-phases. In the first one, a simulated annealing seeks for the best mode for each activity. In the second phase an existing heuristic algorithm is applied to provide a solution for the problem with unique mode for activity.

#### 3 - Sensibility and robustness in a dynamic and online rcpsp/max problem.

*David Gómez-Cabrero*, Clinical Gene Networks AB, Clinical Gene Networks AB, Karolinska Science Park,

171 77, Stockholm, Sweden, [david.gomez@uv.es](mailto:david.gomez@uv.es), *Vicente Valls*

In this paper we deal with a dynamic online stochastic multimode resource constrained project scheduling problem. Due dates for the starting and finishing times of the tasks and temporal constraints are considered. We develop several surrogate measures of robustness on the idea of emptying those types of workers which would be required for future "expected" tasks. Those surrogate measures are used in a proactive-reactive method and the sensibility of the method is tested against (a) "decrease in the workforce" and (b) "increase in the expected duration".

#### 4 - 2d parameterized models for project management test generation

*Constanta-Nicoleta Bodea*, Economic Informatics, The Academy of Economic Studies, 15-17, Calea Dorobanti Street, Sect 1, Bucharest, 010552, Bucharest, Romania, [bodea@ase.ro](mailto:bodea@ase.ro), *Maria Dascalu*

The paper proposes two models for project management test generation, using assessed knowledge difficulty and diversity as parameters. One model is a test generator producing tests with L, level of difficulty. It selects a minimum number of questions, having the required difficulty level and covering all the concepts related to the assessed competences. The second model chooses k questions covering most of the concepts needed by assessed competence. Both models consider the test generation as a constrained optimization problem and use a knowledge representation based on concept space graphs.

## MG-18

Monday 17:25-18:45

Lenné

### Convex and Nonconvex Optimization

Stream: Convex Optimization 2

Invited session

Chair: *Asuman Ozdaglar*, Massachusetts Institute of Technology, 02139-4307, Massachusetts, United States, [asuman@MIT.EDU](mailto:asuman@MIT.EDU)

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, [gweber@metu.edu.tr](mailto:gweber@metu.edu.tr)

#### 1 - Computing bounds for the capacitated multifacility Weber problem by branch and price and lagrangean relaxation

*Burak Boyaci*, Industrial Engineering, Engineering, Bogazici Universitesi Endustri Muhendisligi, Guney Kampus Bebek, 34342, Istanbul, Turkey, [burak.boyaci@boun.edu.tr](mailto:burak.boyaci@boun.edu.tr), *I. Kuban Altinel*, *Necati Aras*

The capacitated multi-facility Weber problem is concerned with locating m facilities in the plane, and allocating their capacities to n customers at minimum total cost, which is a non-convex optimization problem and difficult to solve. In this work we relax the capacity constraints and solve the uncapacitated Lagrangean subproblems every step of a subgradient algorithm. Their objectives have facility dependent distance functions, which is different than the usual multifacility Weber problem. We solve them by branch-and-price using column generation with concave minimization pricing.

#### 2 - Efficient heuristics for the multi-commodity capacitated multi-facility Weber problem

*Mehmet Hakan Akyüz*, Industrial Engineering, Galatasaray University, Ciragan Caddesi No:36

Ortakoy, 34357, Istanbul, Turkey,  
mhakyuz@gsu.edu.tr, *Temel Öncan, I. Kuban Altinel*

The Multi-commodity Capacitated Multi-facility Weber Problem (MCMWP) is concerned with locating  $I$  capacitated facilities in the plane to satisfy the demand of  $J$  customers to  $K$  distinct commodities with the minimum total transportation cost. Given fixed customer locations, demands and capacities, the commodity flow between each pair of facility and customer is subject to road capacity constraints. The MCMWP is a non-convex optimization problem and difficult to solve. We propose several efficient heuristics for MCMWP and report computational experiments on randomly generated test instances.

### 3 - A feasible direction method for nonsmooth nonconvex optimization

*Mario Tanaka Filho*, Mechanical Engineering, Federal University of Rio de Janeiro, CAIXA POSTAL 68503 CIDADE UNIVERSITARIA 21945-970 - Rio de Janeiro, RJ - Brasil - Caixa-Postal: 68503, 21945-970, Rio de Janeiro, Rio de Janeiro, tanaka@ufpa.br, *Jose Herskovits, Napsu Karmita*

A technique for locally Lipschitz continuous functions is proposed. We define an equivalent constrained nonlinear program EP. A sequence of auxiliary linear programs AP is constructed by substitution of the constraints of EP by cutting-planes. A Feasible Descent Direction for AP is obtained, based on the Feasible Directions Interior Point Algorithm, FDIPA, and a step-length is computed. The step length is considered serious if an appropriated rule is satisfied. If the step is not serious, AP is updated and a new search direction is computed. This is repeated until a serious step is obtained.

### 4 - Simplex based solution of convex quadratic programming problems

*Zsolt Csizmadia*, Fair Isaac, Trinity 64, CV32 5YN, Leamington Spa, United Kingdom, zsoltesizmadia@fairisaac.com

The talk presents the numerical behavior of four different simplex based approaches to convex quadratic programming problems: a cut generation and a column generation approach inspired by methods from nonlinear programming, a generalized direct primal simplex method, and the simplex based solution of the Karush-Kuhn-Tucker system. We identify problem classes that are the most suitable to each approach, as well as presenting worst case scenarios. The presented results are based on recent research related to the enhancement of the simplex based quadratic solver in the FICO Xpress-MP suite.

## MG-19

Monday 17:25-18:45

Haber

### Genetic Algorithms

Stream: Metaheuristics

Invited session

Chair: *André Rossi*, Lab-STICC - UBS, Université Européenne de Bretagne, 56100, Lorient, France, andre.rossi@univ-ubs.fr

### 1 - Tuning genetic algorithms by using simulation optimization techniques

*Helcio Vieira Junior*, Divisão de Engenharia Mecânica, Instituto Tecnológico de Aeronáutica, Praça Marechal Eduardo Gomes, 50 - Vila das Acácias, 12.228-900, São José dos Campos, SP, Brazil, helcio@ita.br, *Karl Heinz Kienitz, Mischel Carmen N. Belderrain*

Adequate tuning of Genetic Algorithm (GA) parameters is very important to achieve good performance but trial and error procedures can be very time-consuming. To solve this problem, we propose the use of the Simultaneous Perturbation Stochastic Algorithm to perform the tuning of GA parameters. We implemented the Simple Genetic Algorithm (SGA) to optimize two difficult test-functions. The SGA with optimally tuned parameters achieved an average improvement of 64.2% and 40.7% in, respectively, 100 independent replicas of the Griewank and Pintér test-functions in relation to the non-optimized SGA

### 2 - Index tracking with genetic algorithms

*Peter Rossbach*, Wirtschaftsinformatik, Frankfurt School of Finance & Management, Sonnemannstraße 9-11, 60314, Frankfurt, p.rossbach@frankfurt-school.de, *Denis Karlow*

Index Tracking is a method to reproduce the performance of a stock market index without purchasing all of its stocks. For a fixed number of stocks the problem is to choose the appropriate titles and weights, a vast combinatorial problem. We apply a hybrid genetic algorithm (GA), where the stocks are selected by the GA and the weights by quadratic programming. We implement a GA with a binary coded and one with a real-value coded problem representation. The empirical results show that both variants outperform the heuristics used in practice and that the real-value coded GA outperforms all others

### 3 - A hybrid simulated annealing/genetic algorithm method for the global optimization of mixed-integer nonlinear programming problems with applications to industrial design

*Fattaneh Cauley*, Business Division, Pepperdine University, 24255 Pacific Coast Highway, 90263, Malibu, CA, United States, fattaneh.cauley@pepperdine.edu, *Stephen Cauley, Linda Wang*

In this research a Mixed-Integer Nonlinear Programming model has been developed for the design and operation of Simulated Moving Bed (SMB) chromatography. SMB is used in the manufacturing of products that require purification ranging from sugars for soft drinks, to insulin for diabetics, and other complex pharmaceuticals. The proposed algorithm is a hybrid of genetic algorithm, simulated annealing, and a quasi-Newton method. The use of the algorithm is illustrated through examples from the pharmaceutical industry, and the food industry.

### 4 - A genetic algorithm for the complex-constrained assembly line balancing problem

*Aliye Ayca Supciller*, Industrial Engineering, Dokuz Eylül University, Muhendislik Fakültesi Endüstri Muhendisliği Bölümü, Tınaztepe Yerleşkesi, Buca, 35160, Izmir, Turkey, ayca.supciller@deu.edu.tr, *Latif Salum*

The complex-constrained assembly line balancing problem is a line balancing problem that employs rule-bases to address disjunctions (OR relations), and some other complicated constraints in modeling assemblies. This paper discusses this problem and proposes a genetic algorithm based solution. The paper demonstrates that the well-known "if-then-rules" are very convenient to model any assembly constraint which cannot be modeled easily by conventional precedence graphs. It also demonstrates how genetic algorithms can be used for this problem.

## ■ MG-20

Monday 17:25-18:45

Mann

### DEA Methodology II

Stream: DEA and Performance Measurement

*Invited session*

Chair: *Ozren Despic*, Aston Business School, Aston University, Aston Triangle, B4 7ET, Birmingham, West Midlands, United Kingdom, o.despic@aston.ac.uk

#### 1 - Elliptical frontier model: a new approach for input allocation in parametric DEA

*José Virgílio Guedes Avellar*, Instituto de Estudos Avançados, 12228800, Sao Jose dos Campos, Sao Paulo, Brazil, avellar@ieav.cta.br, *Armando Milioni*

Parametric DEA models for input allocation are based on the assumption that the efficiency frontier follows a predefined locus of points. With this assumption, the problem of fairly assigning a new input to a set of DMUs becomes easy to solve (Avellar et al. 2007, "Spherical frontier DEA model based on a constant sum of inputs", JORS, pp. 1246-1251). We show that the spherical frontier model (SFM) is not always adequate to represent the efficiency frontier, present the Elliptical Frontier Model (EFM) and show that, in opposition to SFM, EFM allows control of the input and output weights.

#### 2 - Combining AHP and DEA to enhance entrepreneurial decision making

*Ulrich Bodmer*, Life Science Center, Technical University of Munich, Chair of Agricultural Economics, Alte Akademie 14, 85350, Freising, Bavaria, Germany, Ulrich.Bodmer@tum.de, *Tatyana Vlasjuk*

Stakeholders' cognitive maps may be a hindrance in group-decision-making. Some approaches like the "AHP - Combined Group Judgement" strive to solve this problem by means of an algorithm. But this kind of "enforced" solution may provoke stakeholders' resistance. Newer management theories therefore assume that divergences are to be solved by means of communication that has to be based on detailed knowledge about the reasons and extend of divergence. Combining AHP and DEA will be presented to evaluate diverging perceptions — thus enhancing the stakeholders' communication and decision-making.

#### 3 - Data envelopment analysis with nonlinear virtual inputs and outputs

*Lamprini V. Stamati*, Informatics, University of Piraeus, 80, Karaoli & Dimitriou, 18534, Piraeus, Greece, ldamati@unipi.gr, *Dimitris Despotis*, *Yannis Smirlis*

An underlying assumption in DEA is that the weights coupled with the ratio scales of the inputs and outputs imply linear value functions. In this paper we relax this assumption, letting some outputs and/or inputs be characterized by nonlinear value functions. Our approach is to represent the nonlinear virtual outputs and/or inputs in a piece-wise linear fashion. The corresponding CCR and BCC models are presented. Further, we extend the models to deal with concave output and convex input value functions. Our formulations transform the original data set in order to apply standard DEA models.

#### 4 - Geometric dea: theory, models and properties

*Ozren Despic*, Aston Business School, Aston University, Aston Triangle, B4 7ET, Birmingham, West Midlands, United Kingdom, o.despic@aston.ac.uk

Some specific geometric DEA models are well known to the researchers in DEA through so-called multiplicative or log-linear efficiency models. Valuable properties of these models were noted by several authors but the models still remain somewhat obscure and rarely used in practice. The purpose of this paper is twofold: to show from a mathematical perspective where the geometric DEA fits in relation to the classical DEA, and through some example geometric DEA models to demonstrate their further beneficial properties in practice of decision making and/or efficiency measurement.

## ■ MG-21

Monday 17:25-18:45

Hauptmann

### Various Topics in Health Care Management

Stream: Health Care Management

*Invited session*

Chair: *Jan Vissers*, institute of Health Policy and Management, Erasmus University Medical Centre, Burg. Oudlaan 50, 3062 PA, Rotterdam, Netherlands, j.m.h.vissers@erasmusmc.nl

#### 1 - The story of orahs: the euro working group on operational research applied to health services

*Jan Vissers*, institute of Health Policy and Management, Erasmus University Medical Centre, Burg. Oudlaan 50, 3062 PA, Rotterdam, Netherlands, j.m.h.vissers@erasmusmc.nl, *Sally Brailsford*

ORAHs is one of the domain specific EURO Working Groups. We report on the development of ORAHs as a platform for OR in health. We have used the papers presented during the meetings of ORAHs since its inception in 1975 to describe the development in applying OR approaches and techniques to health care. We present an overview of the main application areas and challenges.

#### 2 - Designing for economies of scale vs. economies of focus in hospital departments

*Nelly Litvak*, Applied Mathematics, University of Twente, P.O.Box 217, 7500 AE, Enschede, Netherlands, n.litvak@ewi.utwente.nl, *Peter T. Vanberkel*

Hospitals traditionally segregated resources into centralised functional departments. This organisational model is being challenged by the idea that higher efficiency and quality of care can be achieved when services are organised into specialized clinics, which have an advantage of economies of focus. We present a queuing model, which is used to measure the tradeoffs between centralised and decentralised scenarios. From this model we give direct "rules of thumb" for hospital managers. The results support strategic planning for a new hospital facility at the Netherlands Cancer Institute.

#### 3 - Supporting lean workshops with simulation modelling

*Ruth Davies*, Warwick Business School, University of Warwick, Coventry, CV4 7AL, Coventry, Warks, ruth.davies@wbs.ac.uk

Our research team observed workshops concerned with the operation of the Acute Medical Unit which was frequently full and blocked the flow of patients from the Emergency Department to the wards. A discrete event simulation showed how the AMU operated and how it might operate if some patients were admitted directly to their destination wards. The Trust chose to increase the beds on the AMU rather than to change the admissions policy. We will present an evaluation of the simulation model which showed that, those that had seen it, had thought that it had been helpful in the decision making.

## ■ MG-22

Monday 17:25-18:45

Arndt

### Optimization in Sustainable Energy

Stream: OR and Environmental Management

*Invited session*

Chair: *Steffen Rebennack*, Industrial and Systems Engineering, University of Florida, 303 Weil Hall, P.O. Box 116595, 32611, Gainesville, Florida, United States, [steffen@ufl.edu](mailto:steffen@ufl.edu)

Chair: *Niko Iliadis*, PSR / EnerCoRD, Plastira street 4, Nea Smyrni, 171 21, Athens, Greece, [nikolaos.iliadis@a3.epfl.ch](mailto:nikolaos.iliadis@a3.epfl.ch)

Chair: *Panos Pardalos*, ISE Department, University of Florida, 303 Weil Hall, FL 32611, Gainesville, Florida, United States, [pardalos@ufl.edu](mailto:pardalos@ufl.edu)

#### 1 - Electricity and CO2 emissions system prices modeling and optimization

*Niko Iliadis*, PSR / EnerCoRD, Plastira street 4, Nea Smyrni, 171 21, Athens, Greece, [nikolaos.iliadis@a3.epfl.ch](mailto:nikolaos.iliadis@a3.epfl.ch), *Steffen Rebennack*, *Mario Veiga Pereira*, *Panos Pardalos*

We present two stochastic models optimizing a power system; from the perspective of a global system and from a sub-system's perspective within a liberalized market. CO2 emission quotas and certificate prices are considered. The first model seeks to compute the electricity system marginal price and the CO2 emissions marginal price by minimizing the system's operation cost. In the second model, the revenues of the sub-system are maximized while considering stochastic inflows, electricity, fuel and CO2 prices. The resulting stochastic linear program will be solved via hybrid SDP/SDDP.

#### 2 - Wind farm layout optimization

*Michele Samorani*, Leeds School of Business, University of Colorado at Boulder, UCB 419, 80309-0419, Boulder, CO, United States, [michael.samorani@colorado.edu](mailto:michael.samorani@colorado.edu), *Harald Reinertsen*, *Manuel Laguna*

Wind is the fastest growing source of renewable energy. Wind turbines are grouped in wind farms in order to keep the construction and maintenance costs low. Finding the optimal positions of wind turbines in the farm is a challenging problem: the wake effect reduces the wind speed behind a turbine and therefore also the energy production of the turbines downwind. We propose a stochastic mixed 0-1 linear formulation, where we consider all wind directions. This leads to a better layout and higher revenue for the wind farm operator than previously proposed methods.

#### 3 - Managerial biases and energy savings: an empirical analysis of the adoption of process improvement recommendations

*Charles Corbett*, UCLA Anderson School of Management, 110 westwood plaza, box 951481, 90095-1481, Los Angeles, CA, United States, [charles.corbett@anderson.ucla.edu](mailto:charles.corbett@anderson.ucla.edu), *Suresh Muthulingam*, *Shlomo Benartzi*, *Bohdan Oppenheim*

We investigate adoption of energy efficiency initiatives using a database of over 100,000 recommendations provided to more than 13,000 small and medium sized manufacturing firms in the US. We identify four managerial biases. Managers are myopic; they are more influenced by upfront costs than by net benefits; adoption of a recommendation depends on the sequence in which the recommendations are presented; adoption is not influenced by the number of options provided to decision makers.

## ■ MG-23

Monday 17:25-18:45

Planck

### ANP III

Stream: Analytic Hierarchy Processes, Analytic Network Processes

*Invited session*

Chair: *Sule Onsel*, Industrial Engineering Department, Dogus University, Engineering Faculty Acibadem, Kadikoy, 34722, Istanbul, Turkey, [sonsel@dogus.edu.tr](mailto:sonsel@dogus.edu.tr)

#### 1 - Analysis of the environmental effects of leather firms active in marmara region in Turkey

*Arzum Ozgen*, Industrial Engineering Department, Engineering Faculty, Okan University, Akfirat, Tuzla, ISTANBUL, 34959, 34959, Istanbul, Turkey, [arzumozgen@gmail.com](mailto:arzumozgen@gmail.com)

Leather manufacturers have scattered settlement in Marmara region of Turkey. Fast growth of the region has caused the leather manufacturers to locate very close to the living quarters. As much as leather manufacturers get closer to the living areas the inconvenience they have made increase. Evaluation of the leather manufacturers' current and potential locations respect to the damages and discomfort they have caused become inevitable. In this study we have evaluated the existing and potential appropriate locations according to the criteria mentioned above by Fuzzy ANP beside sensitivity analysis.

#### 2 - A bi-objective approach for the design of reverse logistics networks and an application from Turkish white good industry

*Gulfem Tuzkaya*, Industrial Engineering Department, Yildiz Technical University, Barbaros Street, Yildiz, 34349, Istanbul, Turkey, [gtuzkaya@yildiz.edu.tr](mailto:gtuzkaya@yildiz.edu.tr), *Bahadır Gulsun*, *Sule Onsel*

In this study, a novel methodology for reverse logistics network design problem is proposed. This methodology is constituted from two stages: Centralized Return Center (CRS) evaluation stage and the reverse logistics network design (RLND) stage. In the first stage and integrated fuzzy-ANP & TOPSIS methodology is utilized. In the second stage, using the CRC weights obtained in the first stage, the RLND model is solved via Genetic Algorithms (GAs). The proposed methodology is applied to a case from a Turkish white good industry.

#### 3 - Location selection for taiwanese seaside resorts

*Pin-Ju Juan*, Department of Tourism and Hospitality, Tamkang University, 180, Linwei Road, Chiao-hsi Shiang., 26247, I-lan County, Taiwan, [pj@ocit.edu.tw](mailto:pj@ocit.edu.tw), *Shin-Yi Lin*, *Shiuan-Ying Huang*

By selecting a new seaside resort, this study intends to explore a decision model for location selection of seaside resorts. The factors and criteria for the evaluation decision model are derived from exhaustive literature review and experts interviews. By applying the fuzzy analytical network process (Fuzzy ANP) to obtain factors and criteria weights. Finally, a recommended solutions are presented and analyzed based on the strategic plan and can provide valuable insights for tourism administrators and academics in establishing a new seaside resort.

## ■ MG-24

Monday 17:25-18:45

GSI - S 20

### Theory of Semi-infinite Programming

Stream: Semi-Infinite Optimization

*Invited session*

Chair: *Francisco Guerra-Vázquez*, Actuarial and Mathematics, Universidad de las Americas, Ex Hacienda Sta Catarina Martir S/N, 72820, Cholula, Puebla, Mexico, francisco.guerra@udlap.mx

#### 1 - A local duality theorem for nonconvex semi-infinite programming problems

*Francisco Guerra-Vázquez*, Actuarial and Mathematics, Universidad de las Americas, Ex Hacienda Sta Catarina Martir S/N, 72820, Cholula, Puebla, Mexico, francisco.guerra@udlap.mx, *Jan-J Ruckmann*

A local convexification result of the Lagrangian function for finite nonconvex optimization problems with inequality constraints was obtained by D. Li and X. L. Sun (J. Optim. Theor. Applic. 104, No. 1, 2000, 109-120), under the linear independence constraint qualification and the second-order sufficiency condition. We show that, a similar result can be obtained for semi-infinite optimization problems under a weaker condition, namely, at the local minimizer the Extended Mangasarian-Fromovitz constraint qualification holds.

#### 2 - Explicit exchange method for convex semi-infinite programming problems with second-order cones

*Shunsuke Hayashi*, Graduate School of Informatics, Kyoto University, Yoshida-Honmachi, Sakyo-Ku, 606-8501, Kyoto, Japan, shunhaya@amp.i.kyoto-u.ac.jp, *Soon-Yi Wu*

We consider the convex semi-infinity programming problem with second-order cone constraints (for short, SOCCSIP). The purpose of this study is to propose an explicit exchange method for solving SOCCSIP. Under some mild conditions, we prove that the algorithm terminates in a finite number of iterations and the output is an approximate solution of SOCCSIP by using the so-called complementarity slackness condition with second-order cone and the spectral factorization in Euclidean Jordan algebra. Preliminary numerical results are reported to illustrate the effectiveness of the algorithm.

#### 3 - The exact feasibility of randomized solutions of semi-infinite convex programs

*Marco Campi*, University of Brescia, Brescia, Italy, marco.campi@ing.unibs.it, *Simone Garatti*

In previous contributions, it has been shown that solutions to convex semi-infinite programs that bear a high probability to satisfy the constraints can be obtained at low computational cost through constraints randomization. Here, we present a new fundamental result on the exact feasibility of the randomized solution: the portion of unsatisfied constraints has a Beta distribution for all fully-supported programs. Moreover, the feasibility of the randomized solutions for all other programs can be bounded based on the feasibility result for the prototype class of fully-supported programs.

## ■ MG-25

Monday 17:25-18:45

GSI - S 25

### Cooperative Games and their Applications

Stream: Cooperative Game Theory

*Invited session*

Chair: *Joaquín Sánchez-Soriano*, Centro de Investigación Operativa, Universidad Miguel Hernández, Elche, Alicante, Spain, joaquin@umh.es

#### 1 - How to divide a cake when people have different metabolism?

*M<sup>a</sup> Luisa Carpena*, Matemáticas, University of La Coruña, Campus de Elviña, 15071, A Coruña, luisacar@udc.es, *Balbina-Virginia Casas-Méndez*, *Natividad Llorca*, *Manuel A. Pulido Cayuela*, *Joaquín Sánchez-Soriano*

This work deals with bankruptcy problems in which the agents have different utility functions defined in terms of the quantity of allocated resource. These problems appear for example in some kind of telecommunications situations or in problems of sharing water resources. We tackle this kind of situation by means of an NTU-game, which turns out to be ordinally convex and balanced. We introduce the CEA-rule in this context and provide two characterizations of this.

#### 2 - The position value for generalized probabilistic communication situations

*Enrique González-Aranguena*, Statistics and Operation Research III, Complutense University of Madrid, Avda. Puerta de Hierro s/n, 28040, Madrid, Madrid, Spain, egaran@estad.ucm.es, *Conrado M. Manuel*

In Gómez et al. (2008, EJOR 190, 539) an extension of the model developed by Myerson (1977, Math. of Oper. Res. 2, 225) for games with communications restrictions is introduced. Authors consider the usual framework in which players in a cooperative game have restrictions in communication possibilities, but they suppose that these restrictions are reflected in a set of different possible networks. In this work, a generalization of the position value (Borm et al., 1992, SIAM J. on Discrete Math. 5, 305) to these more general context is defined and characterized.

#### 3 - On a new bankruptcy rule

*Mikle Álvarez-Mozos*, Universidade de Santiago, 15782, Santiago, Spain, mikle.alvarez@usc.es, *M<sup>a</sup> Gloria Fiestras-Janeiro*, *Jose M<sup>a</sup> Alonso-Mejide*

A bankruptcy problem arises when a group of agents claim a portion of a resource larger than the amount available (the estate). The problem of dividing the total amount among agents satisfying some fairness principles has been discussed in the literature (Thomson, 2003). We propose a new procedure for splitting the estate and study its properties.

Thomson, W. (2003) Axiomatic and game-theoretic analysis of bankruptcy and taxation problems: a survey. Mathematical Social Sciences 45, 249-297.

## ■ MG-26

Monday 17:25-18:45

GSI - S 35

### Transportation Planning

Stream: Discrete Optimization

Contributed session

Chair: *Damien Prot*, LICIT, INRETS, 25, avenue François Mitterrand, 69675, Bron Cedex, France, [damien.prot@inrets.fr](mailto:damien.prot@inrets.fr)

#### 1 - Application of transportation model to the fleet operations problem of flour mills of nigeria plc.

*Joshua Magbagbeola*, BUSINESS ADMINISTRATION (OPERATIONS RESEARCH), UNIVERSITY OF LAGOS, UNIVERSITY OF LAGOS, AKOKA., LAGOS STATE, NIGERIA, 234, AKOKA, LAGOS, [kunle\\_magbagbeola@yahoo.com](mailto:kunle_magbagbeola@yahoo.com)

This paper presents the problem of determining the number of vehicles needed to provide a demand representative transit (DRT) service with a predetermined quality for the user in terms of waiting time at the stops and maximum allowed detour. This methodology can be much more effective and straight forward compared to a simulation approach whenever detailed data on demand patterns are not available. Computational results under a fairly broad range of test problems show that the model can provide an estimation of the required size of the fleet in several different scenarios.

#### 2 - Optimizing reserve capacity of urban road networks, by the concurrent design of one-way and two-way links and lane additions

*Elnaz Miandoabchi*, Faculty of Industrial Engineering, AmirKabir University of Technology, 424, Hafez Ave, 15875, Tehran, Tehran, Iran, Islamic Republic Of, [el.miandoabchi@aut.ac.ir](mailto:el.miandoabchi@aut.ac.ir), *Reza Zanfirani Farahani*

This paper addresses the problem of designing street directions and lane additions in urban road networks, based on the concept of reserve capacity. The problem is to find the optimum configuration of one-way and two-way streets and the optimum selection of street lane addition projects, considering the maximization of reserve capacity, in two problem variations. The proposed problems are modeled as mixed-integer bi-level mathematical models. A genetic algorithm and an evolutionary simulated annealing algorithm are proposed to solve the models. Computational results are presented.

#### 3 - Capacity analysis of railway lines from the perspective of new transport service providers.

*David Canca*, School of Engineers, University of Seville., Av. de los Descubrimientos s/n, Isla de la Cartuja, 41092, Seville, Spain, [dco@us.es](mailto:dco@us.es), *Alejandro Zarzo*, *Enelis Palma*

The EU policy on transport shows a strong commitment to use of rail transport. This paper, from a mixed model of scheduling and re-scheduling, analyzes the actual capacity of railway tracks shared by different service providers. The initial interest lies in knowing the potential number of trains that can be scheduled in the existing free intervals. We discuss the desirability of modifying the infrastructure in order to allow train overlapping and overtaking. This work was developed with the support of projects CEDEX. PT-2007-003-08CCPP and Andalusian Government. Ref P06-TEP-02219.

#### 4 - Connecting maximum air traffic density and colouration problems

*Damien Prot*, LICIT, INRETS, 25, avenue François Mitterrand, 69675, Bron Cedex, France,

[damien.prot@inrets.fr](mailto:damien.prot@inrets.fr), *Sophie Constans*, *Rémy Fondacci*, *Christophe Rapine*

We define and study the maximum density problem linked to the design of a new European air traffic system. Our aim is to minimize the number of conflicts between aircraft flying on orthodromic routes. We model this problem as the search for a special independent set on the conflicts graph: this set has to be dense on each route. An additional difficulty arises because the conflicts graph is infinite; however the problem can be represented in a compact way with another graph modeling. We show a link between our problem and coloration. We give upper and lower bounds on the density of a solution.

## ■ MG-27

Monday 17:25-18:45

GSI - S 21

### Auctions

Stream: Auctions

Contributed session

Chair: *Georg Ziegler*, Boltzmannstr. 3, 85748, Garching, Germany, [georg.ziegler@mytum.de](mailto:georg.ziegler@mytum.de)

#### 1 - Optimal procurement auctions design with endogenous quantity

*Junyi Pu*, Industrial & Manufacturing System Engineering, The University of Hong Kong, Room 824, Haking Wong Building, The University of Hong Kong, 100027, Hong Kong, [joseph.jypu@gmail.com](mailto:joseph.jypu@gmail.com), *Lingyau Chan*

This paper studies the optimal auction design for a buyer faced with multiple competing suppliers. It is known that the buyer can maximize its profits by using a payment-quantity schedule in an auction. This paper shows that a well-designed demand schedule which specifies the quantity as a function of price can also be optimal. The new approach equals the former one under certain settings, which helps to explain the reasons why the former approach is sensitive to different auction formats.

#### 2 - Xml-based data standard for market clearing mechanisms

*Eugeniusz Toczyłowski*, Institute of Control & Computation Engineering, Warsaw University of Technology, Nowowiejska 15/19, 00-665, Warsaw, [mkaleta@elka.pw.edu.pl](mailto:mkaleta@elka.pw.edu.pl), *Mariusz Kaleta*, *Kamil Smolira*, *Piotr Palka*, *Przemysław Kacprzak*, *Izabela Zoltowska*, *Tomasz Traczyk*

A great number of different attempts to the market clearing mechanisms can be observed. These attempts are hard to compare on the common test cases due to huge effort needed for data adaptation. M3 is a XML-based data model, which describes the input and output data of a market clearing process, which usually takes a form of optimization task. Its main advantage is high expressiveness. M3 covers most of the known trade mechanisms, including different auction types, multi-commodity mechanisms, bilateral contracts. An on-line repository of the tools and reference data cases is established.

#### 3 - Combinatorial versus multicommodity auction for indivisible network resources allocation

*Kamil Koltys*, Institute of Control and Computation Engineering, Warsaw University of Technology, ul. Nowowiejska 15/19, 00-665, Warsaw, Poland, [K.J.Koltys@elka.pw.edu.pl](mailto:K.J.Koltys@elka.pw.edu.pl), *Izabela Zoltowska*, *Eugeniusz Toczyłowski*, *Piotr Palka*

Efficient bandwidth trade requires development of advanced business tools. Auctions seem to be the best forms of optimized trading mechanisms, facilitating end-to-end network paths trading. We analyse two important types of mechanisms auctioning indivisible amounts of bandwidth: combinatorial and multicommodity auctions. The comparison of both approaches is based on a large set of test data generated from the SNDlib library. It is performed in terms of allocation, revenue and computational efficiency.

#### 4 - On the worst-case efficiency of the combinatorial clock auction

*Georg Ziegler*, Boltzmannstr. 3, 85748, Garching, Germany, [georg.ziegler@mytum.de](mailto:georg.ziegler@mytum.de), *Martin Bichler*, *Pasha Shabalin*

For many combinatorial auctions (CAs) no formal solution concept is available. However, CAs are promising to increase economic utility. The US Federal Communication Commission (FCC) has discussed several CA formats and used one in an auction of frequency licenses last year. Worst case efficiency analysis of CAs has not been discussed in the literature so far although it helps to understand what can get wrong and provides a benchmark of certain CA designs. We show the worst case efficiency of the Combinatorial Clock auction under different assumptions on bidding behavior and auction size.

## ■ MG-28

Monday 17:25-18:45

GSI - S 1

### Financial Optimization 4

Stream: Financial Optimization

*Invited session*

Chair: *Giacomo Patrizi*, Statistica, Probabilita' e Statistiche Applicate, La Sapienza, University of Rome, Piazza Aldo Moro 5, 00185, Rome, [g.patrizi@caspur.it](mailto:g.patrizi@caspur.it)

#### 1 - Own-company stockholding and work effort preferences of an unconstrained executive

*Sascha Desmettre*, Department of Financial Mathematics, Fraunhofer ITWM, Fraunhofer Platz 1, 67663, Kaiserslautern, Germany, [sascha.desmettre@itwm.fraunhofer.de](mailto:sascha.desmettre@itwm.fraunhofer.de), *John Gould*, *Alexander Szimayer*

We develop a framework for analyzing an executive's own-company shareholding and work effort preferences. The executive invests his personal wealth without constraint in the financial market, including the shares of his own company whose value he can influence by work effort. The executive's investment and work effort strategy is derived in closed-form, and an indifference utility rationale is used to determine his compensation. Our results have implications for the assessment of executive quality, e.g. our executive's investment in his own company's shares identifies his work effectiveness.

#### 2 - Dynamic analysis of empirical stochastic financial processes

*Laura Di Giacomo*, Statistica, Probabilita' e Statistiche Applicate, La Sapienza Universita' di Roma, Piazza Aldo Moro 5, 00185, Roma, Italy, [lauradg@caspur.it](mailto:lauradg@caspur.it), *Giacomo Patrizi*

Models to determine optimal control policies of empirical financial processes require simultaneous estimation and optimization techniques, through a dynamic constrained system specification.

The dynamic processes must be considered non stationary and exhibit uncertainty effects, often modelled as additive components but should not be excluded from the model.

The algorithm is described and certainty equivalent solutions are derived. This dominates other approaches which are limited by the assumptions of efficient markets, linear disturbances and stationary series.

#### 3 - Portfolio optimization under the value-at-risk constraint

*Traian Pirvu*, McMaster University, Hamilton Hall, Room 218, L8S 4K1, Hamilton, Ontario, Canada, [tpirvu@math.mcmaster.ca](mailto:tpirvu@math.mcmaster.ca)

In this paper we analyse the effects arising from imposing a Value-at-Risk constraint in an agent's portfolio selection problem. The financial market is incomplete and consists of multiple risky assets (stocks) plus a risk-free asset. The risk of the trading portfolio is re-evaluated dynamically, hence the agent must satisfy the Value-at-Risk constraint continuously. The portfolio selection, a stochastic control problem, is reduced, in this context, to a deterministic control one, which is analysed, and a numerical treatment is proposed.

#### 4 - Dynamic derivative financial management: a certainty equivalent formulation

*Giacomo Patrizi*, Statistica, Probabilita' e Statistiche Applicate, La Sapienza, University of Rome, Piazza Aldo Moro 5, 00185, Rome, [g.patrizi@caspur.it](mailto:g.patrizi@caspur.it), *Laura Di Giacomo*

Non stationary and stochastic processes require simultaneous estimation and optimal control algorithms to determine ex ante certainty equivalent solutions to financial processes which are ex post fact optimal solutions so that precise predictions are obtained.

The appropriate structure of the optimal model of the financial process and the optimal control are determined by an algorithm formulated as generalized variational inequalities with setvalued maps. Convergence results are derived and comparative implementations are given

## ■ MG-29

Monday 17:25-18:45

GSI - S 2

### Financial Aspects of Energy Topics

Stream: Energy and Emission Markets

*Invited session*

Chair: *Steffen Rebennack*, Industrial and Systems Engineering, University of Florida, 303 Weil Hall, P.O. Box 116595, 32611, Gainesville, Florida, United States, [steffen@ufl.edu](mailto:steffen@ufl.edu)

Chair: *Niko Iliadis*, PSR / EnerCoRD, Plastira street 4, Nea Smyrni, 171 21, Athens, Greece, [nikolaos.iliadis@a3.epfl.ch](mailto:nikolaos.iliadis@a3.epfl.ch)

Chair: *Panos Pardalos*, ISE Department, University of Florida, 303 Weil Hall, FL 32611, Gainesville, Florida, United States, [pardalos@ufl.edu](mailto:pardalos@ufl.edu)

#### 1 - Managing risk through option contracts on the strategic petroleum reserve

*Fernando Oliveira*, Operations Management, Essec Business School, Avenue Bernard Hirsch - BP 50105, 95021, Cergy-Pontoise, [oliveira@essec.fr](mailto:oliveira@essec.fr), *Frederic Murphy*

We design and evaluate financial options for market-based management of the U.S. government's Strategic Petroleum Reserve (SPR). We use a Markov Game to model the interactions between a public player that maximizes social welfare and a representative private player that can be a pure speculator or a refiner. We value the options required to manage the SPR. We show how the options trading model can be used to partially finance the SPR and that a market-based management of the SPR can be used to manage private risks.

## 2 - Centralized and decentralized compressed air storage for enhanced grid integration of wind power

Reinhard Madlener, RWTH Aachen University, 52056, Aachen, Germany, rmadlener@eonerc.rwth-aachen.de, Jochen Latz

We model the economic feasibility of compressed air storage (CAS) to improve wind power integration. The base case is a wind park with 100 MW installed capacity and no storage facility. In Variant 1 we add a central CAS system with 90 MW compressor and 180 MW generation capacity. The CAS system is operated independently of the wind park so profits at the spot market and reserve power market are maximized. Variant 2 is an integrated, decentralized CAS system, where each wind turbine is equipped with a compressor and no generator.

## 3 - Power plant investments under uncertainty

Ralf Schemm, BET Aachen, 52070, Aachen, Germany, Ralf.Schemm@bet-aachen.de

The approach examines investment decisions in power generation technologies and the resulting power price in the year 2040 with the help of a stochastic bid-based spot model. The decision process is based on modern portfolio theory, whereby decisions under uncertainty are made by considering the trade off between the mean and risk parameters of the portfolio return in an utility function. The focus of this analysis is on the parameters and the degree of technological diversification of the optimal portfolio decision and their dependence on the risk aversion of the investors.

## MG-30

Monday 17:25-18:45

GSI - S 26

## Discrete and Global Optimization

Stream: Discrete and Global Optimization

Invited session

Chair: Duan Li, Systems Engineering & Engineering Management, Chinese University of Hong Kong, Shatin, NT, Hong Kong, 00000, Shatin, NT, dli@se.cuhk.edu.hk

Chair: Xiaoling Sun, School of Management, Fudan University, 670 Guoshun Road, Shanghai 200433, P. R. China, 200433, Shanghai, China, xls@fudan.edu.cn

### 1 - Separable relaxation for nonconvex quadratic integer programming: an integer diagonalization approach

Xiaoling Sun, School of Management, Fudan University, 670 Guoshun Road, Shanghai 200433, P. R. China, 200433, Shanghai, China, xls@fudan.edu.cn, Xiaojin Zheng, Duan Li

We present an integer diagonalization approach for deriving new lower bounds for general quadratic integer programming problems. Semi-unimodular transformations are introduced to diagonalize a symmetric matrix and meanwhile preserve integral property of the feasible set. Separable quadratic integer program can then be obtained as a relaxation of the nonseparable quadratic integer program via semi-unimodular transformation. Lagrangian decomposition and convex relaxation schemes for the relaxed separable quadratic integer programming problem are analyzed and their tightness are compared.

### 2 - Cardinality constrained quadratic optimization

Jianjun Gao, System engineering and Engineering management, The Chinese University of Hong Kong, Room 910a, MMW Engineering Building., The Chinese University of Hong kong, Shatin, N.T, Hong

Kong, NA, Hong Kong, Hong Kong, jjgao@se.cuhk.edu.hk, Duan Li

We consider in this paper the problem of minimizing a strictly convex quadratic function subject to a cardinality constraint. Such a problem formulation naturally arises in portfolio selection and statistical analysis. Motivated by a geometric point of view that solving such a problem is equivalent to finding the minimum-volume ellipsoid that touches an  $s$ -subspace, where  $s$  is the given cardinality number, we propose in this research some efficient bounds. By integrating such bounds into a branch and bound algorithm, CQO problems with a relatively large size can be solved efficiently.

### 3 - Convex relaxation for nonconvex quadratic programming problems: best d.c. decomposition and sdp formulation

Duan Li, Systems Engineering & Engineering Management, Chinese University of Hong Kong, Shatin, NT, Hong Kong, 00000, Shatin, NT, dli@se.cuhk.edu.hk, Xiaojin Zheng, Xiaoling Sun

We investigate a general convex relaxation scheme via D.C. decompositions for linearly constrained nonconvex quadratic programming and reveal an equivalence between the "best" parametric D.C. decomposition and its corresponding semidefinite relaxation formulation. We gain dual benefits from this interesting equivalence: (i) Reduction of the iterative dual search process in finding the best D.C. decomposition to a single SDP formulation, and (ii) Identification of a feasible solution of the primal problem by solving the convex relaxation corresponding to the SDP solution.

## MG-31

Monday 17:25-18:45

GSI - S 34

## Data mining in finance

Stream: Data Mining

Contributed session

Chair: Steve Frensch, Chemical Engineering, University of Toronto, Department of Chemical Engineering & Applied Chemistry University of Toronto, 200 College Street, M5S 3E5, Toronto, Ontario, Canada, s.frensch@utoronto.ca

### 1 - Data mining for mutual funds' success drivers and future performance

Steve Frensch, Chemical Engineering, University of Toronto, Department of Chemical Engineering & Applied Chemistry University of Toronto, 200 College Street, M5S 3E5, Toronto, Ontario, Canada, s.frensch@utoronto.ca, Joseph Paradi

With data from the Canadian Mutual Fund industry this paper looks at applications of machine learning to better understand fund level asset flows. Existing work in this field has traditionally used linear regression forecasting models, yet has also uncovered nonlinear relationships between past performance and asset flows. This paper investigates methods of incorporating nonlinearities into existing empirical models as well as looking at the forecasting performance gains from using machine learning algorithms to select attributes and construct nonlinear asset flow forecasting models.

### 2 - Probabilistic delay-accuracy trade-off in trend turning detection of noisy stock time series

Hang Yu, 605 W Madosion St Apt #1613, 60661, Chicago, IL, United States, garyyh@yahoo.com

In this paper, we establish a statistical model to quantify the link between delay and accuracy in turning point detection for stock time series. We model stock prices as an aggregation of a trend and a noise. The trend is modeled as a Poisson process after empirical analysis and the noise is modeled as an ARCH process. We perform a closed form analysis and obtain a theoretical relationship between the accuracy-delay trade-off for the linear filtering de-noising technique. We verify the solution by our experiment on real stock time series.

### 3 - Analyzing financial resource structuring patterns using data mining: evidence from istanbul stock exchange

*Banu Esra Aslanertik*, Business Administration, Dokuz Eylül University Faculty of Business, Kaynaklar Campus Tınaztepe, Buca, 35160, Izmir, esra.aslanertik@deu.edu.tr, *Sabri Erdem*

The two basic types of creating financial resources are to make debt and/or equity financing. The balance between these two mainly determines the resource portfolio of the companies. This study examines the financial resource types in a portfolio using data mining techniques like association rules, cluster analysis. The aim is to find the relations between the portfolio structures and company characteristics. The data is derived from the companies' financial statements and their disclosures that were registered in ISE. The results will provide great benefits to financial decision makers.

### 4 - Evaluating the impact of adding a new retail to an existing loyalty club

*Maximo Bosch*, Industrial Engineering, University of Chile, Republica 701, Santiago, Chile, mbosch@dii.uchile.cl, *Jose Godoy*

We present the case of a Loyalty Club with a large number of associate retailers that needs to estimate the impact of introducing a new member to the alliance. A new retailer is expected to increment total club sales. Sale increase can be decomposed in sales by the new member, sales by other members due to new customers, but also some cannibalization may happen, particularly in same industry retailers. We model sales on different groups of customers. Groups were formed according their card use behavior.

## MG-32

Monday 17:25-18:45

GSI - S 4

### Entrepreneurship

Stream: Financial Modelling

Contributed session

Chair: *M E Shah*, Nottingham University Business School, University of Nottingham, Jubilee Campus, NG8 1BB, Nottingham, lixmesm@nottingham.ac.uk

### 1 - Poisson event, exponential decay, information cost and R&D value

*Yu Wen Lan*, Finance and Banking, Lunghwa University of Science and Technology, No.300, Sec.1, Wanshou Rd., Guishan, Taoyuan County 33306, Taiwan (R.O.C.), 33306, Taoyuan County, Taiwan, Taiwan, 93441007@cc.ncu.edu.tw, *Tze Chin Huang*

Bellalah(1999) firstly incorporated the information cost into an real option model (ROM) for R&D valuation. However, the Bellalah's model though exhibited the R&D's market value based upon information cost; it failed to depict the change of R&D's payoff within project's lifetime. More than this, it is plausible of that the R&D may depreciate while time elapses; its value could also vanish over night because of some exceptions for example the 'protocol' change. The aforesaid issues were not addressed by Bellalah therefore we are trying to propose a modified model for supplementation.

### 2 - Black investment holes in id2s

*John-Christ Panayiotopoulos*, Informatics, University of Piraeus, Karaoli & Dimitriou 80, 18534, Piraeus, Greece, jcp@unipi.gr, *Pavlos Petrantonakis*

Investing in new products with no history is a dangerous task. The investment is even more risky in the case of Irregular Dynamic Data Space (ID2S), where the data changes within a given planning horizon in an unknown way. Consequently, an optimal solution based on the data of present, it is possible to become a complete disaster within our planning horizon. Not only we will not get a maximum profit, but we will lose and our initial budget too. The present work proposes some new considerations on Investment theory in order to avoid such black investment holes.

### 3 - Design of experiments on ann's training data for predicting Turkish ipos

*Sabri Erdem*, Business Administration, Dokuz Eylül University Faculty of Business, Tınaztepe Kampusu, BUCA, 35160, IZMIR, Turkey, sabri.erdem@deu.edu.tr, *Aysun Kapucugil-ikiz*, *Yilmaz Goksen*

This study employs Design of Experiments methodology to achieve lower training error and better performance of an Artificial Neural Network (ANN) model for prediction. The main motivation is to predict returns of Turkish Initial Public Offerings (IPOs) affected by often noisy/incomplete data. To price IPOs, an ANN model using publicly available financial data as inputs and output is developed. The dataset is completely transformed into categorical variables to enclose most common situations. Feeding these categorical variables to our ANN model reduced the error compared to the traditional one.

### 4 - Value versus growth: a rational expectations exposition

*M E Shah*, Nottingham University Business School, University of Nottingham, Jubilee Campus, NG8 1BB, Nottingham, lixmesm@nottingham.ac.uk

This paper studies the value growth puzzle in the context of conflict of interest between taxable and institutional investors. We model this conflict in a rational expectations framework and demonstrate how the differences in firm's characteristics and the risk profile of the investors can explain the shape of CAPM's frontier in the overall economy without involving the beta parameter. We also explicate that the changes in taxable and non-taxable investors profile in a dynamic environment rationalize the value growth premium as illustrated by Malkiel (2003).

## MG-33

Monday 17:25-18:45

GSI - S 7

### Special Topics in Global Optimization

Stream: Global Optimization

*Invited session*

Chair: *Yaroslav Sergeyev*, Department of Electronics, Computer Science and Systems, University of Calabria, DEIS, Via P. Bucci, Cubo 42C, I-87036, Rende (CS), Italy, yaro@si.deis.unical.it

Chair: *Eligius M.T. Hendrix*, Computer Architecture, Universidad de Málaga, Campus de Teatinos, ETSI 2.2.28, 29017, Málaga, Spain, eligius.hendrix@wur.nl

#### 1 - Global optimization with a set of lipschitz constants for the first derivative

*Dmitri Kvasov*, Department of Electronics, Computer Science and Systems, University of Calabria, DEIS, Via P. Bucci, Cubo 42C, I-87036, Rende (CS), Italy, kvadim@si.deis.unical.it, *Yaroslav Sergeyev*

A global optimization problem is considered where the objective function is univariate, black-box, and its first derivative satisfies the Lipschitz condition with an unknown Lipschitz constant. Methods working with a set of Lipschitz constants for the objective function are known (e.g., DIRECT method), whereas algorithms working in this way with the objective function having a Lipschitz derivative have not been proposed until now (see: Optimization Letters, 3(2), 2009, pp. 303-318). In this talk, such an algorithm is presented and discussed together with results of numerical experiments.

#### 2 - A lexicographic approach on unconstrained optimization

*Christina D. Nikolakakou*, Department of Mathematics, University of Patras, University Campus, 26504, Rio, Greece, c\_nikol@yahoo.gr, *Theodoula N. Grapsa*, *Ioannis A. Nikas*, *George S. Androulakis*

In this paper a lexicographic approach is applied to solving unconstrained optimization problems. The original problem is transformed to an equivalent multiobjective optimization one. Moreover, prioritizing the objective functions contributes on alleviating the problem of convergence to the same local minima. Thus, the usage of our lexicographic technique may converge to global optima.

#### 3 - Some optimality and duality results for multiobjective measurable subset selection problems under weaker assumptions of convexity

*Andreea Madalina Stancu*, Institute of Mathematical Statistics and Applied Mathematics, The Romanian Academy, Calea 13 Septembrie, nr 13, RO-050711, Bucharest, andreea\_madalina\_s@yahoo.com, *Ioan Stancu-Minasian*

In this paper, we consider a multiobjective programming problem involving  $n$ -set functions. We shall present some sufficient efficiency optimality conditions and duality results under various generalized (F, b,  $\gamma$ ,  $h_0$ ,  $heta$ )-univexity hypotheses, where F is convex, not as usually, a sublinear application. Moreover, an application to the fractional case is indicated.

## MG-34

Monday 17:25-18:45

GSI - S 8

### Fuzzy Optimization and Decision Analysis 2

Stream: Fuzzy Systems, Neural Networks & Artificial Intelligence

*Invited session*

Chair: *Masahiro Inuiguchi*, Department of Systems Innovation, Osaka University, 1-3 Machikaneyama, 560-8531, Toyonaka, Osaka, Japan, inuiguti@sys.es.osaka-u.ac.jp

#### 1 - Efficiencies and their relations in possibilistic data envelopment analysis with interval input-output data

*Masahiro Inuiguchi*, Department of Systems Innovation, Osaka University, 1-3 Machikaneyama, 560-8531, Toyonaka, Osaka, Japan, inuiguti@sys.es.osaka-u.ac.jp

In this paper, various possibility theoretic extensions of efficiency in DEA with interval input-output data are investigated. Based on extended inequalities between intervals, 16 kinds of domination relations are defined. A production possibility set with interval inputs and outputs is independently defined. As the results, 16 kinds of efficiencies are obtained. The relations among 16 efficiencies are investigated. Moreover, other extensions are introduced using logical operations. Their relations to the 16 efficiencies are shown. As the results, we show that 25 efficiencies are essential.

#### 2 - Mathematical programming approaches to efficiency evaluations in possibilistic data envelopment analysis with interval input-output data

*Masahiro Inuiguchi*, Department of Systems Innovation, Osaka University, 1-3 Machikaneyama, 560-8531, Toyonaka, Osaka, Japan, inuiguti@sys.es.osaka-u.ac.jp, *Fumiki Mizoshita*

We showed that 25 efficiencies are essential in DEA with interval input-output data based on possibility theory. In this paper, efficiency test problems are formulated as mixed integer programming problems. Efficiency scores are defined based on the solutions of efficiency test problems. It is shown that problems for 14 efficiencies can be reduced to LP problems and that the other problems can be evaluated by iterative use of linear programming techniques. The proposed approaches are applied to real world data about banks in Japan.

#### 3 - Scheduling in project-management under vagueness and uncertainty

*Wolfgang Anthony Eiden*, Am Kreuzweg 2b, 67310, Hettenleidelheim, Germany, gor@wolfgang-eiden.de

Projects are often characterized by complexity, singularity, and interdisciplinary. From these result vagueness, inevitably which is not apparent in classical tasks. Hence, scheduling in project management is subjected to conditions other than classical scheduling. This talk demonstrates that for scheduling in project management under vagueness, a practical, applicable, holistic approach is possible which can be an opportunity for scheduling closer to reality. The purpose of this talk is to show how theory and practice can be linked considering the particular conditions in project management.

#### 4 - Stock market prediction by combining multiple neural network models for standard technical analysis tools

*Tonci Kokan*, Ekonomski fakultet, Sveuciliste u Splitu,

Matice hrvatske 31, 21000, Split, Croatia,  
tonci.kokan@efst.hr

Neural network models are one of the most frequently used alternatives to traditional technical analysis tools for stock market prediction. In this paper we combine the two approaches by modeling several widely used technical analysis techniques by neural networks. Similarities and differences between those techniques are then explored by comparing their corresponding neural network models. Algorithms for construction of neural networks as combinations of the obtained models are presented. Performances of the constructed models are tested against performances of the standard techniques.

## ■ MG-35

Monday 17:25-18:45

GSI - S 9

### Facilitated Problem Structuring II

Stream: Facilitated Modelling Interventions

*Invited session*

Chair: *Leroy White*, University of Bristol, BS8 1TN, Bristol, United Kingdom, Leroy.White@bristol.ac.uk

#### 1 - The use of multimethodology in practice

*Yolanda Brown*, Kent Business School, University of Kent, 36 Highwood Gardens, Ilford, Essex, IG5 0AA, London, United Kingdom, yfb4@kent.ac.uk

Multimethodology, the practice of combining together different OR methodologies, is becoming increasingly popular. This study will report on the results of a survey of OR practitioners that is currently being carried out, and on a review of multimethodology case studies that have been published in the literature. The results will throw light on the extent of successful use of multimethodology; combinations of methods that are particularly popular or successful; and areas for future theoretical or methodological developments.

#### 2 - Developing visually-enhanced problem structuring methods for wicked problems

*Steven Barr*, 17 Onslow Road, KT3 4AR, London, steven.barr@paconsulting.com

Rosenhead and Mingers have classified Problem Structuring Methods (PSMs) for making progress with ill-defined, 'wicked' problems. Simple visualisation is commonly used in support of PSMs (eg rich pictures and strategy maps). Enhanced visualisation for example in 'info-murals' can enhance public policy decision making. A new generation of PSMs integrated with effective visual tools could help stakeholders to make better progress with wicked problems, by: Improving access to the debate; Communicating uncertainty more clearly; and Supporting collaboration on sustainable solutions.

#### 3 - Value priorities in organizations through problem structuring methods

*Leroy White*, University of Bristol, BS8 1TN, Bristol, United Kingdom, Leroy.White@bristol.ac.uk

It is now widely accepted that policy and strategy development requires both an appreciation of values and an ability to involve insights from stakeholders. This paper presents research about values, policy making and problem structuring (PSM). Developments in identifying more clearly value priorities of stakeholders will be presented, and alongside PSMs they provide the potential for new avenues for PSM research and practice.

#### 4 - Understanding problem structuring interventions in multi-organizational settings: a frame analytical perspective.

*L. Alberto Franco*, Warwick Business School, University of Warwick, ORIS Group, Gibbet Hill

Road, CV4 7AL, Coventry, United Kingdom,  
alberto.franco@warwick.ac.uk, *Ashley Carreras*

This presentation proposes frame analysis as a potential means to better understand problem structuring interventions in multi-organisational settings. Frame analysis enables the clarification of the potential role and impact of PSMs within the dynamic processes of framing that take place within problem structuring interventions. We illustrate its use by drawing on data gathered from an intervention conducted for a collaboration between a global organisation and its joint venture partners. Implications for the understanding and evaluation of PSM interventions are also offered.

## ■ MG-36

Monday 17:25-18:45

GSI - S 11

### Dependence Modelling

Stream: Optimal Control in Finance and Insurance

*Invited session*

Chair: *Alfred Müller*, Fachbereich Mathematik, Universität Siegen, Walter-Flex-Str. 3, 57072, Siegen, Germany, mueller@mathematik.uni-siegen.de

#### 1 - A multivariate default model based on Lévy-frailty copulas

*Jan-Frederik Mai*, Financial Mathematics, TU München, Boltzmannstr. 3, 85748, Garching, Germany, mai@ma.tum.de, *Matthias Scherer*

A d-dimensional distribution is constructed by considering the crossing times of a Lévy subordinators across independent exponentially distributed random variables. The components of the resulting random vector may be interpreted as companies' default times. The survival copula of this random vector is computed in closed-form. It is shown that this copula family shares many analytical similarities with Archimedean copulas. The model supports positive probabilities that two or more companies default at the same time.

#### 2 - Valuation of CDO with multifactor and copulae models

*Barbara Choros*, Institute for Statistics and Econometrics, Humboldt-Universität zu Berlin, Spandauer Strasse 1, 10099, Berlin, Germany, barbara.choros@wiwi.hu-berlin.de

We propose the valuation model of Collateralized Debt Obligations based on copulae and default intensities estimated from market data. The method is used to reproduce the spreads of the iTraxx Europe tranches. The two-parameter model incorporates the fact that the risky assets of the CDO pool are chosen from six different industry sectors. The dependency among the assets from the same group is described with the higher value of the copula parameter, otherwise the lower value is ascribed. Our approach outperforms the standard market pricing procedure based on the Gaussian distribution.

#### 3 - A generalization of Tyler's M-estimators taking account for incomplete data

*Gabriel Frahm*, Statistics & Econometrics, University of Cologne, Meister-Ekkehart-Straße 9, 50937, Cologne, frahm@statistik.uni-koeln.de

Tyler's M-estimator has been recognized as the 'most robust' M-estimator for the shape matrix of elliptically symmetric distributed data. We generalize Tyler's M-estimators for location and shape by taking account for incomplete data. Our shape matrix estimator remains distribution-free under the class of generalized elliptical distributions. We derive its asymptotic distribution and present a fast algorithm for the estimator. A simulation study with clean and contaminated data covers the complete-data and the incomplete-data case, where the missing data are MCAR, MAR, and NMAR.

#### 4 - Optimal storing strategy

*Nils Unger*, University of Karlsruhe (TH),  
Kaiserstr.20, 76351, Linkenheim, Germany,  
nils.unger@fbv.uni-karlsruhe.de, *Marliese*  
*Uhrig-Homburg*

In this paper, we investigate the valuation of storage contracts. We present novel properties of the underlying stochastic control problem. These results can be used to reduce execution time and to improve stability of the numerical solution. Our analysis establishes the relevant set of delivery contracts and shows how trading policy depends on these. We show how admissible strategies can be restricted to a subset without affecting the solution of the optimization problem. Finally, we provide conditions that are sufficient in order to characterize the optimal control by exercise boundaries.

### MG-37

Monday 17:25-18:45  
GSI - S 12

#### Applications in Revenue Management

Stream: Revenue Management

*Invited session*

Chair: *Ayse Kocabiyikoglu*, Department of Business Administration, Bilkent University, Bilkent, 06800, Ankara, Turkey, aysekoca@bilkent.edu.tr

##### 1 - Salesforce incentives in revenue management

*Ayse Kocabiyikoglu*, Department of Business Administration, Bilkent University, Bilkent, 06800, Ankara, Turkey, aysekoca@bilkent.edu.tr, *Ioana Popescu*

In numerous revenue management settings, capacity management decisions are delegated to the salesforce, whose objectives are often not aligned with those of the firm's, hence leading to allocation policies that are suboptimal from the firm's point of view. In this paper, we study the optimal allocation decision of a sales agent under a number of incentive schemes and provide comparisons. We also investigate the impact of various problem parameters on the agent's decision.

##### 2 - Estimation of cross-price elasticities and markdown optimization in an apparel retailer

*Ufuk Kula*, Industrial Engineering, Sakarya University, Esentepe Kampusu, 54187, Sakarya, Turkey, ukula@sakarya.edu.tr, *Ayhan Demiriz*

An important problem that retailers face is markdown optimization. Single product stochastic demand markdown optimization problem may be solved by using dynamic programming. However, when substitution between a group of products exists, as the number of products in the group increase, it becomes very difficult to find the optimal markdowns for products. We use an apparel retailer's sales data first to estimate substitution effects between products by using multinomial logit model (MNL). Then, we use approximate dynamic programming to find the optimal markdown policy for the retailer.

##### 3 - Revenue management and rail freight transportation

*Luce Brotcorne*, LAMIH-SIADE, Universite de Valenciennes, Le Mont Houy, 59313, Valenciennes cedex 9, France, luce.brotcorne@univ-valenciennes.fr, *Ioana Bilegan*, *Dominique Feillet*, *Yezekael Hayel*

We consider a freight rail transportation problem where a carrier strives to maximize revenue by efficiently allocating capacities taking into account punctual demands as well as estimations of future demands for container transportation. We propose a revenue management approach based on solving a mathematical program with respect to a space-time modelling of the transportation network. Numerical results are given

### MG-38

Monday 17:25-18:45  
GSI - S 13

#### Accounting for Lean Operations

Stream: Lean Accounting

*Invited session*

Chair: *DeWayne Searcy*, School of Accountancy, Auburn University, 301 Lowder Business Building, 36849, Auburn, AL, searcydl@auburn.edu

##### 1 - Evaluating the benefits of volume flexibility instruments using design-of-experiments methods

*Matthias Walter*, Institut für Wirtschaftswissenschaft, Technische Universität Clausthal, Julius-Albert-Str. 2, 38678, Clausthal-Zellerfeld, Germany, matthias.walter@tu-clausthal.de, *Thomas Sommer-Dittrich*, *Jürgen Zimmermann*

Volume flexibility enables firms to cope with demand variability but flexibility is not a free good. Hence, firms are challenged to choose adequate volume flexibility instruments. To tackle this challenge we present a framework based on a model that minimizes production costs taking into account volume flexibility instruments. We use design-of-experiments methods to assess the impact of each instrument and their interactions. In a case study we apply our framework to a real life production system to gain managerial insights into the value of different combinations of flexibility instruments.

##### 2 - Providing relevant information in a lean environment: an empirical model of lean accounting

*Rosemary Fullerton*, School of Accountancy, Utah State University, 3540 Old Main Hill, 84322-3540, Logan, Utah, United States, rosemary.fullerton@usu.edu, *Frances Kennedy*

Traditional accounting fails to provide relevant information to Lean organizations. An emerging accounting approach, coined Lean accounting (LA), is better suited to lean firms, with information simpler to prepare, easier to understand, and more useful for decision making. The exploratory survey study examines issues related to accounting practices and Lean environments. The SEM results suggest that LA firms demonstrate the following: top management support; empowered workers; lean manufacturing tools; visual, strategic information; reduced inventory tracking; and simplified accounting systems

##### 3 - Performance benefits of the lean strategy

*Frances Kennedy*, Accountancy and Legal Studies, Clemson University, 301 Sistine Hall, Clemson University, 29634-1303, Clemson, SC, fkenned@clemson.edu, *Lisa Jackson*

Lean can be a costly business strategy that affects all the people in an organization. Accountants and business leaders are looking for justification for the investment in lean and breakthroughs in understanding the affects of lean on the financial results and activities of the business. The purpose of this research is to provide empirical support for the performance benefits of lean manufacturing by comparing a sample of Lean companies to competitors of similar size.

#### 4 - Gaining back-office control using lean principles: action research at amg, inc.

*DeWayne Searcy*, School of Accountancy, Auburn University, 301 Lowder Business Building, 36849, Auburn, AL, searcydl@auburn.edu

In February 2008, AMG's management embarked on a lean journey hoping to gain control over their rental operations. The lean transformation was a success. Decision-making improved, transactions were eliminating, efficiencies were gained, and profits increased. The lean implementation affected the rental operations, the accounting system, and the control environment. This study describes AMG's the lean transformation. The author used action research by assuming the role of a facilitator and guided the organization through its lean-office implementation.

## ■ MG-39

Monday 17:25-18:45

GSI - S 14

### Coalitions

Stream: Game Theory

Contributed session

Chair: *Kirill Pogorelskiy*, State University "Higher School of Economics", Myasnitskaya str., 20, 101000, Moscow, Russian Federation, kirill.pogorelskiy@gmail.com

#### 1 - Bargaining schemes in games with fuzzy coalitions

*Tomas Kroupa*, Institute of Information Theory and Automation of the ASCR, Pod Vodarenskou vezi 4, 182 08, Praha 8, kroupa@utia.cas.cz, *Jiří Vomlel*

Bargaining scheme in a game with fuzzy coalitions is an iterative procedure for generating a sequence of payoffs that eventually converges to a payoff from the Aubin's core of the game. We study two kinds of bargaining schemes. First, the Cimmino type bargaining scheme introduced by Butnariu and Kroupa, which is useful for finding a common point from an intersection of infinitely many compact convex sets. Second, the Dykstra algorithm originating in probability theory, which enables to speed up the convergence whenever the game with fuzzy coalitions is convex.

#### 2 - Power and preferences: an experimental approach

*Kirill Pogorelskiy*, State University "Higher School of Economics", Myasnitskaya str., 20, 101000, Moscow, Russian Federation, kirill.pogorelskiy@gmail.com, *Fuad Aleskerov*, *Alexis Belianin*

This paper uses experiments to study the voting power distribution. Taking the work by Montero, Sefton & Zhang (Soc Choice Welf. 2008, 30:69—87) as starting point, we confirm their basic findings and explain some of their empirical paradoxes. Our main contribution deals with the question of how voters' preferences to coalesce influence their behavior and payoffs. We extend the basic design to allow for asymmetric voters' preferences depending on the coalitions they take part in. The results show that even small modifications of preferences lead to statistically significant differences in players' shares.

#### 3 - Core membership testing for additive hedonic coalition formation games

*Kouji Suzuki*, Department of Industrial and Systems Engineering, Aoyama Gakuin University, Room 415, Building O, 5-10-1 Fuchinobe, 2298558, Sagamihara, Kanagawa, Japan, koujis0830@gmail.com, *Shao-Chin Sung*

We are concerned with the problem of core membership testing in additive hedonic coalition formation games. The problem is to test whether a given coalition structure is stable or not in a certain sense. We first provide a short proof of Co-NP completeness of the problem when core stability is under consideration. Then, we show that the problem remains Co-NP complete when either strict core stability or strong core stability is under consideration. Moreover, we show that the existence problem of strong core stable coalition structure is NP hard.

#### 4 - Essential coalitions for stabilities on hedonic coalition formation games

*Kouji Suzuki*, Department of Industrial and Systems Engineering, Aoyama Gakuin University, Room 415, Building O, 5-10-1 Fuchinobe, 2298558, Sagamihara, Kanagawa, Japan, koujis0830@gmail.com, *Shao-Chin Sung*

An outcome of a hedonic coalition formation game is a partition of the set of finite players into coalitions. Several stability concepts are proposed for the outcomes, and each of which is defined based on a certain set of coalitions called deviations. We are concerned with the coalitions which are essential for stability concepts, i.e., coalitions which either form a stable outcome or being a deviation. By introducing a new concept called strong internal stability for coalitions, we provide new characterizations of core stability and strict core stability.

## ■ MG-40

Monday 17:25-18:45

GSI - S 27

### Development in Asian Countries

Stream: OR for Development and Developing Countries

Invited session

Chair: *Graham Rand*, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, g.rand@lancaster.ac.uk

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

#### 1 - Managerial accounting: cost systems in thai organizations

*Thanatas Tupmongkol*, School of Accounting, Sripatum University, 61 Phaholyothin Road, 10900, Bangkok, ttupmongkol@hotmail.com

The purpose of this study is to investigate the cost systems in the Thai organizations. The survey consisted of 385 mailed questionnaires, and giving the response rate of 19%. The results show that 80% are still using the traditional accounting system, the standard costing and absorption costing are the most popular to use as a cost technique. The majority of respondents indicate that the current cost systems provides good and adequate cost information. They have not considered an activity-based costing (ABC) system because too costly, and due to a lack of knowledge of ABC.

#### 2 - An exploratory study of supply chain management in China

*Lawrence Fredendall*, Department of Management, Clemson University, 101 Serrine, 29634-1305, Clemson, SC, United States, lawren@clemson.edu, *Peter Letmathe*, *Nadine Uebe-emden*

Overall trade volume between China and Germany in 2006 exceeded 76 billion Euro and many German companies continued to invest in production sites throughout China. There is limited understanding of the problems that face these investors and how they manage these problems within their existing supply chains. This is an empirical study conducted through telephone interviews with managers responsible for Chinese production sites. This study examined management differences between companies involved in joint ventures and companies which operated their Chinese facilities independently.

### 3 - "altruism under pressure: experimental evidence from indonesia"

Laura Marie Schons, Marketing, Ruhr University Bochum, Universitätsstrasse 150, 44780 Bochum, 44780, Bochum, NRW, Laura.Schons@rub.de

Ultimatum Game experiments have been played numerous times and the bottom line is clear: the results robustly contradict the economic model of human behavior. However in the existing literature, the role of the respondent's income has been largely ignored. Where the respondent's income has played a role, the lack of variance in income restricts the interpretability of the results. We use a sample of 75 respondents from Indonesia. Compared to previous studies, we find a significantly lower degree of reciprocal punishment for those respondents who are subject to severe economic pressure.

## MG-41

Monday 17:25-18:45

GSI - S 28

### OR in Agriculture and Fisheries

Stream: OR in Agriculture and Forest Management

*Invited session*

Chair: Victor Albornoz, Departamento de Industrias, Universidad Tecnica Federico Santa Maria, Av. Santa Maria 6400, 6671219, Santiago, Chile, victor.albornoz@usm.cl

#### 1 - Seafood value chain stochastic optimization model

Yousaf Shad Muhammad, IØT, NTNU, IØT, NTNU, Trondheim, Norway, 7491, Trondheim, yousaf@iot.ntnu.no

We are presenting a seafood value chain model where a single management decides about optimal use of logistics and installed facilities on multiple locations. Complex processing of seafood is addressed in the model. This is a problem of multi-product, multi-facility locations, multi-period and a supply chain design. The objective of this study is to develop tools for the management by structuring an economic optimization model that accommodates the operational complexity of the economical modeling of resources, logistics, and yield management and market demand under uncertainty.

#### 2 - A new methodology to estimate the emissions of pollutant gases of spanish livestock: an aggregate linear programming model

Concepcion Maroto, Estadística e Investigación Operativa, Universidad Politécnica de Valencia, Camino de Vera S/N, 46022, Valencia, Valencia, Spain, cmaroto@eio.upv.es, Carlos Fernández, Baldomero Segura, Paloma García-Rebollar, Javier Alcaraz, Antonio Torres

In Spain, livestock farming is responsible for a substantial share of the ammonia and greenhouse gas emissions coming from the agricultural sector. The Kyoto Protocol involves a commitment not only to reduce, but also to provide an accurate estimation of gas emissions. Thus, this paper suggests a new methodology based on the use of an aggregate linear programming model of livestock feeding in Spain. The model takes into account all the relevant characteristics inherent to the livestock feeding process that have an influence on the emission of pollutant gases (ammonia, methane, nitrous oxide).

#### 3 - A total allowable catch quota in the common sardine (strangomera bentincki) and anchovy (engraulis ringens): a multispecies Chilean fishery

Victor Albornoz, Departamento de Industrias, Universidad Tecnica Federico Santa Maria, Av. Santa Maria 6400, 6671219, Santiago, Chile, victor.albornoz@usm.cl, Cristian Canales

In this paper the authors present an optimization model as a planning tool in the simultaneous exploitation of common sardine and anchovy. In Chile, the most important fishing regulation instrument is the establishment of global and individual capture quotas for each regulated resource, whose values are based on a total allowable capture quota, incorporated as a decision variable in such model. The proposed decisions must take into account the species mixture in their catches and must be based on the knowledge of the population dynamic behavior through aging and spatial mathematical relations.

## MG-42

Monday 17:25-18:45

GSI - S 3

### Health Care III

Stream: Health Care

*Contributed session*

Chair: John-Christ Panayiotopoulos, Informatics, University of Piraeus, Karaoli & Dimitriou 80, 18534, Piraeus, Greece, jcp@unipi.gr

#### 1 - Bayesian networks to prognoses and management of prostate cancer

Narcisa Teodorescu, Technical University of Civil Engineering Bucharest, 66, Pache Protopopescu Blvd, Sector 2, 021414 Bucharest, Romania, 021414, Bucharest, narcisa.teodorescu@gmail.com, Camelia Gavrilă

In this paper, we describe an application of Bayesian networks to the prognoses of prostate cancer. Bayesian-network and decision-theoretic systems which intend to assist medical doctors in diagnosing prostate cancer, predicting likely outcome and selecting appropriate treatment. The main reason for this is that it is still a major undertaking to develop systems for problems of the complexity in monitoring prostate cancer.

#### 2 - Enhancement of sandwich algorithms for approximating higher dimensional convex pareto sets with applications to imrt

Gijs Rennen, P.O. Box 90153, 5000 LE, Tilburg, Netherlands, g.rennen@uvt.nl

In this presentation, we focus on the approximation of convex Pareto frontiers for multi-objective problems with three or more objectives. Sandwich algorithms are used for the approximation as they have the advantage of providing a quality guarantee on the accuracy of the approximation. Our enhancements are aimed at determining an accurate approximation more efficiently and at simplifying the calculation of an easily interpretable error measure. We will illustrate these benefits using a numerical comparison with three existing sandwich algorithms.

### 3 - Using simulation to assess a novel public health scheme with spatial complexities

*Karen J Cairns*, Centre for Statistical Science and Operational Research (CenSSOR), Queen's University Belfast, University Road, BT7 INN, Belfast, United Kingdom, [k.cairns@qub.ac.uk](mailto:k.cairns@qub.ac.uk), *Adele Marshall*

Assessing the benefits of a novel public health scheme with mobile cardiac First-Responders (FRs) is not straightforward given its stochastic and spatial nature e.g. cardiac arrest occurrences across time/space; response times of ambulances/FRs; long-term survival. A Monte-Carlo simulation-based model has been constructed. Validation was via comparison with observed in a sub-region of the UK. The benefits in a different rural region, under various FR configurations, have been evaluated. These conclude that the scheme would not be the most efficient use of National Health Service resources.

#### 4 - Categorizing diseases based on digital protocols

*John-Christ Panayiotopoulos*, Informatics, University of Piraeus, Karaoli & Dimitriou 80, 18534, Piraeus, Greece, [jcp@unipi.gr](mailto:jcp@unipi.gr), *Pavlos Petrantonakis*

So far there has not been some digital standardization of diseases. In this paper, it is proposed a new approach based on digital protocols. For each disease category a matrix of symptoms is introduced which offers the capability of automated diagnosis. Furthermore, an expert diagnosis support system is presented which also may be used as a Tutor to new practitioners.

## ■ MG-43

Monday 17:25-18:45  
GSI - S 10

### Cognitive, risk-based, and socio-economical perspectives on sustainable development and climate change

Stream: Sustainable living: Cognitive, Social, Economical, Ecological and World View

*Invited session*

Chair: *Annette Hohenberger*, Middle East Technical University (METU), Informatics Institute, Cognitive Science Program, Inonu Bulvari, 06531, Ankara, Turkey, [hohenberger@ii.metu.edu.tr](mailto:hohenberger@ii.metu.edu.tr)

#### 1 - Cognitive perspectives on future scenarios related to climate change: a cross-cultural turkish-german study

*Annette Hohenberger*, Middle East Technical University (METU), Informatics Institute, Cognitive Science Program, Inonu Bulvari, 06531, Ankara, Turkey, [hohenberger@ii.metu.edu.tr](mailto:hohenberger@ii.metu.edu.tr)

In this comparative study to be carried out in Turkey and Germany simultaneously, we ask subjects to rate 14 future scenarios related to climate change (7 negative, 7 positive) in four temporal conditions (future1, future2, present, subjunctive) with respect to several dimensions (worry, likelihood, imaginability, desirability, credibility). We expect major differences for each independent variable (country, valence, perspective) and possible interactions. The study shall contribute to our understanding of the effect of different cognitive perspectives on a major future threat, climate change.

#### 2 - Multiple criteria evaluation of transportation modes used in turkey

*Banu Soylu*, Department of Industrial Engineering, Erciyes University, 38039 Kayseri, Turkey, 38039, Kayseri, Turkey, [bsoylu@erciyes.edu.tr](mailto:bsoylu@erciyes.edu.tr), *Kezban Bulut*

The aim of this study is to evaluate the transportation modes used in Turkey in terms of different criteria. The common transportation modes in Turkey are road, airway and railway. The increasing rate of road usage and the fast growth in transportation sector cause some environmental, economical and safety problems. Reforming the transportation policies and shifting to the suitable transportation modes may increase efficiency and safety. In this study, we perform a multiple criteria analysis in order to determine the promising transportation modes for future investments and new regulations.

#### 3 - Risk-based assessment and management of total petroleum hydrocarbon contamination

*Aisha Bello-Dambatta*, School of Engineering, Computing and Mathematics, Harrison Building, New Park Road, University of Exeter, EX4 4QF, Exeter, United Kingdom, [ab353@exeter.ac.uk](mailto:ab353@exeter.ac.uk), *Akbar Javadi*

Petroleum hydrocarbon contamination is the most common form of soil and groundwater contamination in the urban environment. This contamination pose risks to human health via various exposure pathways. We present a Web-based knowledge-based management system for sustainable management which works by carrying out a site specific risk assessment and evaluation to identify exposure pathways by comparisons and rule-based inferencing from the knowledge-base. If remedial action is needed, the system finds the most sustainable remedial alternatives and rank them in order of the most sustainable.

#### 4 - Dynamic simulation of trb1 region : projections and scenarios

*Hasan Soyler*, Econometrics, Inonu University, Inonu University Business Administration Faculty, Econometrics Department, 44280, Malatya, Turkey, [hsoyler@inonu.edu.tr](mailto:hsoyler@inonu.edu.tr)

Regional development models have many feedback loops, will change over time and have nonlinear structure. System dynamics is effective way for modelling of socio-economic system, making predictions in future, providing improvement in the system of policies. This study is about to analyze socio-economic development model of TRB1 Region (Malatya-Elazig-Bingol-Tunceli) using system dynamics approach. To ensure socio-economic development in the region to the country level, model will run according different scenarios through 2009-2030. This study is supported by TUBITAK.

## ■ MG-44

Monday 17:25-18:45  
GSI - S 16

### Uncertainty in Water and Energy Management

Stream: Uncertainty and Environmental Decision Making

*Invited session*

Chair: *John Boland*, School of Mathematics and Statistics, University of South Australia, Mawson Lakes Blvd., 5095, Mawson Lakes, South Australia, Australia, [john.boland@unisa.edu.au](mailto:john.boland@unisa.edu.au)

Chair: *Julia Piantadosi*, School of Mathematics and Statistics, University of South Australia, Mawson Lakes Campus, Mawson Lakes Boulevard, Mawson Lakes, 5095, Adelaide, South Australia, [julia.piantadosi@unisa.edu.au](mailto:julia.piantadosi@unisa.edu.au)

### 1 - A decomposition approach for stochastic dynamic programming models of reservoir networks

Thomas Archibald, School of Management, University of Edinburgh, 50 George Square, EH8 9JY, Edinburgh, United Kingdom, T.Archibald@ed.ac.uk

Stochastic dynamic programming is often used to model reservoir control problems. However, in most practical cases, these models are computationally intractable due to the high dimension of the state and action spaces. This paper presents an approach which decomposes the problem into low-dimensional subproblems, each concentrating on one reservoir in the network. The approach works well for certain types of reservoir network under the objective of maximizing expected value. The paper examines how the approach can be adapted for different networks and objectives which take more account of risk.

### 2 - The value of a domestic photovoltaic power station

John Boland, School of Mathematics and Statistics, University of South Australia, Mawson Lakes Blvd., 5095, Mawson Lakes, South Australia, Australia, john.boland@unisa.edu.au

An innovative method is proposed for determining the economic worth of the use of PV cells for electricity production in the urban environment. Instead of estimating the payback period, the system is regarded simply as the investment of capital in an additional feature added to the domestic dwelling. The analysis is performed using stochastic programming techniques. The objective is to minimise the capital value that has to be added to the house with solar radiation and ambient temperature being stochastic inputs to give a payback period of a predetermined time.

### 3 - Stochastic control of river systems

Julia Piantadosi, School of Mathematics and Statistics, University of South Australia, Mawson Lakes Campus, Mawson Lakes Boulevard, Mawson Lakes, 5095, Adelaide, South Australia, julia.piantadosi@unisa.edu.au

Almost every major water supply system in Australia is under stress. This is true of metropolitan systems in all mainland capital cities and many of the important river systems especially the Murray-Darling. We wish to determine new management policies that satisfy environmental constraints and user demands subject to appropriate regard for the future health of the river. A crucial issue is managing the various risks involved, which will be formulated via Conditional Value-at-Risk (CVaR). It is well known that CVaR is a robust measure that can be used in stochastic optimization procedures.

### 4 - Addressing variability in renewable and decentralised energy systems

Simon Dunstall, Mathematical and Information Sciences, CSIRO, Australia, Simon.Dunstall@csiro.au, Andreas Ernst, Rodolfo Garcia-Flores, Gaurav Singh, Rene Weiskircher

The management of renewable and/or decentralized energy generators within an energy market is complicated by short and long-term variability in energy sources, prices and demand for electrical and heat outputs. For residential combined-heat-and-power systems, for example, we must predict and react to changes in heat energy demand while optimizing for emissions, economics or both. We present methods for addressing this variability and uncertainty that we have used for research into large-scale decentralized energy deployments and the use of batteries to smooth wind farm power output

## MG-45

Monday 17:25-18:45

GSI - S 33

### OR in sustainable development modeling

Stream: Young People for System Theory, Optimization and Education

Invited session

Chair: Alexis Pasichny, Students' Science Association, National Technical University of Ukraine "Kyiv Politechnic Institute", 37, Peremohy av., 03056, Kiev, Ukraine, alexis.pasichny@gmail.com

Chair: Kateryna Pereverza, Students Science Association, National Technical University of Ukraine, Kyiv, Revutskogo, 19/1, app. 282, 02091, Kyiv, Ukraine, pereverza.kate@gmail.com

#### 1 - Approach to global modeling which based on signals exchanging

Oleksii Leonov, Institute for Applied Systems Analysis, str. Vitrianni Gory, b. 2-b, app. 25, 04123, Kyiv, Ukraine, alex@leonov.com.ua, Olga Trubnikova

This paper presents an approach to global modeling which based on sustainable development concept. It uses representation of countries in the form of objects with interface for economic, ecological and social signals exchanging between each other that allow to provide real-time computations with hundreds of complex models and thousands interconnections between them. Simulation allows predicting the influence of some important changes in one country or region to other part of world, research of the threats with potential catastrophic consequences, finding the best ways for world development.

#### 2 - Methodology of scenario constructing based on sustainable development data

Kateryna Pereverza, Students Science Association, National Technical University of Ukraine, Kyiv, Revutskogo, 19/1, app. 282, 02091, Kyiv, Ukraine, pereverza.kate@gmail.com

This paper describes the method of constructing scenarios for development of countries, regions, cities. The method based on using sustainable development data and such tools as SWOT-analysis, expert methods and morphological analysis. Sustainable development's data are values of indices and indicators that include economic, ecological, socially-institutional characteristics of development. As example of proposed method using will be presented scenarios which were constructed for Ukraine's development.

#### 3 - Modelling of the civilizations' break lines in context of their fundamental cultural differences

Alexis Pasichny, Students' Science Association, National Technical University of Ukraine "Kyiv Politechnic Institute", 37, Peremohy av., 03056, Kiev, Ukraine, alexis.pasichny@gmail.com

Given paper describes a development of a methodology of world geopolitics research with the use of contemporary geopolitical paradigms based on the work of expert groups in definition of the examined objects, development the set of evaluation criteria, and quantitative estimation of the cultural differences of different objects. Current research was based on hypothesis of S. Huntington about the 'clash of civilizations'.

## Tuesday 08:00-09:20

### ■ TA-01

Tuesday 08:00-09:20

Beethoven

#### Recent advances in combinatorial optimization I

Stream: Combinatorial Optimization

Invited session

Chair: *Andrea Lodi*, D.E.I.S., University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, andrea.lodi@unibo.it

Chair: *Michele Monaci*, D.E.I., University of Padova, Via Gradenigo 6/A, 35131, Padova, Italy, monaci@dei.unipd.it

##### 1 - Optimal patchings for consecutive ones matrices

*Marc Pfetsch*, Institute for Mathematical Optimization, Technische Universität Braunschweig, Pockelsstr. 14, 38106, Braunschweig, Germany, m.pfetsch@tu-bs.de, *Giovanni Rinaldi*, *Paolo Ventura*

We deal with the problem to find the minimal number of 0s of a 0/1-matrix that have to be changed to yield a matrix that has the consecutive ones property. We discuss an application in production planning, the corresponding polytopes, and a branch-and-cut approach that builds on old and new cutting planes. Furthermore, the algorithm features inequalities that are obtained via the equivalence of separation and optimization - the corresponding optimization problems are solved by a dynamic programming algorithm on submatrices. At the end, we present computational results.

##### 2 - Integer knapsacks: average behavior of the Frobenius numbers

*Iskander Aliev*, School of Mathematics, Cardiff University, Senghennydd Road, CF24 4AG, Cardiff, alievi@cf.ac.uk

Feasibility of integer knapsacks is known to be closely related to the behavior of associated Frobenius numbers. In the present talk we show that the asymptotic growth of the Frobenius number in average is significantly slower than the growth of the maximum Frobenius number. The obtained results also imply a new upper estimate for the Frobenius number associated with a "typical" integer knapsack. The talk is based on a joint work with Martin Henk (Magdeburg).

##### 3 - Computer aided discovery of families of valid inequalities

*Stefan Ropke*, Department of Transport, Technical University of Denmark, Bygningstorvet 115, 2800, Kgs. Lyngby, Denmark, sr@transport.dtu.dk, *Jean-Francois Cordeau*, *Gilbert Laporte*

When designing a branch-and-cut method for a specific problem class it is important to know classes of valid inequalities for the problem. We present a computer program that helps the user discovering new families of valid inequalities. It does so by finding simple valid inequalities that are violated by a fractional solution supplied by the user. It is up to the user to generalize these examples further. We will present examples of new families of inequalities for the capacitated vehicle routing problem and the traveling salesman problem with pickup and deliveries found using the program.

##### 4 - A framework for solving sub- and supermodular problems

*Gerald Lach*, Institut für Mathematik, TU Berlin, Straße des 17. Juni 136, 10623, Berlin, Berlin, Germany, lach@math.tu-berlin.de, *Marco Lübbecke*

Several combinatorial problems can be described using normalized, monotone increasing, sub and supermodular functions. Many of these functions, which describe real world problems, include a more restrictive characteristic, which we call antichainwidth-boundedness. An example of such a function is the supermodular functions describing the single machine scheduling polytope. The facets of these polymatroids possess an unexplored combinatorial structure. Based on this structure we introduce a mathematical framework, which provides an oracle free separation algorithm for this kind of problems.

### ■ TA-02

Tuesday 08:00-09:20

Schumann

#### Online Planning in Vehicle Routing and Scheduling

Stream: Transportation Planning

Invited session

Chair: *Joern Schoenberger*, Chair of Logistics, University of Bremen, Wilhelm-Herbst-Straße 5, 28359, Bremen, Germany, jsb@uni-bremen.de

##### 1 - Online planning: challenges and lessons learned

*René Schumann*, Computer Science, Information Systems and Simulation, Goethe Universität Frankfurt, Robert-Mayer-Str. 10, 60325, Frankfurt, Germany, reschu@informatik.uni-frankfurt.de, *Juergen Sauer*

Shifting the focus from offline to online planning implies changes that increase complexity tremendously. Optimality can only be proven ex-post. Events triggering planning actions must be abstracted from primitive data. Effects where no stable plan exists must be avoided. A key challenge is the notion of robustness. Robustness reduces the number of needed repair steps but is in conflict with classical objective functions. In the article we point out the aspects mentioned and survey how these issues have been tackled in Artificial Intelligence planning and scheduling.

##### 2 - Data provision for time-dependent vehicle routing in city logistics

*Jan Fabian Ehmke*, Decision Support Group, Business Information Systems, Mühlenpfordtstraße 23, 38106, Braunschweig, Germany, j-f.ehmke@tu-bs.de, *Dirk Christian Mattfeld*

Customer-oriented vehicle routing in city logistics demands for the consideration of congestion in urban infrastructure. Therefore, telematics based data collection technology provides traffic data in a large extent. This data is analyzed by Data Mining methods and described by an information model, which is used in time-dependent vehicle routing algorithms. In this context, customer time windows are considered.

##### 3 - Methods for the real-time distribution of perishable goods using past request information to forecast future demand

*Francesco Ferrucci*, WINFOR (Business Computing and Operations Research), University of Wuppertal, Gaußstraße 20, 42119, Wuppertal, NRW, Germany, fferrucci@winfor.de, *Stefan Bock*, *Michel Gendreau*

This talk introduces a real-world variant of the well-known Dynamic Vehicle Routing Problem (DVRP). In this DVRP, goods have to be delivered under extreme time pressure because of their high perishability. In order to increase quality of service, future demands are anticipated by applying sophisticated methods for analyzing historical data and request forecasting. The efficiency of the applied instruments is analyzed using computational experiments. Besides designed test scenarios, results obtained for a real-world case of subsequent deliveries of a German newspaper vendor are presented.

#### 4 - Approximate dynamic programming for routing a service vehicle with stochastic customer requests

*Stephan Meisel*, Information Systems, Technical University Braunschweig, Abt-Jerusalem-Str. 4, 38106, Braunschweig, [stephan.meisel@tu-bs.de](mailto:stephan.meisel@tu-bs.de), *Dirk Christian Mattfeld*

We present an Approximate Dynamic Programming approach to a dynamic vehicle routing problem with one vehicle and stochastic requests. Two groups of customers are considered. Early customers definitely request for service, whereas late request customers appear randomly over time according to individual request probabilities. Late requests must be either confirmed or rejected after becoming known. The goal is serving the maximum number of customers within a fixed period. The performance of our approach is compared to the performance of state-of-the-art waiting strategies and a greedy heuristic.

## ■ TA-03

Tuesday 08:00-09:20

*Reger*

### Container Terminal Planning

Stream: Transportation Planning

*Invited session*

Chair: *Jörg Wiese*, DS&OR Lab, University of Paderborn, Warburgerstr. 100, 33098, Paderborn, Germany, [wiesej@upb.de](mailto:wiesej@upb.de)

#### 1 - Integer programs for designing optimal container yards

*Jörg Wiese*, DS&OR Lab, University of Paderborn, Warburgerstr. 100, 33098, Paderborn, Germany, [wiesej@upb.de](mailto:wiesej@upb.de), *Leena Suhl*, *Natalia Kliewer*

The container yard is the main part of a container terminal layout. We define different categories of container yard layouts. Focusing on a layout category where rubber tired gantries are used for stacking containers, we present an integer program for designing container yard layouts. We show that an intuitive formulation of the problem can be reformulated as a special type of a resource constrained shortest path problem. Due to a problem specific cost structure instances can be solved in polynomial time. Computational results are presented for typical terminal scenarios.

#### 2 - Solving a berth allocation problem

*Serigne Gueye*, Le Havre University, LMAH, 25 rue Philippe Lebon B.P. 540, 76058, Le Havre, France, [serigne.gueye@univ-lehavre.fr](mailto:serigne.gueye@univ-lehavre.fr), *Sophie Michel*, *Adnan Yassine*, *Philippe Michelin*

The Berth Allocation Problem (BAP) is the problem of allocating and scheduling container vessels on berths so as to minimize total weighted flow time. We study a version of BAP in which containers are moved between vessels and berth space is abundant. Thus, the problem reduces to optimally assign vessels to berths. We formulate it as a non standard Quadratic Assignment Problem. The problem is simplified, linearized, and valid inequalities is found. Numerical results are shown.

#### 3 - From simulation to emulation — optimising container terminal operation

*Holger Schuett*, Optimisation and Simulation, ISL - Institute of Shipping Economics and Logistics, Barkhausenstrasse 2, D27568, Bremerhaven, Germany, [schuett@isl.org](mailto:schuett@isl.org)

Simulation found its way from industrial to logistic applications. Automation and increasing vessel sizes led to the demand of optimising container terminal operations. The paper will give an overview about terminal simulation (starting in the 80ies) up to emulation technology, which nowadays is used for (semi-)automated terminals needing high level Terminal Operating Systems (TOS). Device emulators are coupled to the TOS to generate a software testbed. Furthermore this systems may be used for optimising terminal processes controlled by the TOS as well as for training terminal operators.

#### 4 - The impact of truck arrival information on container handling operations at marine terminals

*Wenjuan Zhao*, Department of Civil and Environmental Engineering, University of Washington, 98105, Seattle, WA, United States, [wz@u.washington.edu](mailto:wz@u.washington.edu), *Anne Goodchild*

Reducing container rehandling work within a container terminal improves yard crane productivity and reduces drayage truck transaction time. This paper focuses on using truck arrival information to improve import container handling operation by reducing rehandles. Simulation is used to evaluate the reduction in rehandles made possible by exploiting truck arrival information in a variety of scenarios. The research demonstrates that significant benefit can be achieved for both the terminal and truck operator with relatively small amount of information, particularly if it is updated in real-time.

## ■ TA-04

Tuesday 08:00-09:20

*Liszt*

### Online Scheduling and Batching

Stream: Scheduling

*Invited session*

Chair: *Sleman Saliba*, ABB Corporate Research Center Germany, Wallstadter Str. 59, 68526, Ladenburg, Germany, [sleman.saliba@de.abb.com](mailto:sleman.saliba@de.abb.com)

#### 1 - An on-line approach for solving flexible flow shop problems where jobs arrive over time

*Verena Gonddek*, Fachbereich Mathematik, Universität Duisburg-Essen, Forsthausweg 2, LE 431, 47057, Duisburg, Germany, [verena.gonddek@uni-due.de](mailto:verena.gonddek@uni-due.de)

We consider a problem that arises from the workflow in a steel mill. During the whole manufacturing process, the quality of the produced steel and slack is observed in an automated laboratory. The organization of the corresponding list of operations can be classified as a flexible flow shop problem where jobs arrive over time and the objective is to minimize the total weighted completion time or flow time. Since this problem is known to be NP-hard, we deal with heuristic solution techniques and develop an approach based on dispatching rules, decomposition and bottleneck related strategies.

#### 2 - Batch scheduling of simple linear deteriorating jobs on a single machine to minimize makespan

*Min Ji*, Department of Logistics and Maritime Studies, Zhejiang Gongshang University & The Hong Kong Polytechnic University, Hong Kong, [jimkeen@163.com](mailto:jimkeen@163.com), *T.C. Edwin Cheng*

We consider a single-machine scheduling problem in jobs are to be processed in batches and the processing time of each job is a simple linear function of its waiting time. The objective is to minimize the makespan. We show that the general problem and some special cases are all strongly NP-hard or NP-hard. If the number of batches is  $B$ , for the case that  $B$  is not larger than  $U$ , we present an FPTAS, where  $U$  is a constant not less than 2. Furthermore, we provide an optimal linear time algorithm for the special case where the jobs are subject to a linear precedence constraint.

### 3 - A best possible deterministic on-line algorithm for minimizing makespan on parallel batch machines

*Xiwen Lu*, Dept. of Math, East China University of Science & Technology, Dept. of Math., East China University of Science & Technology, Shanghai 200237, China, 200237, Shanghai, xwlu@ecust.edu.cn, *Peihai Liu, Yang Fang*

On-line scheduling problem is studied on parallel batch machines. Jobs arrive over time. A batch processing machine can handle up to  $B$  jobs simultaneously and  $B$  is sufficiently large. The objective is to minimize makespan. We give the lower bound of competitive ratio of this problem. An optimal on-line algorithm is presented.

### 4 - Strategies for the online target date assignment problem

*Sleman Saliba*, ABB Corporate Research Center Germany, Wallstadter Str. 59, 68526, Ladenburg, Germany, sleman.saliba@de.abb.com, *Sven Krumke, Elisabeth Gassner, Johannes Hatzl*

The online target date assignment problem models a two-stage decision process encountered often in practice: upon arrival of a new request, an irrevocable first-stage decision must be made, while in a second stage, certain downstream problems can be solved to optimality later. We consider the case of deferral time one and un-splittable requests for a general class of downstream problems comprising many problems like routing, binpacking or scheduling. We prove a lower bound of  $3/2$  on the competitive ratio of any online algorithm and give an algorithm which matches the lower bound.

## ■ TA-05

Tuesday 08:00-09:20

Haydn

### Bioinformatics III

Stream: Computational Biology, Bioinformatics and Medicine

Invited session

Chair: *Julie Greensmith*, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, Nottinghamshire, United Kingdom, jgq@cs.nott.ac.uk

### 1 - Fuzzy systems in breast cancer treatment decision making

*Jonathan Garibaldi*, Computer Science & IT, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, jmg@cs.nott.ac.uk, *Xiao-Ying Wang*

In this study we apply a non-stationary fuzzy system to a post-operative breast cancer treatment decision problem. The experimental results show that by applying the non-stationary fuzzy model, the overall system performance is better than purely employing a conventional type-1 fuzzy model. The results also indicate that when perturbing membership functions with a diverse standard deviation, the performance within different non-stationary fuzzy expert systems are very small. Based on this observation, a new paradigm in designing fuzzy inference systems is proposed.

### 2 - Assessing feasibility of a homeostatic approach to thermal management of a data centre

*Naisan Benatar*, School of Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, Nottinghamshire, United Kingdom, nxb@cs.nott.ac.uk

This presentation outlines the initial work to be used in assessing the use of a homeostatic control system for management of thermal challenges present in modern data centers. Using an agent based model to model sensors and actuators this presentation attempts to lay the ground work for a system inspired by the human glucose regulatory system and exhibits some of its characteristics such as its distributed nature and self organizational abilities. The intended result is to demonstrate that homeostatic based systems can equal or exceed current systems performance in terms of energy usage.

### 3 - An immune inspired real-time detection system

*Feng Gu*, School of Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, Nottinghamshire, United Kingdom, ffg@cs.nott.ac.uk

To develop an effective real-time detection system based on the Dendritic Cell Algorithm (DCA), we propose two approaches, namely theoretical and empirical. In theoretical approach, formal methods including the Duration Calculus, Timed Automata, and PLC Automata are used. They provide the formal specification and automatic verification, as well as the mathematical foundation of the designed system. Conversely, in empirical approach, an adaptive real-time analysis component is added to the algorithm, and the newly implemented system is tested by multiple datasets for the purpose of validation.

### 4 - Cluster interpretation of the self-organising map

*Jan Feyereisl*, School of Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, Nottinghamshire, United Kingdom, jqf@cs.nott.ac.uk

The Self-Organising Map algorithm developed by Teuvo Kohonen is an established machine learning technique that maps high-dimensional data onto a lower-dimensional representation, while maintaining topographic properties of the input data within the output representation. We propose to exploit both the self-organisation and the topographic property of Kohonen's algorithm in combination with a biologically inspired concept for the purpose of better cluster interpretation. This combination provides a variable-type independent expert knowledge information fusion for improved data exploration.

## ■ TA-06

Tuesday 08:00-09:20

Koch

### Networks for forward and returned products

Stream: OR and Real Implementations

Invited session

Chair: *Belarmino Adenso-Diaz*, Engineering School at Gijon, Universidad de Oviedo, Campus de Viesques, 33204, Gijon, Spain, adenso@epsig.uniovi.es

### 1 - A mathematical model for empty container allocation

*Carlos Andres*, Management Department, Technological University of Valencia, Camino de Vera S/N, 46022, Valencia, Spain, candres@omp.upv.es, *Salvador Furió, Belarmino Adenso-Diaz, Sebastián Lozano*

Empty container management is a key issue in the maritime business nowadays. This article analyzes the problem from the local maritime agent point of view, which controls and manages land container logistics. Specifically, it is presented a mathematical model to optimize land empty container movements among shippers, consignees, terminals and depots, along with minimizing storage costs. The mathematical model is defined and solved by using CPLEX. Obtained results confirm the benefits of implementing this kind of models.

## 2 - A vehicle routing problem with flexibility in the delivery dates: a real case

Joaquín Pacheco, Applied Economy, University of Burgos, Plaza Infanta Elena s/n, 09001, Burgos, Spain, jpacheco@ubu.es, Ada Alvarez, Irma García

The work addresses a new routing problem based in a real case. The objective is minimizing the total distance traveled for the daily routes over the week. Flexibility in the dates of delivery is introduced. The problem is a generalization of CVRP and also a particular case of the PVRP. A formulation as a integer linear problem and a method based in GRASP and PR are proposed. The method find the optimal solution in small instances in very short time. In these instances commercial software spent much more time. Also our method performs better than recent and well-know methods for PVRP

## 3 - A single machine scheduling problem with periodic maintenance and sequence-dependent setup times

Francisco R. Angel-Bello, ITES de Monterrey, 64849, Monterrey, Mexico, fangel@itesm.mx, Joaquín Pacheco, Ada Alvarez

In this paper a problem of sequencing tasks in a machine with programmed preventive maintenance and sequence-dependent set-up times is addressed. The problem has similarities with the Vehicle Routing Problem with distance constraint and asymmetric costs and represents an NP-hard problem. A solution approach based on metaheuristic procedures has been designed and implemented and the computational experiments show that it finds good solutions in reasonably short times.

## 4 - Modeling the reverse logistic network for the periodic collection of end-of-life appliances: a case study

Belarmino Adenso-Diaz, Engineering School at Gijon, Universidad de Oviedo, Campus de Viesques, 33204, Gijon, Spain, adenso@epsig.uniovi.es, Julio Mar-Ortiz, Jose Luis Gonzalez-Velarde

We discuss a real-life case study to optimize the logistics network for the periodic collection of end-of-life appliances in the Spanish region of Galicia. A three phase hierarchical approach is considered. In the first and second phase both the reverse logistics facility location and the periodic vehicle routing problems are solved respectively (details are described in Mar-Ortiz et al, 2009). Finally, in the third phase several runs of a simulation model on the vehicle routing results are performed and analyzed to gain insight into the long-term performance of the recovery system.

## 5 - An axiomatic design approach for the reverse logistics networks design

Didem Cinar, Industrial Engineering, Istanbul Technical University, istanbul technical university management faculty, macka besiktas, 34367, istanbul, Turkey, cinard@itu.edu.tr, Ronay Ak, Y. Ilker Topcu

Reverse logistics(RL) has been increasingly researched because of growing green concerns. Reusing, recycling and remanufacturing have been considered as environmentally and financially effective processes for various drivers -government, corporations and customers. In RL literature, A significant number of articles have been written about specific aspects of RL, such as remanufacturing or recycling. This paper presents a conceptual framework for reverse logistics by the axiomatic design(AD) approach. AD can be used to design RL and distinguish objectives and means of RL for different levels.

## ■ TA-07

Tuesday 08:00-09:20

GSI - S 29

### Network design & scheduling

Stream: Optimization in Public Transport

Invited session

Chair: *Ernesto Cipriani*, Dept. Civil Engineering, University of Roma TRE, Via Vito Volterra 62, 00146, Roma, Italy, eciprian@uniroma3.it

#### 1 - Public transport service optimization through an analytical investigation of avm data collection

*Stefano Carrese*, Department of Civil Engineering, University of Roma TRE, Via Vito Volterra 62, 00146, Roma, Italy, carrese@uniroma3.it, *Sandro Bartolucci*, *La Spada Simone*

In this paper the service optimization of public transport through an analytical investigation of AVM data will be analyzed. Transport and mathematical rules have been both combined to find two models to use the large amount of AVM data. The 2 models are based on binary and fuzzy logic. Then the 2 models have been applied to the Rome public transport service to test them. Particularly more of 80M AVM data have been used, analyzing for 6 months 11 bus lines with different characteristics. This trial test has allowed to calibrate the models and compare binary with fuzzy results.

#### 2 - Transit network design: a procedure and an application to a large urban area

*Ernesto Cipriani*, Dept. Civil Engineering, University of Roma TRE, Via Vito Volterra 62, 00146, Roma, Italy, eciprian@uniroma3.it, *Stefano Gori*, *Marco Petrelli*

In the present study authors propose a transit network design procedure to deal with a large urban areas characterized by complex network topology, not obviously described as a simple radial or grid network, and the public transport system can be composed by different transit modes. This new feature allows to estimate the bus transit network in terms of main and feeder lines.

#### 3 - The use of pricing revenues for improving public transport services

*Luca D'Acerno*, Dipartimento di Ingegneria dei Trasporti, Università degli Studi di Napoli "Federico II", Via Claudio, 21, 80125, Napoli, Italy, dacierno@unina.it, *Roberta Ciccarelli*, *Bruno Montella*, *Mariano Gallo*

In recent years several European cities have introduced road pricing as a tool for managing transport demand, especially to reduce traffic congestion and rebalance the modal split between private vehicles and mass-transit systems. The aim of this research is to develop an optimisation model that allows fares to be calculated according to economic theory of 'efficient tolls' in the case of different pricing schemes (such as parking, cordon and road pricing) and analyse effects of pricing revenue reinvestments in terms of user accessibility increase and mass-transit fare reductions.

#### 4 - A bi-level formulation for the optimal transit network design problem

Randy Machemehl, Civil Engineering, The University of Texas, 3208 Red River, 78705, Austin, Texas, United States, [rbm@mail.utexas.edu](mailto:rbm@mail.utexas.edu), Wei Fan

ABSTRACT: The thrust of this paper is to formulate the optimal transit network design problem (TNDP) using a bi-level approach for the first time and illustrate its equivalence to the model currently used by many researchers. Some computational insights based on our 10-year research experience working on the TNDP are presented. Several meta-heuristics solution methods such as Genetic Algorithms (GA), Simulated Annealing (SA), and the combination of the GA and SA are implemented and performance compared. Computational results and recommendations for future research directions are also given.

## ■ TA-08

Tuesday 08:00-09:20

GSI - S 30

### Robust Optimization II

Stream: Optimization in Public Transport

Invited session

Chair: Juan A. Mesa, University of Seville, 41092, Sevilla, Spain, [jmesa@us.es](mailto:jmesa@us.es)

#### 1 - Robustness of railway rolling-stock schedule: issues about optimization and evaluation

David De Almeida, Innovation & Research Department, SNCF, 75379, Paris CEDEX 08, France, [david.de\\_almeida@snf.fr](mailto:david.de_almeida@snf.fr), Francis Sourd, Christian Weber

This work deals with the evaluation of the robustness that can be introduced inside rolling-stock schedules at a planning level, which is of primary importance for disturbance management. We present an approach based on a macroscopic simulation model for evaluating actual propagated delays in a schedule, with the possible application of basic repairing strategies to limit those delays. Various numerical experiments are undertaken to study the influence of input parameters on robustness. The preliminary benefits need further numerical tests to be demonstrated at a systematic level.

#### 2 - Robust planning of airport platform busses

Marjan van den Akker, Information and Computing Sciences, Utrecht University, POBox 80089, 3508TB, Utrecht, [marjan@cs.uu.nl](mailto:marjan@cs.uu.nl), Guido Diepen, Han Hooegeveen, Barbara Pieters

Most airports have two types of gates: gates with an air bridge to the terminal and remote stands. For flights at a remote stand, passengers are transported by platform busses. In this talk we present a column generation algorithm for planning of platform busses that maximizes robustness. We also present a discrete-event simulation model to compare our algorithm to a first-come-first-served heuristic as is used in current practice. Our computational results indicate that our algorithm reduces the number of replanning steps and special recovery measures during the day of operation.

#### 3 - Indexes to evaluate the robustness of a railway network from the passenger point of view

Federico Perea, Matemática Aplicada 2, Universidad de Sevilla, 41092, Sevilla, Spain, [perea@us.es](mailto:perea@us.es), Alicia De-los-Santos, Juan A. Mesa

This paper deals with an evaluation of the robustness of a railway network. A network is considered robust when it reacts well to failures on links or stations. Indexes measuring the overall travel time of a network when links fail are introduced for two different cases: short interruptions and long interruptions. In the first, all lines using the failing arc are delayed, while in the second a bus between the affected stations allows the rest of the network to function properly. The implementation of those indexes in the Madrid commuter system shows their applicability.

#### 4 - Railway network robustness and the complex network science

Juan A. Mesa, University of Seville, 41092, Sevilla, Spain, [jmesa@us.es](mailto:jmesa@us.es)

During last two decades some research efforts have been made to understand the functioning of large and complex networks. Railway networks present some specific features that give rise to new challenges regarding measuring efficiency and robustness. In this work we discuss these issues.

## ■ TA-09

Tuesday 08:00-09:20

GSI - S 5

### Human Resources Management II

Stream: Supply Chain Management

Invited session

Chair: Bernd Irlenbusch, Department of Management, London School of Economics, Houghton Street, WC2A 2AE, London, United Kingdom, [b.irlenbusch@lse.ac.uk](mailto:b.irlenbusch@lse.ac.uk)

#### 1 - Optimal assignation of public actions for labor insertion

Eugenio Martinez-Falero, Forest economy and management, Technical University of Madrid, ciudad universitaria sn, 28040, Madrid, [eugenio.mfalero@upm.es](mailto:eugenio.mfalero@upm.es), Susana Martin-Fernandez

Employment Polices aim at implementing personalized labor itineraries for each jobseeker which are made by different activities financed by public funds. We have applied a heuristic optimization method to maximize the global insertion over feasible itineraries, occupations and jobseekers' preferences. The result is a pre assignation of an itinerary to each jobseeker that requires later interviews with labor advisers who evaluate how the itinerary fits the jobseeker needs. The adviser can propose a new itinerary which starts the adaptive phase of the process by incorporating new constraints.

#### 2 - Integrated competency management information system

Nikos Tsotsolas, Department of Statistics and Insurance Science, University of Piraeus, 2, Feidiou Str, 15236, Penteli, Greece, [ntsotsol@unipi.gr](mailto:ntsotsol@unipi.gr), Eleni Koutsouraki, Dimitrios Drosos

Employees' training should be integrated into total human resources' development plans under a framework which includes the mapping of competences, the tracking of training needs, the implementation of training activities and the evaluation of the outcomes. The main aim of the developed Competency Management Information System is to satisfy the needs of managers in HR departments by supporting a systematic and well defined approach of the procedures regarding the analysis, the designing, the implementation and the evaluation of human resources skills development activities.

#### 3 - Sabotage in tournaments: evidence from the lab

Bernd Irlenbusch, Department of Management, London School of Economics, Houghton Street,

WC2A 2AE, London, United Kingdom,  
b.irlenbusch@lse.ac.uk, *Christine Harbring*

Organizations often implement incentive schemes in which rewards depend on relative performance. We provide evidence of the influence of tournament design on two activity dimensions: productive activities and destructive ones (called sabotage). We find that (1) Subjects heavily sabotage when they have the possibility to do so. (2) Both activities increase with widening the wage gap. (3) For a given prize spread the output is increased by a higher fixed wage component. (4) Framing the situation as a work environment or allowing for communication keeps the results largely unaffected.

## ■ TA-10

Tuesday 08:00-09:20

GSI - S 6

### Workforce Planning

Stream: Timetabling and Rostering

*Invited session*

Chair: *Sanjeev Kumar Guleria*, Computer Centre, Thapar University, P.B. No. 32, 147004, Patiala, Punjab, skguleria@thapar.edu

#### 1 - Reducing the workload of modification in small-scale staff scheduling from strategies of optimization

*Takuma Kubo*, The Graduate University for Advanced Studies (SOKENDAI), 2-1-2 Hitotsubashi, Chiyoda-ku, Tokyo, 101-8430, Tokyo, Japan, kubo\_tk@nii.ac.jp, *Takeaki Uno*

On staff scheduling in small offices, users usually have to modify the schedules obtained by optimization, and this task is usually the bottleneck. For such offices customization is always too expensive, thus we thought it is quite important to make optimization method and environment which lighten this task. We had real-world experiments operated by human, and clarified that too much focused objectives, and sophisticated optimization make the solutions hard to be modified. We also developed excel based scheduling system which can reduce the workload of users without much literacy.

#### 2 - Simulated annealing algorithm for the temporary workforce planning with firm contracts

*Muhammad Al-Salamah*, Systems Engineering, King Fahd University, Box 5067, KFUPM, 31261, Dhahran, Western, salamah@kfupm.edu.sa

Temporary employment is a policy frequently used to adjust the working hour capacity against fluctuating demand. Temporary workforce planning has been unnecessarily simplified to account to only periodic hiring and laying off; a company can review its workforce requirement every period and make hire-fire decisions accordingly, usually with a layoff cost. We present a more realistic temporary workforce planning modeling that assumes a firm contract, which can extend to several periods. A simulated annealing algorithm is proposed to solve the MIP model that is developed for this problem.

#### 3 - Local search for shift and break scheduling

*Nysret Musliu*, Vienna University of Technology, 1040, Wien, Austria, musliu@dbai.tuwien.ac.at, *Andreas Beer*, *Johannes Gaertner*, *Werner Schafhauser*, *Wolfgang Slany*

In this paper we address a workforce scheduling problem in which we have to design a shift plan, containing a great number of breaks, satisfying several criteria, e.g. staffing demand, labour rules and ergonomic requirements. While most of previous research follows a two-phase approach, meaning that a shift plan is designed first and breaks are inserted afterwards, we model the entire problem and optimize it with a local-search-based solver. We present the application of our approach on real-life instances.

#### 4 - Decision support system for planned student scheduling in a backlog supporting institute

*Sanjeev Kumar Guleria*, Computer Centre, Thapar University, P.B. No. 32, 147004, Patiala, Punjab, skguleria@thapar.edu, *A.k. Lal*, *Daljit Singh Bawa*

An Institute that offers the facility of backlogs to its students often finds difficulty while offering backlog subjects. The reason for this is that as a student studies subjects in junior class, his current class should be free at that time. The methodology used to create a decision support system to solve this problem is discussed. The approach has been first to do some planning like deciding the subjects which have to be scheduled in same time, next facilitate this offering while timetabling so that the backlog subjects can be scheduled easily at the time of registration.

## ■ TA-11

Tuesday 08:00-09:20

GSI - S 17

### MCDA: Theory, Computations, and Applications I.

Stream: Multiple Criteria Decision Analysis

*Invited session*

Chair: *Diederik J.D. Wijnmalen*, Dept. for Operational Analysis (BU2), TNO Organisation for Applied Scientific Research, P.O. Box 96864, 2509 JG, The Hague, Netherlands, diderik.wijnmalen@tno.nl

#### 1 - A multiple criteria decision aiding assignment methodology for assisted reproductive

*Sara Matias*, Instituto Superior Técnico, Technical University of Lisbon, Av. Rovisco Pais, 1049-001, Lisboa, Portugal, saramatias@ist.utl.pt, *José Rui Figueira*, *Maria José Carvalho*, *Carlos Plancha*

A Multiple Criteria Decision Aiding methodology was used to obtain a recommendation on the number of embryos to transfer in Assisted Reproductive Technology cycles. ELECTRE TRI-C method by Almeida-Dias et al. (2008) was used to sort couples into predefined ordered categories associated with the transfer of 1 to 4 embryos. The parameters were obtained with the experts and using SRF software. 53 couples from a private infertility clinic in Lisbon were used. 43 received the same transfer recommendation by both rules of the method, with 33 matching the number of embryos effectively transferred.

#### 2 - A MCDM ranking method based on a dominance measure: computational study

*Antonio Jiménez*, Department of Artificial Intelligence, Technical University of Madrid (UPM), Facultad de Informática, Campus de Montegancedo S/N, 28660, Boadilla del Monte, Madrid, Spain, ajimenez@fi.upm.es, *Alfonso Mateos*

The additive multi-attribute utility model is widely used in MCDM. However, many times it is not easy to elicit precise values for the scaling weights. Several decision rules have been proposed to select an alternative under these circumstances since weaker information is required, such as ordinal information. We propose a new approach based on an intensity of dominance measure and compare it with other existing approaches using Monte-Carlo simulation. The results show that the new approach yields more accurate results in terms of the best alternative and the overall ranking.

### 3 - Using value systems for the creation of perspective-based criteria weights

*Diederik J.D. Wijnmalen*, Dept. for Operational Analysis (BU2), TNO Organisation for Applied Scientific Research, P.O. Box 96864, 2509 JG, The Hague, Netherlands, [diederik.wijnmalen@tno.nl](mailto:diederik.wijnmalen@tno.nl)

Perspectives often serve as a reference for groups when assigning weights to criteria. Each perspective should lead to a typical set of weights. Many people have difficulty being forced to imagine themselves in a particular perspective to come up with appropriate weights, leading to a meaningless average weight per criterion. We propose a participatory procedure, using morphological and cluster analysis and value assessment, for creating perspective-based criteria weights. This combines individual value systems and weights with collectively established generic clusters of value profiles.

## ■ TA-12

Tuesday 08:00-09:20

GSI - S 18

### Minimax problems with uncertainty

Stream: Stochastic Programming

*Invited session*

Chair: *Jitka Dupacova*, Probability and Math. Statistics, Charles Univ. Faculty of Math. and Physics, Sokolovska 83, CZ-18675, Prague, Czech Republic, [dupacova@karlin.mff.cuni.cz](mailto:dupacova@karlin.mff.cuni.cz)

Chair: *David Morton*, Graduate Program in Operations Research, The University of Texas at Austin, 1 University Station, C2200, 78712-0292, Austin, TX, United States, [morton@mail.utexas.edu](mailto:morton@mail.utexas.edu)

#### 1 - A framework for optimization under ambiguity

*David Wozabal*, ISDS, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, [david.wozabal@univie.ac.at](mailto:david.wozabal@univie.ac.at)

Stochastic programs with ambiguous distributions for the involved random variables are studied. Though the true distribution is unknown, the existence of a reference measure  $P$  enables the construction of an ambiguity set  $B$  as Kantorovich ball around  $P$ . The original problems are robustified using the measures in  $B$ . To solve the resulting infinite optimization problems, equivalent formulations as finite dimensional non-convex, semi definite problems are proposed. Finally a portfolio selection problem is studied in the proposed framework and numerical results for sample problems are reported.

#### 2 - Interdicting smuggled nuclear material

*Ned Dimitrov*, Operations Research, University of Texas at Austin, 1 University Station, 78712, Austin, TX, [ned.dimitrov@gmail.com](mailto:ned.dimitrov@gmail.com), *David Morton*

In a smuggling event, a nuclear smuggler maximizes the probability that he smuggles material from a nuclear facility, through the transportation network, to a destination. We model the smuggler's movements via a Markov Decision Process (MDP), where the smuggler is probabilistically operating the direction in which he moves. Our goal is to place nuclear detectors to stop the smuggler. The optimal placement decision can be viewed as hedging against the worst of a set of probability distributions, where the smuggler selects the worst distribution on paths out of those allowed by the MDP.

### 3 - Stability for minimax stochastic programs

*Jitka Dupacova*, Probability and Math. Statistics, Charles Univ. Faculty of Math. and Physics, Sokolovska 83, CZ-18675, Prague, Czech Republic, [dupacova@karlin.mff.cuni.cz](mailto:dupacova@karlin.mff.cuni.cz)

When using the minimax approach one tries to hedge against the worst possible distribution belonging to a specified class. A suitable stability analysis of results wrt. choice of this class is an important issue. It has to be tailored to the type of the minimax problem, to the considered class of probability distributions and to the anticipated input perturbations. We shall point to relevant stability analysis techniques and concentrate on the effect of changes in input information for classes of probability distributions described by (possibly perturbed) moments values and support.

## ■ TA-13

Tuesday 08:00-09:20

GSI - S 31

### Airport and Airline Networks

Stream: Location Analysis

*Invited session*

Chair: *Amedeo Odoni*, Operations Research Center, Massachusetts Inst. of Technology, Room 33-219, MIT, 2139, Cambridge, MA, United States, [arodoni@mit.edu](mailto:arodoni@mit.edu)

Chair: *Antonio Antunes*, Civil Engineering Department, University of Coimbra, Polo 2, 3030-788, Coimbra, Portugal, [antunes@dec.uc.pt](mailto:antunes@dec.uc.pt)

#### 1 - Forecasting airline flight routing network changes under airport capacity constraints

*Antony Evans*, Department of Architecture, University of Cambridge, 1-5 Scroope Terrace, CB4 3AL, Cambridge, [ade26@cam.ac.uk](mailto:ade26@cam.ac.uk)

This paper describes a model that forecasts changes in flight network routing under airport capacity constraints. The model integrates several components describing different aspects of the air transport system, including passenger demand, flight delay, and airline cost. Individual airline flight network routing is forecast by maximizing airline profit. Competition is modeled by simulating a game between airlines. The model is validated by comparing results to actual data for a network of airports in the US in 2005. The model is then applied to forecast changes in this network through 2025.

#### 2 - A queuing model for a network of airports

*Amedeo Odoni*, Operations Research Center, Massachusetts Inst. of Technology, Room 33-219, MIT, 2139, Cambridge, MA, United States, [arodoni@mit.edu](mailto:arodoni@mit.edu), *Nikolaos Pyrgiotis*

The paper describes the Approximate Network Delays model, a stochastic and dynamic queuing model that computes delays at individual airports in a network, as well as captures the propagation of delays through this network. The AND model is a strongly enhanced version of the one originally developed by Malone and has been applied to a network of 22 of the busiest commercial airports in the United States. It offers very interesting insights on how congestion at one or more airports affects the other elements of the network. A number of ongoing further model improvements will also be discussed.

### 3 - An optimization model for the expansion of capacity of an airport network

*Miguel Santos*, Civil Engineering Department, University of Coimbra, 3030-788, Coimbra, Portugal, msantos@dec.uc.pt, *Antonio Antunes*, *Amedeo Odoni*

In this presentation we introduce an optimization model aimed at assisting air transport authorities in their expansion decisions regarding the capacity of an airport network, while complying with a given budget. Expansion actions consist of building new airports in cities with or without airport, or increasing the capacity of existing airports. The objective is to maximize the satisfaction of air travel demand within the airport network, taking into account the impact of air travel costs upon demand. The strengths and limitations of the model are illustrated through practical examples.

### 4 - An optimization model for the allocation of slots in an airport network

*João Pita*, Civil Engineering, University of Coimbra, 3030-788, Coimbra, Portugal, joaopita@gmail.com, *Antonio Antunes*, *Amedeo Odoni*

In this presentation we introduce an optimization model to determine the number of slots to be made available for each slot planning period in the different airports of an airport network. The objective is to minimize the total socio-economic costs of satisfying the leg-based travel demand faced by the airlines operating in the network, while taking into account the capacity of the airports. The model is intended at helping air transportation authorities in the negotiation processes within which slots are allocated. The usefulness of the model is illustrated with a real-world example.

## ■ TA-14

Tuesday 08:00-09:20

GSI - S 32

### Stochastic Inventory Control

Stream: Inventory Management

*Invited session*

Chair: *Sandra Transchel*, Department of Supply Chain and Information Systems, Penn State University, 461 Business Building, 16802, University Park, PA, United States, sxt37@psu.edu

#### 1 - A newsvendor model with service and loss constraints

*Werner Jammerneegg*, Department of Information Systems and Operations, Vienna University of Economics and Business, Nordbergstrasse 15, A-1090, Wien, Austria, werner.jammerneegg@wu-wien.ac.at, *Peter Kischka*

We present a newsvendor model with the objective to maximise the expected profit with respect to a service constraint and a loss constraint. For the price-independent demand distribution a condition for the existence of an optimal order quantity and its structure is presented. For the price-setting newsvendor the admissible region of the order quantity and the selling price is characterised for the additive and the multiplicative demand model. Furthermore, it is shown that higher variability of demand leads to a smaller admissible region thereby easing the computation of the optimal decisions.

#### 2 - Bicriteria optimization in the newsvendor problem

*Francisco Arcelus*, Departamento de Gestión de Empresas, Universidad Pública de Navarra, Campus de Arrosadía, 31006, Pamplona, Navarra, Spain, arcelus@unb.ca, *Satyendra Kumar*, *Gopalan Srinivasan*

This paper considers the newsvendor problem of a retailer with the conflicting goals of maximizing the expected profit and the probability of exceeding it, with a closed form solution for a uniformly distributed demand, by using the existence of a closed form solution for the second criterion to arrive at the solution for the bicriteria problem. The decision variable remains the traditional order quantity, but there is no solution that maximizes each goal simultaneously. The search for optimality reduces to simple comparisons between parameters and the estimation of a critical weight

#### 3 - Managing lost-sales inventory systems with batch ordering and non-negligible ordering costs

*Alina Curseu*, Technische Universiteit Eindhoven, Den Dolech 2, 5600MB, Eindhoven, Netherlands, a.curseu@tue.nl, *Tom Van Woensel*, *Nesim Erkip*, *Jan C. Fransoo*

We consider a single-item stochastic inventory system with lost sales, fixed batch ordering and positive ordering costs. Optimal policies have quite complicated structures. We analyze a heuristic policy, which is intuitive and partially captures the structure of optimal policies. In a numerical study, we compare the performance of the heuristic with those commonly used as well as optimal solutions, under a variety of conditions and demonstrate its effectiveness. Furthermore, we conduct sensitivity analysis with respect to the problem parameters and provide managerial insights.

#### 4 - Periodic review inventory-control for perishable products under service-level constraints

*Sandra Transchel*, Department of Supply Chain and Information Systems, Penn State University, 461 Business Building, 16802, University Park, PA, United States, sxt37@psu.edu, *Stefan Minner*

Food retail inventory control faces major challenges by uncertain demand, perishability, and high service levels. In this paper, we present an exact method to determine order quantities for perishable products with non-stationary demand, limited shelf-life, positive lead time, FIFO or LIFO issuing policy, and lost sales under multiple service level constraints. We illustrate the superiority of the proposed method over commonly suggested order-up-to policies and show that a constant order policy might provide good results under stationary demand, short shelf-life and LIFO inventory depletion.

## ■ TA-15

Tuesday 08:00-09:20

Einstein

### Constrained Vehicle Routing Problems

Stream: Vehicle Routing

*Invited session*

Chair: *Paolo Toth*, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, paolo.toth@unibo.it

#### 1 - A hybrid algorithm for an inventory-routing problem

*M. Grazia Speranza*, Dept. of Quantitative Methods, University of Brescia, C.da Santa Chiara, 50, 25122,

Brescia, Italy, speranza@eco.unibs.it, *Claudia Archetti, Luca Bertazzi, Alain Hertz*

We consider an inventory-routing problem. Shipments are performed by a vehicle of given capacity. We aim at minimizing the sum of the inventory cost and of the routing cost. An exact approach to this problem is known. A heuristic is presented that combines a tabu search with two mixed integer programming models, namely a Route-Assignment model and a Client-Assignment model. Such models are run whenever a new best solution is obtained by the tabu search. The hybrid procedure has been tested on benchmark instances where the optimal solution is known. The average error is lower than 0.1%.

## 2 - Vehicle loading optimization with stochastic supply

*Thierry Pironet*, HEC - Management School, University of Liège, Bd. du Rectorat 7., Bat B31 Bur 2.46, B-4000, LIEGE, Belgium, thierry.pironet@ulg.ac.be, *Yasemin Arda, Yves Crama, David Kronus*

The increased availability of information makes it possible to coordinate processes usually separated in large companies, such as production and transportation. This work investigates the vehicle loading optimization for individual orders over a multiperiod horizon when items have stochastic release dates from production and time windows are imposed at the customer plant. The loading decisions are made in order to minimize the expected cost. From the deterministic model, we develop scenario-based models for the stochastic problem and investigate the performance of various solution methods.

## 3 - An exact algorithm for the pickup and delivery problem with time windows

*Enrico Bartolini*, Department of Computer Science, University of Bologna, 40127, Bologna, Italy, ebartoli@cs.unibo.it, *Roberto Baldacci, Aristide Mingozzi*

This paper presents a new exact algorithm for the Pickup and Delivery Problem with Time Windows (PDPTW) based on a set partitioning-like formulation. We describe a bounding procedure to find a near optimal dual solution of its LP-relaxation. The final dual solution is used to generate a reduced problem. The reduced problem is solved by an integer programming solver if it has moderate size; otherwise it is solved by branch-and-cut-and-price. Computational results on benchmark instances show that the new method outperforms the currently best known method.

## ■ TA-16

Tuesday 08:00-09:20

*Koenig*

### Set-valued Optimization

Stream: Multi-Objective Optimization and Decision Theory 2

*Invited session*

Chair: *Frank Heyde*, Institute of Mathematics, MLU Halle-Wittenberg, Theodor-Lieser-Str. 5, D-06099, Halle (Saale), Germany, heyde@mathematik.uni-halle.de

#### 1 - Vector optimization with infimum and supremum

*Andreas Löhne*, Institut für Mathematik, MLU Halle-Wittenberg, Theodor-Lieser-Straße 5, 06099, Halle (Saale), Germany, andreas.loehne@mathematik.uni-halle.de

It is possible to approach vector optimization by a consequent usage of infimum and supremum in an appropriate complete lattice. The corresponding theory is in appearance very similar to the scalar optimization theory. An overview on the concepts and results is given. This includes solution concepts, existence results, duality theory and several results for linear problems.

#### 2 - Optimality and duality for convex optimization problems with a set-valued objective

*Andreas Hamel*, Operations Research and Financial Engineering, Princeton University, Sherrerd Hall 224, 08544, Princeton, NJ, ahamel@princeton.edu

(1) A new solution concept for optimization problems with a set-valued objective is introduced which is related to dual variables in the images space. (2) A duality scheme is provided which produces all the results well-known in the scalar case. It is shown that this scheme yields the existence of solutions of the dual problems in the sense introduced in (1). (3) New conditions of the type "zero is in the subdifferential" and "the directional derivative is non negative" are given and shown to be as powerful as in the scalar case.

#### 3 - Directional derivative and subdifferential for set-valued convex and proper functions

*Carola Schrage*, c/ Migdia 53-4-2, 08788, Vilanova del Cami, carolaschrage@web.de

A set-valued directional derivative and a subdifferential in an appropriate dual space will be defined for set-valued functions with certain convexity and properness properties using a new set-valued "order difference". Under an additional inner point condition, the subdifferential is nonempty and a counterpart to the scalar max-formula can be shown.

#### 4 - Set-valued optimization in mathematical finance

*Frank Heyde*, Institute of Mathematics, MLU Halle-Wittenberg, Theodor-Lieser-Str. 5, D-06099, Halle (Saale), Germany, heyde@mathematik.uni-halle.de, *Andreas Hamel*

We will apply methods of set-valued optimization to problems of mathematical finance. The focus will lie on set-valued measures of risks and its use in portfolio optimization.

## ■ TA-17

Tuesday 08:00-09:20

*Rheinaue*

### Cutting and Packing 4

Stream: Cutting and Packing

*Invited session*

Chair: *Yuri Stoyan*, Department of Mathematical Modeling and Optimal Design, Institute for Mechanical Engineering Problems of the National Academy of Sciences of Ukraine, 2/10 Pozharsky St., 61046, Kharkov, Ukraine, stoyan@ipmach.kharkov.ua

#### 1 - A tutorial in irregular shape packing problems

*Julia Bennell*, School of Management, University of Southampton, Highfield, SO17 1BJ, Southampton, Hampshire, United Kingdom, jab2@soton.ac.uk, *Jose Fernando Oliveira*

Irregular shape packing has received increased research attention of the last 15 years. The evolution of solution approaches can be attributed to increased computer power and advances in geometric techniques as well as more sophisticated and insightful algorithm design. In this paper we will focus on the latter. Our aim is to draw on the literature to describe and evaluate the core approaches. We will explore different ways of representing the problem and mechanisms for moving between solutions. We will also propose where we see the future challenges for researchers in this area.

## 2 - Mathematical model and efficient algorithm for object packing problem

*Tatiana Romanova*, Department of Mathematical Modeling and Optimal Design, Institute for Mechanical Engineering Problems of the National Academy of Sciences of Ukraine, 2/10 Pozharsky St., 61046, Kharkov, Ukraine, sherom@kharkov.ua, *Yuri Stoyan*, *Nikolai Chernov*

The article is devoted to mathematical models and practical algorithms for solving the cutting and packing problems. We review and further enhance the main tool of our studies phi-functions. Those are constructed here for 2D and 3D objects. We also demonstrate that in all realistic cases the phi-functions and their derivatives can be described by quite simple formulas without radicals and other complications. Lastly, a general solution strategy using the phi-functions is outlined and illustrated by several 2D and 3D examples.

## 3 - Optimization packing problem of equal circles

*Yuri Stoyan*, Department of Mathematical Modeling and Optimal Design, Institute for Mechanical Engineering Problems of the National Academy of Sciences of Ukraine, 2/10 Pozharsky St., 61046, Kharkov, Ukraine, stoyan@ipmach.kharkov.ua, *Andrey Chugay*

The paper considers an optimization packing problem of equal circles into a region with a finite number of prohibited areas. A frontier of the region consists of circular arcs and line segments. A mathematical model is constructed. On the ground of characteristics of the model a solution strategy is offered. The strategy consists of a combination of an algorithm of generating starting points, the feasible direction method to calculate local maxima and a modification of the decremental neighborhood method to search for an approximation to the global maximum. Numerical examples are given.

## ■ TA-18

Tuesday 08:00-09:20

Lenné

### Optimization under Uncertainty

Stream: Mathematical Programming

Invited session

Chair: *Milan Hladik*, Department of Applied Mathematics, Charles University, Faculty of Mathematics and Physics, Malostranske nam. 25, 11800, Prague, Czech Republic, milan.hladik@matfyz.cz

#### 1 - New framework for supply chain decision making under uncertainty: an analysis of the computational effort

*Abhilasha Aswal*, Infosys Technologies Limited, Bangalore, India, #26/C Electronics City, Hosur Road, 560100, Bangalore, Karnataka, India, abhilasha.aswal@iiitb.ac.in, *G. N. Srinivasa Prasanna*

We present a new & intuitive approach for optimization under uncertainty, useful in supply chains. We couple convex optimization and information theory. Unique features of our work include the ability to qualitatively compare different future sets of assumptions (scenarios) using polytope geometry, and quantification of the Shannon information content in a scenario. Scenarios equivalent in information content to one another can be generated. Our optimization methods under these assumptions are fast (handle 1000's of nodes/products in minutes on laptops), even with non-convex cost breakpoints.

## 2 - Steiner tree problems under interval uncertainty

*Eduardo Álvarez-Miranda*, Escuela de Ingeniería Civil Industrial, Universidad de Talca, Curicó, Merced 437, 3340000, Curico, Chile, eduardo.alvmir@gmail.com, *Alfredo Candia-Véjar*, *Nelson Maculan Filho*

In this work we study the Steiner Tree (ST) Problem on Graphs under uncertainty, modeled by cost intervals in the objective function. For first time the problem is studied for both the Minmax Regret and the Robust (Bertsimas & Sim) approaches. MILP formulations with a polynomial number of variables and constraints are presented for both models based on structural properties proved valid for this problem.

The formulations are extended to model the Prize Collecting ST Problem, which is more attractive from a practical perspective when deterministic uncertainty is considered.

## 3 - Generalized linear fractional programming under interval uncertainty

*Milan Hladik*, Department of Applied Mathematics, Charles University, Faculty of Mathematics and Physics, Malostranske nam. 25, 11800, Prague, Czech Republic, milan.hladik@matfyz.cz

Data in many real-life problems suffer from inexactness. Herein we assume that we are given some intervals in which the data can simultaneously perturb. We consider a generalized linear fractional programming problem with interval data and present an efficient method for computing the range of optimal values. We consider also the inverse problem: How much can data of a real generalized linear fractional program vary such that the optimal values do not exceed some prescribed bounds. We illustrate the approach on a simple von Neumann economic growth model.

## ■ TA-19

Tuesday 08:00-09:20

Haber

### Evolutionary approaches

Stream: Metaheuristics

Invited session

Chair: *Marcelo Lisboa Rocha*, Computer Science, Universidade Federal do Tocantins, Av. NS 15, S/N — ALCNO 14 - Bloco 02 — Sala 21, 77020-210, Palmas, Tocantins, Brazil, marcelolisboarocho@yahoo.com.br

#### 1 - Storage arrangement on the yard for transshipment containers by meta-heuristics

*Etsuko Nishimura*, Graduate School of Maritime Sciences, Kobe University, Fukae, Higashinada, 658-0022, Kobe, Japan, e-nisi@maritime.kobe-u.ac.jp, *Akio Imai*

This study is concerned with the container storage arrangement on the container yard for the transshipment containers, in order to carry out the ship handling operations efficiently. Objective function is assumed that the total service time from the mega-containership to feeders and the waiting time for feeder ships. To facilitate the solution procedure we employ the heuristics based by Genetic Algorithm(GA) and Lagrangian relaxation(LR). As our computational results, at the mega-containership early arrival, the total service times obtained by LR are smaller than those done by GA.

#### 2 - A memetic algorithm for a stochastic single product network design model with lead time and safety stock considerations

*Behzad Bagheri*, Department of Industrial Engineering, University of Science and Culture, Ashrafi Esfahani Blvd, Park Street, 13145871, Tehran,

Tehran, Iran, Islamic Republic Of,  
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The single product network design model with lead time and safety stock considerations (SPNDLS) explicitly model the relationship between the flows in a supply chain network, lead times, and safety stock levels. In this paper, we propose a stochastic version of the SPNDLS which minimizes the sum of facility location, pipeline inventory, and safety stock costs over discrete scenarios. In addition, our model, namely SSPNDLS (stochastic SPNDLS) incorporates arbitrary demand variance at the retailers. A memetic algorithm is also proposed to solve SSPNDLS. Numerical instances are then presented.

### 3 - GRASP with path-relinking for the tridimensional Euclidean Steiner tree problem

Marcelo Lisboa Rocha, Computer Science,  
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Amit Bhaja, Flávio Montenegro, Nelson Maculan  
Filho

Given a set of fixed points in a tridimensional space with Euclidean metric, the Tridimensional Euclidean Steiner Tree Problem (TESTP) is that of finding a minimum length tree that spans all these points, introducing extra points, called Steiner points, if necessary. Although there is great interest on this problem, there are few methods that can produce reasonable solutions. In fact, TESTP is a NP-Hard problem. Here is proposed a GRASP with Path-ReLinking for TESTP. The computational results provided are superior to those obtained from the best heuristics reported in the literature.

## ■ TA-20

Tuesday 08:00-09:20

Mann

### DEA Methodology III

Stream: DEA and Performance Measurement

Invited session

Chair: Alireza Amirteimoori, Applied mathematics, Azad university, No. 2., Golsar, 41335-3516, Rasht, Guilan, ateimoori@iaurasht.ac.ir

#### 1 - Data envelopment analysis: a simultaneous measure of technical and allocative efficiency

Mosbah Ezzeddine, training observatory, Ministry of Education and training, bab bnet - Tunis, Tunisia, 1030, kasbah, tunis, Tunisia, ezzeddine\_m@yahoo.fr

ABSTRACT our paper aims to develop a model for measuring simultaneously technical and allocative efficiencies of all DMUs in one operation. For that, some postulates are introduced into basic CCR (1978) model. The first stipulates that a virtual efficient DMUs constitute with their original DMUs a new envelopment datas. The second takes that there is a DMU respecting condition of equality between marginal rate of substitution and input prices ratio. Those hypothesis lead for a new model measuring in one operation technical and allocative efficiency scores for all DMUs.

#### 2 - Proposition of the unified dea model including super-efficiency measure

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Seikei University, 3-3-1 Kichijoji-Kitamachi,  
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In CCR model, BCC model, additive model and SBM model, slacks are maximized. It corresponds to finding a point in the production possibility set that is the farthest point from each Decision Making Unit (DMU) to be evaluated, that is, the most difficult point to refer. We proposed the minimum distance models, which minimize a sum of slacks. The super-efficiency or SuperSBM model is similar to the minimum distance model. In this paper we propose the unified DEA model including super-efficiency measure and propose some efficiency measures.

#### 3 - Two-stage production process in data envelopment analysis

Alireza Amirteimoori, Applied mathematics, Azad university, No. 2., Golsar, 41335-3516, Rasht, Guilan, ateimoori@iaurasht.ac.ir

In DEA we normally assume that the produced outputs are perfect. However, in many real instances, some of the products are imperfect. In this case, the system under consideration is composed of two components: main system and repair shop. The main system consumes output to produce input. The outputs of the main system may be imperfect. The imperfect outputs need to be repaired in the repair shop. In this paper we will investigate the production system that consists of two stages arranged in series, where succeeding stage is fed by a mixture of external inputs and some of the outputs of the first stage.

#### 4 - Fuzzy bi-objective generalized data envelopment analysis

Jafar Pourmohammoud, Tabriz, 5375171379, Tabriz, pourmohammoud@azaruniv.edu

Data envelopment analysis (DEA) requires input and output data to be precisely known. This is not always the case in real applications. This work introduces a new fuzzy bi-objective generalized data envelopment analysis (F-Bi-GDEA) model and defines its efficiency. The new F-Bi-GDEA model is formulated as linear programming models and can be solved to determine fuzzy efficiencies of a group of decision-making units (DMUs).

## ■ TA-21

Tuesday 08:00-09:20

Hauptmann

### Applications of mathematical logic

Stream: Boolean Programming

Invited session

Chair: Ondrej Cepek, Theoretical Informatics and Mathematical Logic, Charles University in Prague, Malostranske namesti 25, 11800, Praha, Czech Republic, ondrej.cepek@mff.cuni.cz

#### 1 - On the chvatal ranks of knapsack problems

Béla Vizvári, Industrial Engineering, Eastern Mediterranean University, Gazimagusa, 10, Mersin, Turkey, vizvaribela@gmail.com

There is a famous result of Chvatal giving a theoretical iterative procedure, which determines the integer hull of a polyhedral set. It starts from the polyhedral set itself and in each iteration new cuts are introduced. This result is considered the theory of the Gomory method of integer programming. The simplest integer programming problem is the knapsack problem. The number of iterations in Chvatal's procedure is investigated in the case of some extremely simple binary knapsack problems. It is shown that the Chvatal rank can be high even in these cases.

#### 2 - Recognition of positive k-interval boolean functions

David Kronus, HEC - Management School, University of Liege, Batiment B31, Rue du Rectorat 7, 4000, Liege, Belgium, dave@matfyz.cz, Ondrej Cepek

The concept of representing Boolean functions using intervals of integers has been introduced in the area of optimizing automatic data generation for software testing. Intervals of integers represent Boolean function  $f$  if these intervals span just the integers having as their binary representation a truepoint of  $f$ . We introduce the original motivation and present an asymptotically optimal algorithm recognizing 1-interval and 2-interval functions. We conclude with some ideas about possible generalization of this algorithm for any number of intervals.

### 3 - A model for analysing microarray data using techniques of boolean functions

*Petr Kucera*, Faculty of Mathematics and Physics,  
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Praha 15, Czech Republic, kucerap@ktiml.mff.cuni.cz,  
*David Kronus, Ondrej Cepek*

We address in this work a problem of discovering dependencies among gene expression levels. The problem is formulated in mathematical terms as a search for a fully defined three valued function defined on three valued variables which is partially specified by the DNA microarray measurements. We present a model, which can be used for analysing this problem and which is strongly motivated by results in the area of logical analysis of data (LAD) and in the area of partially defined Boolean functions (pdBfs).

### 4 - Operational use of a lad model

*Louis-Philippe Kronek*, Laboratoire Leibniz-IMAG,  
Grenoble, France, louis-philippe.kronek@imag.fr,  
*Nadia Brauner, Sylvain Gravier, Frédéric Meunier*

When delivering a LAD model to physicians, we were confronted to the following questions: (1) In which order do I have to do the exams to minimize the cost (which can be the dangerousity of the exams) for tracking a disease in a population ? (2) Which are the 3 (or  $k$ ) exams that allow an efficient first selection. We compare those two questions to classical scheduling problems and derive complexity results. We also generalize the questions asking for a non dominated order of the exams. We study special cases and give algorithmical results.

## ■ TA-22

Tuesday 08:00-09:20

Arndt

### Reverse Logistics: Decision models and their Industrial Applications

Stream: OR and Environmental Management

*Invited session*

Chair: *Baptiste Lebreton*, Lehrstuhl für  
Umweltmanagement / Prof. Tuma, Universität Augsburg,  
WiWi-Fakultät, Universitätsstr. 16, 86159, Augsburg,  
Germany, bblebr@solutia.com

#### 1 - The definition and implementation of a competitive reverse logistics strategy at a plastic films manufacturer.

*Baptiste Lebreton*, Lehrstuhl für Umweltmanagement /  
Prof. Tuma, Universität Augsburg, WiWi-Fakultät,  
Universitätsstr. 16, 86159, Augsburg, Germany,  
bblebr@solutia.com

Company S, the world wide leader for the manufacturing of plastic films for the automotive and architectural glazing industry faced in 2006 the challenge of defining a reverse logistics strategy to protect its business and margins. Company's S customers were reselling production leftovers to free-riders, thus allowing them to access the market for plastic films by reextruding the leftovers into films. The presentation documents the motivation behind the development of a product collection strategy and the optimization models used to roll out this strategy worldwide.

#### 2 - A framework for configuration of procurement networks for secondary raw material using a hybrid system

*Alexander Uffinger*, University of Augsburg,  
Ganghoferstr. 4, 86157, Augsburg, Germany,  
alexander.uffinger@wiwi.uni-augsburg.de

Closed-loop Supply Chain Management is one of the most important concepts to realize a sustainable economy. Thereby the configuration of procurement networks for secondary raw materials is a key factor. The underlying decision problem can be classified as a SNP integrating a continuous location search and a technology selection. The presented framework suggests a structured procedure including a hybrid system. Thereby the hybrid system optimizes the configuration by combining a CPLEX solved MIP-Formulation with a heuristic local search approach. The framework is applied to the paper industry.

#### 3 - Reverse logistics network design: the impact of lead times and stochasticity

*Kris Lieckens*, University of Antwerp, Prinsstraat 13,  
2000, Antwerp, kris.lieckens@ua.ac.be, *Nico Vandaele*

An advanced strategic decision support model is developed for the efficient design of reverse logistics networks. Queuing relationships are integrated into a facility-allocation model to allow for lead time related costs and various sources of uncertainty. This extension is important because fast delivery times are key for the success of global closed-loop supply chains while variabilities complicate their organization. Appropriate flow and capacity levels are determined for transportation and production processes. A genetic algorithm solves this problem and a case study puts it into action.

#### 4 - A two-stage approach for collection network design and modeling reverse logistics activities in a white goods manufacturer

*Tülin Aktin*, Industrial Engineering Department,  
Istanbul Kültür University, Ataköy Campus, Bakirköy,  
34156, Istanbul, Turkey, t.aktin@iku.edu.tr, *Dicle Cevizci, H. Türkan Karaaslan*

Collection of used products, and product recovery requiring disposition decisions such as recycling, remanufacturing, repairing and disposal, are among the important issues for an environmentally conscious company. This study proposes a two-level optimization for modeling reverse logistics activities. The first stage aims to design a network, determining the location of collection centers and the amount of product returns. The output of this stage is fed into the second one, where disposition decisions are made. The framework is implemented in one of Turkey's leading white goods manufacturers.

## ■ TA-23

Tuesday 08:00-09:20

Planck

### Capacity Control

Stream: Demand, Pricing and Revenue Management

*Invited session*

Chair: *Claudius Steinhardt*, Mathematical Methods for  
Business and Economics, University of Augsburg,  
Universitätsstraße 16, 86159, Augsburg, Germany,  
claudius.steinhardt@wiwi.uni-augsburg.de

#### 1 - Revenue management in a make-to-order environment with forecasting errors

*André Hintsches*, Institute of Automotive Management  
and Industrial Production, Technische Universität

Braunschweig, Katharinenstr. 3, 38106,  
Braunschweig, Germany, a.hintsches@tu-bs.de,  
Thomas Spengler, Thomas Volling

Manufacturing companies in a make-to-order environment usually offer multiple products, face a stochastic demand, and a time-varying price for these products. The decision of order acceptance has a direct influence on the maximization of the overall contribution margin of the production network. We will present the results of a static and a dynamic approach for network revenue management and discuss their robustness concerning systematic forecasting errors. Both approaches are applied to a case study of a high performance alloy manufacturer.

## 2 - A dynamic bid-price approach to reduce risk in make-to-order revenue management

Kai Wittek, Institute of Automotive Management and Industrial Production, Technische Universität Braunschweig, Katharinenstr. 3, 38106, Braunschweig, Germany, k.wittek@tu-bs.de, Derya Eren Akyol, Thomas Spengler, Thomas Volling

In make-to-order revenue management, capacity control problems are typically solved by bid-prices, approximating the opportunity costs of accepting a customer order. When facing forecasting errors, this approximation becomes less accurate and the bid-price performance may deteriorate. We present a two step dynamic bid-price approach incorporating reactive elements to exploit online demand information and analyze its robustness. Further, a risk analysis is provided. Simulation results are based on the characteristics of a make-to-order steel manufacturer.

## 3 - Integration of capacity control techniques and vehicle routing

Joern Schoenberger, Chair of Logistics, University of Bremen, Wilhelm-Herbst-Straße 5, 28359, Bremen, Germany, jsb@uni-bremen.de, Herbert Kopfer

Accepting or rejecting transport orders is the most important decision task in operational freight transport planning. The profitability of consecutively arriving requests depends upon already accepted orders and the generated vehicle routes. In order to use the available capacities at highest efficiency, the integration of capacity control techniques seems to be promising. However, due to the high interdependencies of routed requests the allocation of capacities to a given request is hardly possible. We propose an approach to manage this challenge.

## 4 - Revenue management in the car rental industry: a numerical investigation of different modelling approaches

Claudius Steinhardt, Mathematical Methods for Business and Economics, University of Augsburg, Universitätsstraße 16, 86159, Augsburg, Germany, claudius.steinhardt@wiwi.uni-augsburg.de, Jochen Gönsch

Car rental companies provide different types of cars to business and leisure customers. In addition to uncertain demand to come, rental duration and return station are often spontaneously chosen and therefore not known in advance. In this talk, we present several extensions to traditional capacity control models for revenue management, coping with specific challenges like stochastic and transferable capacities, different customer segments, planned upgrades, or multiday rentals. Furthermore, we compare the performance of different approaches by a simulation study based on real-world data.

## ■ TA-24

Tuesday 08:00-09:20  
GSI - S 20

## Linear Semi-Infinite Optimization II

Stream: Semi-Infinite Optimization

Invited session

Chair: Marco A. López-Cerdá, Statistics and Operations Research, Alicante University, Ctra. San Vicente de Raspeig s/n, 3071, Alicante, Spain, marco.antonio@ua.es

### 1 - Sensitivity analysis in linear semi-infinite programming via partitions

Miguel Goberna, Estadística e Investigación Operativa, Universidad de Alicante, Ctra. San Vicente s/n, 03080, San Vicente del Raspeig, Alicante, Spain, mgoberna@ua.es, Tamas Terlaky, Maxim Todorov

We present sufficient conditions for the optimal value of a linear SIP problem to depend linearly on the size of the perturbations, when these perturbations involve either the cost coefficients or the right-hand-side function or both, and they are sufficiently small. Two kinds of partitions are considered. The first one consists of maximal regions on which the optimal value function is linear. The second class of partitions concerns the index set of the constraints through a suitable extension of the concept of optimal partition from ordinary to semi-infinite linear programming.

### 2 - An infinite-dimensional optimization approach to sets separation in normed spaces

Marco A. López-Cerdá, Statistics and Operations Research, Alicante University, Ctra. San Vicente de Raspeig s/n, 3071, Alicante, Spain, marco.antonio@ua.es

We present an algorithm for the strong separation of two bounded sets in a normed space, such that a semi-infinite optimization problem is solved at each step. Its global convergence is analyzed and a stopping criterion is also provided. The particular case of separation in the space  $L_p$  is approached in detail. We also propose an implementable modification of our algorithm for separating two bounded sets in  $L_p([a,b])$ , where  $[a,b]$  is an interval. Some computational experience is reported, and a stopping criterion is given for functions of bounded variation in  $L_2([a,b])$ .

### 3 - Distance to ill-posedness for convex semi-infinite inequality systems under affine perturbations

F. Javier Toledo-Melero, Operations Research Center, Miguel Hernández University, Avda. de la Universidad, s/n, 03202, Elche, Alicante, Spain, javier.toledo@umh.es, Maria Josefa Cánovas, Juan Parra

In this talk we tackle the question of how much a given convex semi-infinite inequality system has to be perturbed in order to destroy its consistency/inconsistency. In our setting the set indexing the constraints is assumed to be arbitrary (possibly infinite and with no structure at all) and each inequality is allowed to be independently perturbed by means of an affine perturbation. In this way we extend to this convex framework some results provided in the linear case.

## ■ TA-25

Tuesday 08:00-09:20

GSI - S 25

### Classes of Cooperative Games

Stream: Cooperative Game Theory

*Invited session*

Chair: *Natividad Llorca*, Operations Research Center, Miguel Hernández University, Avda. del Ferrocarril s/n, (Edif. Torretamarit), 03202, Elche, Spain, nllorca@umh.es

#### 1 - Balanced per capita contributions and level structure of cooperation

*Vidal-Puga Juan J.*, Universidade de Vigo, 36005, Pontevedra, Spain, vidalpuga@uvigo.es, *Gómez-Rúa María*

We define a new value for games with a level structure and introduce a new property in these kind of games, called balanced per capita contributions, related with other properties in the literature. Furthermore, we provide an axiomatic characterization of this value using this new property.

#### 2 - Multilinear extensions for cooperative games in generalized characteristic function form

*Conrado M. Manuel*, Statistics and Operation Research III, Complutense University of Madrid, Avenida Puerta de Hierro s/n, 28040, Madrid, Spain, Spain, conrado@estad.ucm.es, *Enrique González-Arangüena, Guillermo Owen*

A cooperative game in generalized characteristic function form is a TU game such that the worth of each coalition depends not only on its members but on the order in which they incorporate to the coalition. In this communication a family of allocation rules for these games is considered. Moreover the Multilinear Extension of Owen is generalized so that the previous family of rules can be obtained from this generalization similarly as the Shapley value is obtained from the ME. The obtained results apply when calculating centralities for nodes in a digraph using a game-theoretical approach.

#### 3 - Shortest path tree games in wireless multi-hop networks (wmns)

*Nayat Horozoglu*, Operational Research Group, London School of Economics and Political Science, Houghton Street, WC2A 2AE, London, United Kingdom, n.horozoglu@lse.ac.uk, *Katerina Papadaki*

A WMN is composed of a root node that provides connectivity to the Internet to a number of geographically separated users, where users can relay information for other users. If all the users cooperate, then they can use their shortest path tree to route the information. Given the shortest path cost of all the transmissions, the users need to find a mutually satisfactory cost allocation. We formulate the problem as a cooperative game, derive structural properties of the game, and investigate possible cost allocation concepts.

#### 4 - Multi-choice clan games and their core

*Natividad Llorca*, Operations Research Center, Miguel Hernández University, Avda. del Ferrocarril s/n, (Edif. Torretamarit), 03202, Elche, Spain, nllorca@umh.es, *Mariana Rodica Branzei, Joaquín Sánchez-Soriano, Stef Tijis*

In this paper we consider market situations with two corners. One corner consists of a group of powerful agents with yes-or-no choices and clan behavior. The other corner consists of non-powerful agents with multi-choices regarding the extent at which cooperation with the clan can be achieved. The focus is on the analysis of the core of multi-choice clan games. Several characterizations of multi-choice clan games by the shape of the core are given, and the connection between the convexity of a multi-choice clan game and the stability of its core is studied.

## ■ TA-26

Tuesday 08:00-09:20

GSI - S 35

### Travelling Salesman Problems

Stream: Discrete Optimization

*Contributed session*

Chair: *Ali Eshragh Jahromi*, School of Mathematics and Statistics, University of South Australia, School of Mathematics and Statistics, Mawson Lakes Campus, 5095, Adelaide, South Australia, Australia, Ali.EshraghJahromi@unisa.edu.au

#### 1 - A modified electromagnetism-like algorithm for travelling salesman problems with time windows

*Alkin Yurtkuran*, Industrial Engineering Department, Uludag University, Uludag University, Industrial Engineering Department, 16059, Bursa, Turkey, alkin@uludag.edu.tr, *Erdal Emel*

In this study, we propose Electromagnetism-like Algorithm (EMA) to solve traveling salesman problem with time windows. EMA is a population based method which simulates attraction-repulsion mechanism between charged particles. Particles move towards the optimum, according to the force applied on them. Original to this study, particle coordinates are bounded by time-windows of the corresponding customers, by which the algorithm is forced to search only in feasible regions. The results of the numerical experiments show that EMA generates optimal or near-optimal results within acceptable CPU times.

#### 2 - The new formulation for the traveling repairman problem

*Imen Ome Ezzine*, Quantitatives Methods, FSEG SFAX, pharmacie najiba ellouze sakiet ezzit, 3021, sfax, omezineimen@yahoo.fr, *Frédéric Semet, Habib Chabchoub*

The Traveling Repairman Problem is a variant of the Traveling Salesman Problem in which a repairman visits the customers located at the nodes of the graph in such a way that the overall waiting times of the customers is minimized. The objective is to minimize the sum of the arrival times at the vertices including the initial vertex associated with the depot. In this presentation we propose a new integer programming formulation for the TRP. The latter was implemented within the solver CPLEX 11.0 and tested on generated instances. It appears to be competitive with previously proposed models.

#### 3 - An exact method for the double TSP with multiple stacks

*Jesper Larsen*, Management Engineering, Technical University of Denmark, Produktionstorvet, Building 426, 2800, Kgs. Lyngby, Denmark, jesla@man.dtu.dk, *Richard Lusby, Matthias Ehrgott, David Ryan*

The double travelling salesman problem with multiple stacks is a pickup and delivery problem in which all pickups must be completed before any deliveries can be made. The aim of the problem is to produce a stacking plan for the pallets in the container that minimizes the total transportation cost. The container cannot be repacked at any stage. Here we present an exact solution method based on matching k-best TSP solutions for each of the separate pickup and delivery TSP problems and show that previously unsolved instances can be solved within seconds using this approach.

#### 4 - A hybrid simulation-optimization algorithm for the Hamiltonian cycle problem

*Ali Eshragh Jahromi*, School of Mathematics and Statistics, University of South Australia, School of Mathematics and Statistics, Mawson Lakes Campus, 5095, Adelaide, South Australia, Australia,  
Ali.EshraghJahromi@unisa.edu.au, *Jerzy Filar*,  
*Michael Haythorpe*

This new hybrid algorithm alters the Hamiltonian cycle problem to the travelling salesman problem. Thus, there is a stochastic matrix updated as in the Cross Entropy method and used to set a suitable linear programming model. If the solution of the latter yields any tour, the graph is Hamiltonian. Numerical results reveal that when the size of graph is small, there is a high chance to terminate the algorithm in its Cross Entropy component. However, for larger graphs, in most of the tests the algorithm terminated in its optimization component.

### ■ TA-27

Tuesday 08:00-09:20

GSI - S 21

#### Knowledge Discovery and Data Mining 1

Stream: Knowledge Discovery and Data Mining

*Invited session*

Chair: *Luís Cavique*, Universidade Aberta, Rua da Escola Politécnica 147, 1269-01, Lisboa, Portugal,  
lcavique@univ-ab.pt

##### 1 - Cliques of proverbial knowledge

*Matthias Funk*, Mathematic, University of the Azores,  
Rua Gonçalves, 9500, Ponta Delgada, mfunk@uac.pt

By analysing a huge inquiry we get a score matrix about the pairwise common knowledge of proverbs. By vanish all components except the line maximums we isolate 8 oriented sub-graphs. Interpreted as (score-) layered networks we look in each layer for Cliques because they are the base of all cyclic sub-paths. We find a group of 17 structural important Cliques for the characterisation of the regional proverbial usage because each of them form a kind of local sink by the absence of any link to an affluent layer.

##### 2 - Networks in an oral culture study: finding the region of origin for users of proverbs

*Armando Mendes*, Mathematics, Azores University,  
Rua da Mãe de Deus, 9501-801, Ponta Delgada,  
Azores, amendes@uac.pt, *Matthias Funk*, *Áurea Sousa*

Proverbs are a form of popular knowledge present in every culture. A project for proverbial sentences identification produced a data base with 25000 proverbs and 1000 recognition surveys. This work is aimed to extract knowledge from the data base in order to realize the influence of the locations where inquiries have been living and proverbs recognized. Link Analysis is used to highlight the more common pairs of proverbs in the network. Symbolic data tables with HCA algorithms are used to induce clusters of network nodes. The results are compared with domain knowledge, with some surprises.

### 3 - An algorithm to find the k-clique minimum cover in an undirected graph

*Luís Cavique*, Universidade Aberta, Rua da Escola Politécnica 147, 1269-01, Lisboa, Portugal,  
lcavique@univ-ab.pt

In social network analysis, a k-clique is a relaxed clique. A k-clique in a graph is a sub-graph where the distance between any two nodes is no greater than k. The visualization of a small number of vertices can be easy to perform in a graph; however when the number of vertices and edges increases the visualization becomes incomprehensible. In this talk, we proposed a way to obtain a general view of the graph. To find a k-clique cover in an undirected graph, firstly a large set of k-cliques is generated, and secondly the set covering heuristic is used to discover the graph cover.

### ■ TA-28

Tuesday 08:00-09:20

GSI - S 1

#### An Introduction to Vehicle Routing and Network Planning with the Decision Support System TRANSIT

Stream: Workshops

*Workshop session*

Chair: *Tore Grünert*, GTS Systems and Consulting GmbH,  
Raiffeisenstr. 10, 52134, Herzogenrath, Germany,  
gruenert@gts-systems.de

##### 1 - An introduction to vehicle routing and network planning with the decision support system transit

*Tore Grünert*, GTS Systems and Consulting GmbH,  
Raiffeisenstr. 10, 52134, Herzogenrath, Germany,  
gruenert@gts-systems.de

to be announced

### ■ TA-29

Tuesday 08:00-09:20

GSI - S 2

#### Computational Economics 2

Stream: Financial Modelling

*Invited session*

Chair: *Ronald Hochreiter*, Statistics and Decision Support Systems, University of Vienna, Universitaetsstrasse 5,  
1010, Vienna, Austria, ronald.hochreiter@univie.ac.at

##### 1 - Network of firms: an analysis of integrated ownership

*Giulia Rotundo*, Dep. of Business, Technological and Quantitative Studies, University of Tuscia, Faculty of Economics, via del Paradiso, 47, 01100, Viterbo, Italy,  
Italy, giulia.rotundo@uniroma1.it, *Anna Maria D'Arcangelis*

This paper aims to provide a network analysis of the relationships of shareholders in the Italian Stock Market for understanding the relevance of portfolio diversification in integrated ownership and firms control. The analysis combines both a complex network and an operational research approach. The former is used for statistical analyses on portfolio diversification. The latter estimates integrated ownership considering the paths on the network, and it emphasizes the difference between ownership and control. Data were retrieved through CONSOB, AIDA, BANKSCOPE and ISIS databases.

## 2 - Effectiveness of the monopoly regulation on the basis of rate of return regulation

*Michal Fendek*, Department of Operations Research and Econometrics, University of Economics Bratislava, Dolnozemska cesta 1/b, 85235, Bratislava, Slovakia, fendek@euba.sk, *Eleonora Fendekova*

Traditional methodological tool for price regulation applied by price regulators to set maximum price of network industries products is the regulation on the basis of the rate of return regulation.

In the paper we will analyze effectiveness of this very frequently used scheme for monopoly price regulation. On the basis of the firms behavior in the conditions of regulation we show that in this regulatory scheme the monopoly has the tendency to respond to the tightening of the regulatory conditions by increasing the volume of used capital.

## 3 - Application of the price regulation models in the network industries market in slovakia

*Eleonora Fendekova*, Department of Business Economics, University of Economics Bratislava, Dolnozemska cesta 1/b, 85235, Bratislava, Slovakia, nfendek@euba.sk, *Michal Fendek*

Monopoly in modern market structure economically developed countries is acting within the legitimate market conditions and its position is determined by the real market situation. With regard to analysis of equilibrium in network industries models it is important to point out that except for competition policy protection the state fulfils another specific task — regulation of network industries.

The goal of the submitted paper is to present the results of application of models for determination of maximum prices and tariffs of goods of network industries in Slovak national markets.

## ■ TA-30

Tuesday 08:00-09:20

GSI - S 26

### Knowledge Discovery for Decision Support I

Stream: Knowledge Discovery for Decision Support

*Contributed session*

Chair: *Maria Teresinha Arns Steiner*, Mathematics, Federal University of Parana, Rua Padre Anchieta, 1231, ap. 31, 80730-000, Curitiba, Parana, Brazil, tere@mat.ufpr.br

#### 1 - Rough sets and principal components analysis: a comparative study on customer database attributes selection

*Fabio Pereira*, Industrial Engineering Post Graduation, Uninove University, Francisco Matarazzo Av., 612 São Paulo-Brasil, 05001100, São Paulo, São Paulo, Brazil, fabio.pea@gmail.com, *Renato Sassi*, *Rafael Espirito Santo*

The databases of real world contain a huge volume of information; however, part of these data are not interesting for the knowledge extraction. So, data are preprocessed for reducing the amount of information and selecting more relevant attributes. This paper addresses a contrastive study between Rough Sets and Principal Components Analysis on Customer Database attributes selection. The experiments were carried out using the Insurance Company Database to evaluate a Self-Organizing Maps clustering. The objective is to investigate the capacity of these techniques for application in databases.

## 2 - Visual data mining techniques applied to Itaipu dam readings data

*Maria Teresinha Arns Steiner*, Production Engineering, UFPR, R. Pe. Anchieta, 1231 - Ap. 31, 80730-000, Curitiba, Pr, tere@ufpr.br, *Pedro Steiner Neto*, *Marco Aurelio Silva Neto*, *Rosangela Villwock*, *Sergio Scheer*, *Andrea Sell Dyminski*

Itaipu, the greatest hydroelectric in operation in the world, has more than 2,200 monitoring instruments, which have been storing readings in a data base for more than 30 years. Dealing with such a large quantity of data in data bases are non trivial problems during the search for "knowledge" from these data. In this paper, Visual Data Mining algorithms were used to analyze data collected from Itaipu dam. The main objective was to establish relations among variables in order to detect undesired failures in the dam security and integrity.

## 3 - Adaptive decision making by reasoning based on relevant logics

*Jingde Cheng*, Department of Information and Computer Sciences, Saitama University, 255 Shimo-Okubo, Sakura-Ku, 338-8570, Saitama, Japan, cheng@ics.saitama-u.ac.jp

We propose a new method for Decision Making: Adaptive decision making by logical reasoning based on various relevant logics. The basic idea of our adoptive decision making method is to explicitly separate the underlying logic system, reasoning/computing mechanism, and empirical knowledge in any decision making process such that both underlying logic system and empirical knowledge can be revised/replaced in various decision making processes by logical reasoning performed by an area-independent, task-independent, general-purpose reasoning mechanism.

## ■ TA-31

Tuesday 08:00-09:20

GSI - S 34

### Strategic games

Stream: Noncooperative Games

*Invited session*

Chair: *Ignacio García-Jurado*, Department of Mathematics, Coruna University, Faculty of Computer Science, Campus de Elvina, 15071, Coruna, Spain, igjurado@udc.es

#### 1 - Protective behavior in competitive environments

*Manuel Alfredo Mosquera Rodríguez*, Statistics and Operations Research, University of Vigo, Edificio Jurídico-Empresarial, Campus Ourense, 32004, Ourense, Ourense, Spain, mamrguez@uvigo.es, *M<sup>a</sup> Gloria Fiestras-Janeiro*

A two-person non-cooperative game is a competitive environment if agents show antagonistic interests. Matrix games are competitive environments. Several extensions of the class of matrix games appear in the literature. Borm et al. (2009) compare these extensions with regard to their sets of Nash equilibria and protective strategy profiles. They also prove that the set of proper equilibria and the set of protective strategy profiles coincide in unilaterally competitive games. We focus on the characterization of the protective behavior in several classes of competitive environments.

#### 2 - Strategic absentmindedness in finitely repeated games

*Manuel A. Pulido Cayuela*, Estadística e Investigación Operativa, University of Murcia, Campus de Espinardo. Facultad de Matemáticas, 30100, Murcia, Murcia, Spain, mpulido@um.es, *Ignacio*

*García-Jurado, Natividad Llorca, Ana Meca, Joaquín Sánchez-Soriano*

In this paper we consider finitely repeated games in which players can unilaterally commit to behave in an absentminded way in some stages of the repeated game. We prove that the standard conditions for folk theorems can be substantially relaxed when players are able to make this kind of compromises, both in the Nash and in the subgame perfect case. We also analyze the relation of our model with the repeated games with unilateral commitments studied, for instance, in García-Jurado et al. (2000).

### 3 - Delegation equilibrium in strategic games

*Ignacio García-Jurado*, Department of Mathematics, Coruna University, Faculty of Computer Science, Campus de Elvina, 15071, Coruna, Spain, [igjurado@udc.es](mailto:igjurado@udc.es), *Eyal Winter, Luciano Mendez-Naya, Jose Mendez-Naya*

In this paper we introduce and analyze the concept of delegation equilibrium in strategic games. A delegation equilibrium of a strategic game is a profile that: (a) is a Nash equilibrium in a game of delegates, and (b) no player can gain by changing his delegate, a delegate being a new player with a (possibly) different utility function which can be controlled by the original player who appoints the delegate. The main result of this paper is that every finite strategic game has a delegation equilibrium.

## ■ TA-32

Tuesday 08:00-09:20

GSI - S 4

### Agent-Based Modelling

Stream: Agent-Based Modelling

*Invited session*

Chair: *Massimo Genoese*, Institute for Industrial Production, University of Karlsruhe, Hertzstraße 16, 76187, Karlsruhe, Germany, [massimo.genoise@kit.edu](mailto:massimo.genoise@kit.edu)

#### 1 - Modelling the usage of storage systems in reserve markets

*Fabio Genoese*, Energy Policy and Energy Systems, Fraunhofer ISI, Breslauer Str. 48, 76139, Karlsruhe, [fabio.genoise@isi.fraunhofer.de](mailto:fabio.genoise@isi.fraunhofer.de)

German electricity markets for reserve energy are organised as pay as bid auctions. Reserve markets might become an important source of revenues for owners of electricity storage systems. A model will be presented which simulates the main aspects of such a market. In the simulation, several storage owner agents with different storage systems will compete against each other. A storage owner's goal is to maximize the daily profits on a day-ahead reserve market.

#### 2 - Agent-based simulations in energy markets: the devil is in the details

*Augusto Rupérez Micola*, IMD, Chemin de Bellerive, 21, CH 1006, Lausanne, [augusto.ruperezmicola@imd.ch](mailto:augusto.ruperezmicola@imd.ch), *Albert Banal-Estanol*

This paper uses an agent-based model of wholesale electricity markets to explore issues of model validity and consistency. Our simulations address the two main methodological challenges of the agent-based model's literature. We address the issues of software standardisation and theoretical validation. We study several supply and demand specifications and propose an algorithm based on the "experience weighted attraction model" (Camerer and Ho, 2002), which encompasses the existing behavioural algorithms of the literature.

### 3 - A library of agent-based artificial intelligence in any-logic modelling environment

*Enrique Kremers*, EIFER, Universität Karlsruhe, Emmy-Noether-Strasse 11, 76131, Karlsruhe, Germany, [kremers@eifer.org](mailto:kremers@eifer.org), *Pablo Viejo, Nicola Apicella*

This paper presents a bibliographical review, from where a classification of artificial intelligence in agent-based models is derived. From it, elemental units for intelligent behaviour are defined. Building blocks have been modelled as a library arranged by levels of intelligence. The proposed library allows a personalized combination of those elements, allowing customized agents to be rapidly and easily assembled. Depending on the complexity of each agent, the library can be used for the development of behaviours through decision-making involving memory or strategic planning.

### 4 - Agent-based modelling of the german electricity market

*Massimo Genoese*, Institute for Industrial Production, University of Karlsruhe, Hertzstraße 16, 76187, Karlsruhe, Germany, [massimo.genoise@kit.edu](mailto:massimo.genoise@kit.edu), *Dominik Möst, Wolf Fichtner*

Agent-based modelling (ABM) of electricity markets shows an increasing popularity amongst electricity market modellers. The present agent based model is based on detailed fundamental data of the German electricity market. A mark-up function is used to include fixed costs in the price bid of electricity generators. The values of this function depend on the scarcity of the production capacities. In this contribution, we analyze the use of a simple reinforcement learning algorithm to improve the mark-up function. The agents' goal is to maximize the daily profits on a spot market for electricity.

## ■ TA-33

Tuesday 08:00-09:20

GSI - S 7

### Methods for linear inequalities

Stream: Linear Optimization

*Contributed session*

Chair: *Sergei Chubanov*, University of Siegen, Hoelderlinstr. 3, Siegen, Deutschland, 57076, Siegen, Germany, [sergei.chubanov@uni-siegen.de](mailto:sergei.chubanov@uni-siegen.de)

#### 1 - A divide and conquer algorithm for linear inequalities

*Sergei Chubanov*, University of Siegen, Hoelderlinstr. 3, Siegen, Deutschland, 57076, Siegen, Germany, [sergei.chubanov@uni-siegen.de](mailto:sergei.chubanov@uni-siegen.de)

Our algorithm for solving systems of linear inequalities belongs to the class of divide and conquer algorithms. At the same time it can be viewed as a relaxation-type algorithm for linear programming. We analyze the running time and compare the algorithm with the relaxation method of Agmon and of Motzkin and Schoenberg.

#### 2 - Interior-point methods solver based on kernel functions for linear optimization

*El Ghami Mohamed*, Departement of Informatics, University of Bergen, Thormøhlensgate 55 N, 5008, Bergen, Norway, [melghami@ii.uib.no](mailto:melghami@ii.uib.no), *Ivan Ivanov, Steihaug Trond*

In this paper we present the theory and practical aspects of implementing the path following interior point methods for linear optimization LP-IPM, based on kernel function. We will investigate the influence of the choice of the kernel function on the computational behavior of the generic primal-dual algorithm for Linear Optimization. We find that the finite kernel function gives the best results for more than 50 percent of the tested problems.

### 3 - An infinite version of farkas' lemma and infinite linear programming on a purely linear-algebraic basis

*David Bartl*, Department of Mathematics, University of Ostrava, 30.dubna 22, 701 03, Ostrava, Czech Republic, bartl@osu.cz

We shall report an infinite version of Farkas' Lemma. The Lemma involves an infinite number of linear constraints and is formulated in an infinite-dimensional vector space where no additional structure, such as topology, is assumed. We shall also report the corresponding Duality Theorem for infinite linear programming. Though the results can be formulated in the setting of two vector spaces over a common (possibly skew) field with linear ordering, one of the two spaces being linearly ordered too, we shall present only the real case of the results for clarity and simplicity.

## ■ TA-34

Tuesday 08:00-09:20

GSI - S 8

### Computational Statistics

Stream: Computational Statistics

*Invited session*

Chair: *Pakize Taylan*, Mathematics, Dicle University, 21280, Diyarbakir, Turkey, ptaylan@metu.edu.tr

#### 1 - A classification problem of credit risk rating investigated and solved by optimization of the roc curve

*Efsun Kürüm*, Financial Mathematics, Institute of Applied Mathematics, ODTÜ PTT Subesi ODTÜ, 06531, Ankara, efsun.kurum@gmail.com, *Kasirga Yildirak*, *Gerhard-Wilhelm Weber*

We try to classify borrower firms into rating classes with respect to their probability of default. This necessitates the finding of thresholds between rating class. We employed ROC analysis to assess the distinction power of our model about default and non-default. Therefore, we optimize the area under ROC curve and imply model accuracy. Thus, a constrained optimization problem is carefully modelled and turned to a penalized sum-of-squares problem of non-linear regression. We conclude with a discussion of the structural frontiers, an outlook and invitation to future work.

#### 2 - Comparing four methods of handling missing data in partial least square (pls)

*Jastini Jamil*, Operation and Information Management, School of Management, University of Bradford, Emm Lane, BD9 4JL, Bradford, England, United Kingdom, jbmohdj1@bradford.ac.uk, *James Wallace*

The main objective of this work is to bring up in discussion a problem that could affect the quality of estimators and the validation of the models- the missing data. The techniques used for comparison are expectation maximization (EM), mean substitution (MS), regression imputation (RS) and case wise (CW). To make the comparison, this issue will be applied to a Customer Satisfaction Models (CSM) using data taken from previous research. Overall, it was concluded that EM is the best method to be adopted in case of missing data completely at random.

### 3 - Model selection using inductively generated set

*Vadim Strijov*, Computing Center of the Russian Academy of Sciences, Klara Zetkin 13-79A, 127299, Moscow, Russian Federation, strijov@ccas.ru

Model selection is one of the most important subjects of Machine learning. An algorithm of model selection depends on the class of models and on the investigated problems. In the lecture the problems of regression analysis will be observed. Linear as well as nonlinear regression models will be considered. The models are supposed to be inductively generated during the selection process. Properties of Lars, Optimal brain surgery and Bayesian coherent inference algorithms will be analyzed in the light of model selection.

## ■ TA-35

Tuesday 08:00-09:20

GSI - S 9

### Mixed Methods Interventions in Forestry

Stream: Facilitated Modelling Interventions

*Invited session*

Chair: *Pekka Leskinen*, Research Programme for Production and Consumption, Finnish Environment Institute, Joensuu, Finland, pekka.leskinen@ymparisto.fi

#### 1 - Supporting problem structuring by quantitative techniques in the case of regional forest programmes

*Pekka Leskinen*, Research Programme for Production and Consumption, Finnish Environment Institute, Joensuu, Finland, pekka.leskinen@ymparisto.fi, *Teppo Hujala*, *Jukka Tikkanen*, *Annika Kangas*

In Finland, regional forest programmes promote forest policy in privately owned forests. The decision problem is complex and several, mutually incoherent problem definitions can be used. Various quantitative techniques can be utilized to support problem structuring. We consider so-called Q-method and compare its characteristics to the well-known Likert-scale when assessing stakeholders' opinions towards regional forest policy. We consider also Cognitive Mapping and provide some ideas of how the emerged policy options can be further prioritized by statistical simulation techniques.

#### 2 - Top-down and bottom-up - combining soft and hard methods in the hierarchical planning of state-owned forests

*Teppo Hujala*, Department of Forest Resource Management, University of Helsinki, P.O. Box 27, FI-00014, University of Helsinki, Finland, Teppo.Hujala@helsinki.fi, *Mikko Kurttila*, *Veikko Hiltunen*, *Annika Kangas*, *Jouni Pykäläinen*, *Pekka Leskinen*

State forests produce multiple benefits for the society. Participative planning in these forests is a common practice at local levels. Problems may arise when the plans of separate local planning processes are summed up because the result should correspond to national aims. Is it possible to combine meaningfully local, more discursive planning process and the national budget allocation-type decision problems? This presentation responds to the evident need of mixing decision aid methods by illustrating how hierarchical planning might be resolved via hardening the soft and/or softening the hard.

#### 3 - Mapping indicator models: from intuitive problem structuring to quantified decision making in sustainable forest management

*Harald Vacik*, Department of Forest and Soil Sciences, Institute of Silviculture, Peter Jordanstr. 82, A-1190,

Vienna, harald.vacik@boku.ac.at, *Bernhard Wolfslehner*

A Cognitive mapping (CM) approach is used for structuring indicator models in sustainable forest management. Different maps are derived based on existing sustainability concepts. For the analysis of management alternatives we employ the Analytic Network Process (ANP) which takes into account the structure of the indicator maps formed. We test the hypothesis that in a joint application the centrality within CM corresponds to cumulative eigenvalue-based priorities of indicators in the ANP. The benefits and implications of combining qualitative and quantitative decision analysis are discussed.

## ■ TA-36

Tuesday 08:00-09:20

GSI - S 11

### Reducing customer delays in service operations: modelling approaches

Stream: Stochastic Models for Service Operations

*Invited session*

Chair: *Inneke Van Nieuwenhuysse*, Research Centre for Operations Management, K.U.Leuven, Naamsestraat 69, Office 04.112, 3000, Leuven, inneke.vannieuwenhuysse@econ.kuleuven.be

#### 1 - The optimization of an airline check-in area

*Nico Vandaele*, Faculty of Applied Economics, University of Antwerp, Prinsstraat 13, 2000, Antwerp, Belgium, nico.vandaele@ua.ac.be, *Kris Lieckens*

Airline companies are not only pushed to low cost operation, but they also have to comply with service level agreements. To this end, a dynamic queueing based decision tool is constructed which enables them to determine the optimal number of check-in desks, taking into account flight schedules, estimated number of booked seats and explicit constraints on customer performance requirements. As passengers proceed through the airport, issues like queue lengths and waiting times may contribute to a positive experience. It is an integer, non-linear problem that is optimized by a genetic algorithm.

#### 2 - Appointment-driven queueing systems

*Stefan Creemers*, K.U.Leuven, 3000, Leuven, Belgium, stefan.creemers@econ.kuleuven.be, *Marc Lambrecht*

Many service systems are appointment-driven. In such systems, customers make an appointment and join an external queue (the "waiting list"). At the appointed date, the customer arrives at the facility, joins an internal queue and receives service during a service session. Afterwards, he leaves the system. Important measures of interest include the size of the waiting list, the waiting time at the service facility, server idle time and server overtime. These performance measures may support strategic decision making concerning server capacity. We develop a new model to address these issues.

#### 3 - Delay optimization by queueing and simulation

*Nico van Dijk*, Quantitative Economics, University of Amsterdam, Roetersstraat 11, 1018 WB, Amsterdam, Netherlands, N.M.vanDijk@uva.nl, *Erik van der Sluis*

Should we pool or not? First, an instructive example is addressed of two parallel queues. It already shows the necessary and fruitful combination of queueing and simulation. Next, the combined approach is also shown to be fruitful for practical optimization of call centers and MRI scans.

#### 4 - A survey of literature for an efficient planning of operating theater

*Arnauld Hanset*, 151 chaus?e de Binche, 7000, Mons, arnauld.hanset@fucam.ac.be, *Nadine Meskens*

The scheduling of operating theater is critical for an efficient management of hospital. So it is not surprising to notice that the literature of the domain abounds in approaches based on mathematical models and metaheuristics. Therefore, in this paper our aim is to describe what we have observed as human (preferences, skills) and materials (availability of resources) constraints in the scheduling of operating theatre in Belgian hospitals. After that we compare with the literature and look what the others researches took into account as constraints to resolve this scheduling problem.

## ■ TA-37

Tuesday 08:00-09:20

GSI - S 12

### Multi-Objective Decision Making

Stream: Decision Analysis

*Contributed session*

Chair: *Hachem Slimani*, Laboratory of Modelling and Optimization of Systems LAMOS, Operational Research Department, University of Bejaia, 06000, Bejaia, Algeria, haslimani@gmail.com

#### 1 - An interactive probabilistic multi-criteria sorting algorithm

*Aslı Gül Buğdaci*, Industrial Engineering, Middle East Technical University, ODTÜ Endüstri Mühendisliği, Oda no:325 ODTÜ, 06531, Ankara, Turkey, asligul@ie.metu.edu.tr, *Murat Koksalan*

We aim to classify alternatives evaluated in multiple criteria among preference ordered classes assuming an underlying additive utility function. We develop a probabilistic classification method by calculating probability of an alternative being in each class. We assign alternatives to classes based on threshold probabilities. We require the decision maker to place an alternative to a class when no alternatives satisfy the required thresholds. We find new probabilities and repeat the procedure until all alternatives are classified.

#### 2 - Robustness in multi-objective optimization based on a user perspective

*Peter Lindroth*, Mathematics, Chalmers University of Technology / Volvo 3P, Chalmers Tvärgata 3, SE-41296, Gothenburg, Sweden, peter.lindroth@chalmers.se, *Christoffer Cromvik*

The question of robustness is essential for practical problems that are sensitive to small perturbations in the variables or the model parameters. We present a new definition of robustness of solutions to multi-objective optimization problems. The definition is based on an approximation of the underlying utility function for each decision maker. We show an efficient computational procedure to evaluate robustness, and we present numerical results for real-world problems.

#### 3 - Combined dematel technique with vikor method for improving environment watershed plan stragy

*Yi-Chun Chen*, Graduate Institute of Civil and Hydraulic Engineering, Feng Chia University, No. 100 Wenhwa Rd., Seatwen, 40724, Taichung, Taiwan, chen.vivien@gmail.com

Combined DEMATEL technique with VIKOR method was developed to solve MCDM problems for multi-criteria optimization of complex systems. It was multi-criteria with the network relationship map, dependence and feedback, conflicting and non-commensurable among criteria, assuming that compromising is acceptable for conflict resolution, the decision-maker wants a solution that is the closest to the ideal/aspiration solution and the alternatives are evaluated according to all established criteria. Therefore, this study proposes a novel model for improving environment watershed plan strategy.

#### 4 - Characterization of solutions in multiobjective programming under weak invexity

*Hachem Slimani*, Laboratory of Modelling and Optimization of Systems LAMOS, Operational Research Department, University of Bejaia, 06000, Bejaia, Algeria, [haslimani@gmail.com](mailto:haslimani@gmail.com), *Mohammed Said Radjef*

Every vector Kuhn-Tucker (Fritz-John) point is weakly efficient or efficient for a constrained multiobjective programming has characterized by different kinds of invex functions, see Osuna et al. 1999 and Arana et al. 2008. In this paper, we study Fritz-John type optimality for multiobjective problems and we characterize the weakly efficient and efficient solutions by using a new concept of generalized vector Fritz-John point and new kinds of invex functions.

## ■ TA-38

Tuesday 08:00-09:20

GSI - S 13

### Mathematical Programs with Equilibrium Problems

Stream: Variational Inequalities and Bi-Level Problems

*Invited session*

Chair: *Jiri Outrata*, Dep. of decision-making theory, UTIA Praha, Pod vodarenskou vezi 4, 18208, Praha 8, Czech Republic, [outrata@utia.cas.cz](mailto:outrata@utia.cas.cz)

#### 1 - Lifting mpccs

*Oliver Stein*, Faculty of Economics and Business Engineering, University of Karlsruhe, Institute of OR, 76128, Karlsruhe, Germany, [stein@wior.uni-karlsruhe.de](mailto:stein@wior.uni-karlsruhe.de)

We present a new smoothing approach for MPCCs, based on the orthogonal projection of a smooth manifold. We study regularity of the lifted feasible set and introduce a novel concept of tilting stability.

A correspondence between the C-index in the original problem and the quadratic index in the lifted problem is shown. In particular, a local minimizer of the MPCC may numerically be found by minimization of the lifted, smooth problem. We report preliminary computational experience.

#### 2 - On stationarity in a class of mpccs/epccs

*Jiri Outrata*, Dep. of decision-making theory, UTIA Praha, Pod vodarenskou vezi 4, 18208, Praha 8, Czech Republic, [outrata@utia.cas.cz](mailto:outrata@utia.cas.cz)

Under the assumption that the equilibrium constraint defines a locally unique and Lipschitz control-to-state map  $S$ , the  $M$ - and  $S$ -stationarity conditions for a corresponding MPEC will be presented. Then we consider equilibria governed by (control-dependent) variational inequalities of and investigate several situations in which the regular normal cone to the overall constraint system (including possible control constraints) can be computed. All these statements are based on the directional differentiability of  $S$  and lead to strong stationarity conditions for the respective MPEC/EPEC.

#### 3 - On stationarity conditions for an equilibrium problem with equilibrium constraints from an electricity spot market model

*Henrion Rene*, Weierstrass Institute for Applied Analysis and Stochastics, Mohrenstr. 39, 10117, Berlin, Germany, [henrion@wias-berlin.de](mailto:henrion@wias-berlin.de), *Jiri Outrata*, *Thomas Surowiec*

We investigate a specific equilibrium problem with equilibrium constraints (EPEC). After presenting the so-called ISO-regulated electricity spot market model, we discuss some important structural properties like strong regularity or calmness. These are later used to derive (strong or Mordukhovich-) stationarity conditions for the EPEC using a general approach developed in the preceding talk by J. Outrata. We are particularly interested in identifying situations when some of the competitors are driven away from the market.

## ■ TA-39

Tuesday 08:00-09:20

GSI - S 14

### BANK MANAGER'S PERFORMANCE EVALUATION

Stream: Operational Research and Quantitative Models in Banking

*Invited session*

Chair: *David Pla-Santamaria*, Alcoy School, Technical University of Valencia, 03801, Alcoy, Spain, [dplasan@esp.upv.es](mailto:dplasan@esp.upv.es)

Chair: *Enrique Ballester*, Escuela Politecnica Superior de Alcoy, Technical University of Valencia, 03801, Alcoy (Alicante), Spain, [eballe@esp.upv.es](mailto:eballe@esp.upv.es)

#### 1 - Evaluating deposit performance in bank offices

*Ana Garcia-bernabeu*, TECHNICAL UNIVERSITY OF VALENCIA, 03801, ALCOY, Spain, [angarber@esp.upv.es](mailto:angarber@esp.upv.es), *Ignacio Gonzalez*

Measuring deposit performance is viewed as a multicriteria problem of comparing outputs to inputs to determine a performance score for each bank office. Outputs are net inflows of deposits while inputs are debts from deposits of different expiry dates. Both are measured as net present values from a set of discount rates, given uncertainty about the true rate to be used. The scores are computed by Single Price Model with the following advantages: (a) every bank office is scored by one index, which generally differs from the other bank offices; (b) no upper limit is assumed.

#### 2 - Evaluating fund manager's performance

*David Pla-Santamaria*, Alcoy School, Technical University of Valencia, 03801, Alcoy, Spain, [dplasan@esp.upv.es](mailto:dplasan@esp.upv.es), *Lirios Jorda*

We rank a wide set of funds from their performance, which leads to evaluate fund manager's ability. For this purpose, a multicriteria decision model under uncertainty is used from a moderate pessimism perspective. This involves considering several states of nature from different risk measures, each state being associated with composite measures of profitability and safety. The approach is applied to evaluate fund manager's performance for a number of funds offered by La Caixa bank in Spain. Numerical tables are provided with data, computational process and results, which are analysed.

**3 - Evaluating loan performance in bank offices**

*Mila Bravo*, ALCOY SCHOOL, TECHNICAL UNIVERSITY OF VALENCIA, 03801, ALCOY, Spain, [mibrasel@epsa.upv.es](mailto:mibrasel@epsa.upv.es)

To objectively determine performance scores of loans managed by bank offices, a multicriteria approach to output aggregation under uncertainty from a moderate pessimism perspective is used. The outputs are defined to describe net present values with different discount rates, as the true rate to be used is uncertain. The approach allows us to assign one different score to every bank office, so that loan performance for each unit is perfectly determined. Numerical data from a set of offices, as well as the computing process and results are tabulated and analysed.

**4 - X-efficiency of russian commercial banks**

*Veronika Belousova*, Banking Department, SU-HSE, 20, Myasnitskaya, State —University Higher School of Economics, Banking Department, 101000, Moscow, [nica.belousova@gmail.com](mailto:nica.belousova@gmail.com)

The paper aims at X-efficiency assessment of Russian commercial banks into homogeneous groups like Fiorentino et. al. (2006). The literature on Russian banks X-efficiency estimation is very scarce [Yildirim & Philippatos (2002), Fries & Taci (2005), Styrim (2005), Golovan et. al. (2008), Aleskerov et. al. (2008), Karas et.al. (2008)]. The Russian banks are very heterogeneous [Styrim (2005)]. So, two different methodologies for homogeneous group identification are presented here. SFA taking into account banks' risk profile and tradition indicators method are applied.

**■ TA-40**

Tuesday 08:00-09:20

GSI - S 27

**Healthcare Management in Asian Countries**

Stream: OR for Development and Developing Countries

*Invited session*

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, [gweber@metu.edu.tr](mailto:gweber@metu.edu.tr)

Chair: *Honora Smith*, School of Mathematics, University of Southampton, Highfield, SO17 1BJ, Southampton, Hampshire, United Kingdom, [honora.smith@soton.ac.uk](mailto:honora.smith@soton.ac.uk)

**1 - A study on waiting time of emergency department services' delivery of ayatollah kashani hospital of isfahan, Iran by simulation**

*Sima Ajami*, Medical Records & Health Management & Economics Research Center, college of Management & Medical Informatics, P.O.Box: 81745-346, Isfahan, Iran, The Isfahan Medical Sciences University-hezarjarib St.-Esfahan Iran, 81655-639, Isfahan, Isfahan, Iran, Islamic Republic Of, [ajami@mng.mui.ac.ir](mailto:ajami@mng.mui.ac.ir), *Saeedeh Ketabi*, *M.Hossein Yarmohammadian*, *Hosain Bagherian*

Emergency department in Hospitals provide urgency clinical and Para clinical care for patients. The aim of this research was determining waiting time of emergency department services' delivery of Ayatollah Kashani Hospital of Isfahan, Iran. This study was a cross-sectional. Data collected by forms. Population concluded the patients. For analyzing SPSS and Simulation used. Results showed the alternative 15 makes patient waiting time reduce from 112.19 minutes to 99.24 minutes. Physicians need simple tools for logical decision-making.

**2 - Application of fuzzy set theory and topsis on healthcare failure mode and effects analysis- security of drugs in outpatient services as examples**

*Chang-tzu Chiang*, Department of Business Administration,, Yuanpei University, No. 306, Yuanpei St., 30015, Hsin Chu, Taiwan, [ctcamber@mail.ypu.edu.tw](mailto:ctcamber@mail.ypu.edu.tw), *Chin-Tsai Lin*, *Li-Ping Huang*

The quality of health care is getting more importance in these days, and most of medical organization had established specific department or driven related policies on it, and the most important issue which related was safety of patients. In this study Fuzzy set theory and TOPSIS were used in Healthcare Failure Mode and Effects Analysis (HFMEA) in process of dose designation, and tried to gain the important risk factors. The result of this study can be references when hospital managing Security of Drugs in Outpatient Service the safety of patients.

**3 - Research on application of ccr and ccgss model to efficiency evaluation in navy health organization**

*Xiaorong Liu*, Xiangyin Road 800, Shanghai, China, 200433, Shanghai, China, [qingri212@yahoo.com.cn](mailto:qingri212@yahoo.com.cn)

DEA is a linear method that could be used to maximize a service unit's efficiency. We collected data from 11 Chinese navy health organizations in the period from 2001 to 2003. The C2GS2 model was only used to measure technical efficiency, while the C2R model to both technical and scale efficiency?the overall efficiency. More than 60% of the organizations were technically efficient in the three years, but 82% of them were overall inefficient, which was acquired in the C2R model. After getting the results, we conclude that navy health organizations in China had to reduce the cost.

**4 - Malaysian boarding school menu planning using genetic algorithm approach**

*Siti Noor Asyikin Razali*, Department of Statistic, Universiti Tun Hussein Onn Malaysia, Centre of Science Study, 86400 Parit Raja, Batu Pahat, Johor, 06, Johor, Batu Pahat, Malaysia, [noor\\_syikin03@yahoo.com](mailto:noor_syikin03@yahoo.com)

Serving healthier meals at the optimize budget given by government is the stated objective of menu planner in boarding school. But, planning nutritious menu by manual calculation is tedious, and time-consuming. Therefore, this study aims to develop a mathematical model to create nutritious meals specifically for Malaysian boarding schools children aged 13 to 18 years old. Genetic algorithm is applied to determine the most palatable meals that consider Recommended Nutrient Intake, variety, cost, and the budget of menu items. This solution is then compared with integer programming approach.

**■ TA-41**

Tuesday 08:00-09:20

GSI - S 28

**OR in Agriculture I**

Stream: OR in Agriculture and Forest Management

*Invited session*

Chair: *Marcela Gonzalez*, Departamento de Modelación y Gestión Industrial, Universidad de Talca, Merced 437, s/n, Curicó, Región del Maule, Chile, [mgonzalez@utalca.cl](mailto:mgonzalez@utalca.cl)

**1 - Modeling farmers' behavior using the cumulative prospect theory**

*Luis Coelho*, Departamento de Gestao, Universidade de Evora, Largos dos Colegiais, 7000, Evora, Portugal,

Icoelho@uevora.pt, Cesaltina Pires, Andreia Dionisio, Amilcar Serrao

This paper proposes a modeling approach to evaluate the impact of economic policies on the decision maker's behavior. This modeling approach incorporates a careful modeling of the agent's preferences under risk into a discrete sequential stochastic programming model that describes the uncertainties and the constraints faced by the decision maker. Preferences are assumed to follow the Cumulative Prospect Theory. Through utility elicitation methods we estimate the decision maker's functions which constitutes the objective function of our model. Our model was applied to nine farmers of Portugal.

## 2 - Dynamic reserve selection: modeling the land price feedback effect in strategic land retentions in western washington, united states

Sandor Toth, College of Forest Resources, University of Washington, Seattle, Box 352100, 98195, Seattle, WA, United States, toths@u.washington.edu, Robert Haight, Luke Rogers

Urban growth typically compromises open space due to real estate and commercial developments. The resulting loss of ecosystem functions triggered extensive retention efforts. The reserve selection models built to aid these efforts mostly assumed that conservation has no impact on land prices and conversion risks outside the reserves - an assumption that does not hold in localized land markets. A novel, integer programming model will be presented that relaxes this assumption. The mechanics of the approach will be illustrated in real land retention contexts in western Washington, United States.

## 3 - A decision support system based on data envelopment analysis for improving the production process of an apple packing

Marcela Gonzalez, Departamento de Modelación y Gestión Industrial, Universidad de Talca, Merced 437, s/n, Curicó, Región del Maule, Chile, mgonzalez@utalca.cl, Jonathan Rojas

A decision support system based on Data Envelopment Analysis is developed for improving resources allocation and workers distribution in each stage of the production process of an apple packing, considering apple variety and fruits quality. Implementation of the decision support system has allowed to increase productivity in approximately 20 percent and to reduce processed fruit costs in around 19 percent.

## ■ TA-42

Tuesday 08:00-09:20  
GSI - S 3

### Alternative Modelling in Macroeconomics

Stream: Mathematical Models in Macroeconomics

Invited session

Chair: Rudolf Tröster, Electrical&Computer Engineering, Hochschule Furtwangen, 78120 Furtwangen, 79219, Staufen, Germany, troester@hs-furtwangen.de

#### 1 - Modelling a credit crunch in a pure credit economy

Steve Keen, University of Western Sydney, NSW 1797, Sydney, New South Wales, Australia, S.Keen@uws.edu.au

I present a model of a pure credit economy in which there is a sudden change of financial flow parameters. The sudden change causes a collapse in money in circulation that reverses economic growth and causes a severe Depression. I use a new and very simple methodology for the construction of dynamic models in economics.

#### 2 - Dynamic analysis and the longterm behavior of economies

Jürgen Kremer, FB Mathematik und Technik, FH Koblenz RheinAhrCampus Remagen, Südallee 2, 53424, Remagen, Germany, kremer@rheinahr-campus.de

In this talk the chronological development of a macroeconomic model over several time periods is simulated and analysed. It turns out that, under standard assumptions, the economies that are modelled and investigated become unstable in the long term, with the interest rate in the capital market being the crucial causal factor.

These presented models not only explain a range of crucial observable macroeconomic effects, such as rising unemployment, falling wages and increasingly unequal wealth distribution; they also offer the basis for a solution.

## ■ TA-43

Tuesday 08:00-09:20  
GSI - S 10

### Development of bio-energy and bio-technology: Economical and ecological aspects

Stream: Sustainable living: Cognitive, Social, Economical, Ecological and World View

Invited session

Chair: Annette Hohenberger, Middle East Technical University (METU), Informatics Institute, Cognitive Science Program, Inonu Bulvari, 06531, Ankara, Turkey, hohenberger@ii.metu.edu.tr

#### 1 - Economic-ecologic efficiency by bilevel optimization

Gabriela Cristescu, Department of Mathematics and Computer Science, Aurel Vlaicu University of Arad, Aurel Vlaicu University of Arad, Department of Mathematics and Computer Science., Str. Revolutiei, No. 77., 310130, Arad, Romania, gcristescu@inext.ro

A bilevel optimization method is designed to combine the multiple ecologic-technologic-ethic-social criteria with the cost-utility analysis for assessing the ecologic-economic efficiency of an investment policy. The multiple criteria decision method within interval analysis is meant to include problems with incomplete information.

#### 2 - Targeting, timing, and pricing: simulating the effects of marketing activities on the adoption of a novel biomass fuel

Markus Günther, Department of Business Administration, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, markus.guenther@univie.ac.at, Elmar Kiesling, Christian Stummer, Lea M. Wakolbinger

The adoption of new products can be furthered by targeting appropriate marketing activities at the right consumers at the right time. In order to evaluate the effects of such (costly) activities, we have developed an agent-based computer simulation in which consumers are modeled as agents that are embedded in a social network and make their purchase decisions with respect to individual preferences. The applicability of our approach is illustrated by means of a case study on a novel biomass fuel where we investigate different targeting, timing, and pricing strategies.

### 3 - Long term unit commitment with heating and biomass constraints

Niels Kjeldsen, Dept. of Mathematics & Computer Science, University of Southern Denmark, Campusvej 55, DK-5230, Odense M, Denmark, tiels@imada.sdu.dk, Marco Chiarandini

In deregulated electricity markets, power producers use the well known unit commitment problem to decide the operating conditions of their plants. Typically, the problem is solved on time intervals of 1 hour and time horizon of 24 hours. To make strategic decisions, the main Danish producer asked us to solve a one year production plan including cogeneration plants and yearly biomass consumption regulations. This leads to a long term unit commitment problem to be solved very fast. We studied heuristic methods that combine mixed integer programming, dispatchers and stochastic local search.

### 4 - Fuzzy hierarchy integral analytic expert decision process in evaluating foreign investment entry-mode selection of bio-tech firms

Hsu-Hua Lee, Graduate Institute of Management Sciences, Tamkang University, Ying-chuan Road Tamsui, Taipei County Taiwan 25137, Republic of China, 251, Taipei County, 132576@mail.tku.edu.tw, Tsau-Tang Yang, Chie-Bein Chen, Yen-lin Chen

The purpose of this study is to aid the bio-tech firms solving the foreign investment entry mode selection problem. The research findings are: (1) In the different investment entry modes, there's pretty large difference of evaluation focus while the investors select their entry modes. (2) The merge and acquisitions is the priority consideration, and the following is the strategic alliances. The high stock share holding investing mode is priority if the stock share holding is unlimited. (3) The constructs of capital and risk and technology ability have the consistent effect of the entry mode selecting.

## ■ TA-44

Tuesday 08:00-09:20

GSI - S 16

### Uncertainty in Life-Cycle Assessment

Stream: Uncertainty and Environmental Decision Making

Invited session

Chair: Manfred Lenzen, Centre for Integrated Sustainability Analysis, The University of Sydney, School of Physics, A28, 2006, The University of Sydney, NSW, Australia, m.lenzen@physics.usyd.edu.au

Chair: Thomas McKone, School of Public Health, University of California, 50 University Hall MS7360, 94720-7360, Berkeley, California, United States, temckone@lbl.gov

#### 1 - The UK carbon footprint - an example for handling uncertainty in input-output lca

Manfred Lenzen, Centre for Integrated Sustainability Analysis, The University of Sydney, School of Physics, A28, 2006, The University of Sydney, NSW, Australia, m.lenzen@physics.usyd.edu.au, Richard Wood, Tommy Wiedmann

We establish a time series of the UK's carbon footprint using a global, multi-regional input-output (MRIO) framework. We capture variations of underlying data and calculation procedures by modelling random, stochastic variation of the whole MRIO system, and by using Monte-Carlo techniques. 5000 Monte-Carlo simulation runs were carried out, and from these the standard deviations of components of the UK's carbon footprint were estimated using error propagation. We find that the UK's carbon footprint has decreased over the past decade, and that this result is statistically significant.

#### 2 - Confronting the uncertainties in life-cycle impact assessment comparisons

Thomas McKone, School of Public Health, University of California, 50 University Hall MS7360, 94720-7360, Berkeley, California, United States, temckone@lbl.gov

Life-cycle impact assessment (LCIA) strives to compare one or more impacts in order to inform product choices. The reliability and consistency of decisions and policies based on LCIA are diminished by a failure to confront and communicate the inherent uncertainties. Multiple sources of uncertainty arise in any impact assessment, but are particularly problematic for comparisons. This presentation provides a detailed case study with biodiesel life-cycle emissions in order to explore and evaluate how uncertainty can impact decisions and how uncertainty can be addressed in life-cycle comparisons.

#### 3 - Towards consistent management of uncertainties in life cycle assessment

Ralph Rosenbaum, Chemical Engineering, CIRAI, Ecole Polytechnique de Montreal, 2900 Edouard-Montpetit, P.O. Box 6079, Stn. Centre-ville, H3C 3A7, Montreal, Quebec, Canada, ralph.rosenbaum@polymtl.ca, Andreas Ciroth, Fausto Freire, Reinout Heijungs, Jinglan Hong, Olivier Joliet, Manfred Lenzen, Thomas McKone

Although essential for a confident decision, uncertainty in life cycle assessment (LCA) is usually omitted due to lacking methodological guidance and information. The UNEP/SETAC working group on uncertainty in LCA aims to facilitate management of uncertainty in comparative studies. Its focus is the development of a framework for modelling, estimation, communication and interpretation of uncertainty in LCA, ultimately aiming to establish recommended practice and guidance for both practitioners and method developers. This talk will present activities and first results of this working group.

#### 4 - Flaws and structures in ecoinvent data: towards a quality assurance and maintenance suite

Andreas Ciroth, GreenDeltaTC GmbH, Raumerstrasse 7, 10437, Berlin, ciroth@greendeltatc.com

For the complete ecoinvent database, an extensive data analysis was carried out. A broad variety of tools and techniques was investigated in how far they can support three main goals: First, find possible flaws in data; second, find structures inherent in data and classify data in groups and subgroups according to these; and third, find useful combinations of tools for LCA data quality assurance and maintenance. The presentation will propose an "arrangement" of different tools and techniques, for an overall quality assurance of ecoinvent data in an open source software suite.

#### 5 - An intelligent system for estimating a large-size matrix in environmental accounting

Ting Yu, University of Sydney, Room 408, Physics Building A28, 2020, University of Sydney, NSW, Australia, yuting\_sz@yahoo.com, Manfred Lenzen

This paper presents a data mining system being capable of automatically estimating and updating a large-size input-output matrix for Environmental Input-Output Life Cycle Assessment (EIO-LCA). The balancing and reciliation of this matrix is carried out using information on data uncertainty.

## ■ TA-45

Tuesday 08:00-09:20

GSI - S 33

### I : Societal Complexity and Safety

Stream: Methodology of Societal Complexity

Invited session

Chair: *Ludmilla Koshlai*, Systems analysis and OR, Institute of Cybernetics, Gonchar str.,65-a,apt.20, 01054, Kiev, Ukraine, koshlai@ukr.net

#### 1 - Operations research techniques of rare use and catastrophes.

*María J. García G.*, Gerencia General, Minimax Consultores, C.A., Torre Credicar, PB, Local M3, Chacaito, Caracas Venezuela, 78239, Caracas, 1074, Miranda, Venezuela, Minimaxconsultores@yahoo.com, *José G. Hernández R.*

The contribution of this work is to present some Operations Research techniques, rarely highlighted in the literature and that could be of great help to the communities confronting a catastrophe. Therefore, the objective of the work are: To describe the use of: Fuzzy set theory; Decreasing digits; A, B, C, Model; Structure of decision trees; Multiattribute Models (MM) with multiplicative factors and Matrixes Of Weighing (MOW) to construct systems of support that help in case of catastrophes. Key words: Catastrophes, Decision trees, Multiattribute Models, Matrixes Of Weighing.

#### 2 - A proposal of primal and dual problems in macro-economics

*Eizo Kinoshita*, urban science, Meijo University, 4-3-3,nijigaoka, 509-0261, kani, gifu, Japan, kinoshit@urban.meijo-u.ac.jp

While the prolonged recession Japan has experienced during the last fifteen years, and the global downfall in stock prices triggered by the 2008 US sub-prime loan crisis, both adversely affected general consumers, the two events also presented significant difficulties within the study of economics. Macro-economics was born from the Great Depression, a prolonged slump that originated in the US eighty years ago. It is the position of this paper that Japan's recession and the US sub-prime loan crisis have revealed a new fundamental economic truth.

#### 3 - Credit crisis and global safety

*Dorien DeTombe*, Methodology of Societal Complexity, Chair Euro Working Group, P.O.Box 3286, 1001 AB , Amsterdam, Netherlands, detombe@nosmo.nl

The credit crisis is a complex societal problem in which many phenomena, people and actors are involved. Analyzing the causes, stabilizing the financial system and preventing a new fall back needs a multi-disciplinary analysis. Theories of many disciplines should be used to analyze this issue and to make decisions. This can be done by the Compram methodology (DeTombe). The Compram methodology is specialized to handle complex interdisciplinary worldwide problems and offers for politicians a step-by-step approach of analyzing the problem and finding and implementing sustainable decisions.

#### 4 - Modeling of large city problems under credit crisis

*Ludmilla Koshlai*, Systems analysis and OR, Institute of Cybernetics, Gonchar str.,65-a,apt.20, 01054, Kiev, Ukraine, koshlai@ukr.net, *Mikhail Mikhalevich*

The consequences of global crisis are difficult for countries in transition. The interaction of crisis and inadequate development of infrastructure has been generated a number of interrelated problems, which concentrate within the suburban area of large cities. In essence, these problems are typical examples of complex societal problems and Compram method are applied for their solution. The classification of areas in city and its suburbs play the important role for Compram sub-cycles; methods of fuzzy set theory, ordinary regression and hierarchy analysis are applied for these purposes.

## Tuesday 09:35-11:05

### ■ TB-01

Tuesday 09:35-11:05

Beethoven

#### Keynote T1

Stream: Keynote Talks

Keynote session

Chair: *Michel Gendreau*, CIRRELT, Université de Montréal, C.P. 6128, succ. Centre-ville, H3C 3J7, Montreal, Quebec, Canada, michelg@crt.umontreal.ca

Chair: *Erwin Pesch*, FB 5, University of Siegen, Hoelderlinstr. 3, 57068, Siegen, Germany, erwin.pesch@uni-siegen.de

#### 1 - Google's auction for tv ads

*Noam Nisan*, School of Computer Science and Engineering, Hebrew University, 91904, Jerusalem, Israel, noam.nisan@gmail.com

The talk will describe the auction system used by Google for allocation and pricing of TV ads. The auction is based on a simultaneous ascending auction, and has been in use since September 2008.

#### 2 - Airport OR

*Ulrich Dorndorf*, INFORM GmbH, Pascalstr. 23, 52076, Aachen, Germany, udorndorf@acm.org

Airports are increasingly seen as future bottlenecks of the air transport system. Airport and Aircraft Operators, Ground Handling companies and Air Traffic Service Providers are under pressure to improve operational efficiency, predictability and on-time performance.

Airport Operations lead to a number of challenging optimisation problems. The goals are to enhance the use of ground handling resources, to optimise the use of airport infrastructure from runways and taxiways to apron and terminal resources such as stands, gates or check-in counters, to reduce ground movement costs, as well as to reduce Air Traffic Flow Management slot wastage. Problems arise at the planning and at online control level, where the task is complicated by frequent changes of the flight schedule.

We give an overview of Airport OR applications and illustrate it by example problems for scheduling terminal and ground handling resources.

We conclude with current trends in airport applications. Airport OR has traditionally been concerned with the optimisation of individual, local processes. Airports and airlines are beginning to set up Airport (Hub) Operations Control Centers to obtain an overall view of their operations, especially of the aircraft turn-around processes. Airport Collaborative Decision Making (A-CDM) takes this one step further by providing an integrated view of all processes from arrival and departure sequencing, surface movement to turn-around management. The Total Airport Management (TAM) concept extends A-CDM by including passenger processes on the landside.

### ■ TB-02

Tuesday 09:35-11:05

Schumann

#### Keynote T2

Stream: Keynote Talks

Keynote session

Chair: *Ulrike Leopold-Wildburger*, Statistics and Operations Research, Karl-Franzens-University, Universitätsstraße 15/E3, 8010, Graz, Austria, ulrike.leopold@uni-graz.at

#### 1 - Assignment problems

*Rainer Burkard*, Institute of Optimization and Discrete Mathematics, Graz University of Technology, Steyrergasse 30, A-8010 Graz / Austria, Graz, Austria, burkard@tugraz.at

Assignment problems (AP) are classical OR problems which occur in many applications. This lecture will not only outline recent results concerning the history of AP, but will also discuss novel applications, new findings concerning the probabilistic behaviour of AP and a framework for deriving bounds in a very general setting. Namely:

New findings show that linear assignment problems can be traced back to the mathematics of the 19th century.

Bob Machol stated that linear assignment problems have only very few genuine applications. We outline new applications related to the origin of our universe as well as to problems in geometry.

In 1969 Donath conjectured the expected optimal value of a linear AP with random cost coefficients in  $[0,1]$ . More than 30 years later this conjecture has been verified by Aldous. Aldous' theorem gave the impulse for interesting new investigations on random AP.

Finally we outline the concept of admissible transformations which allows to treat sum and bottleneck problems from a unified viewpoint. Many bounding schemes for quadratic and multi-index AP can be formulated within this framework.

#### 2 - Conic programming relaxations for combinatorial optimization

*Franz Rendl*, Institut fuer Mathematik, Universitaetsstr. 65, 9020, Klagenfurt, franz.rendl@uni-klu.ac.at

The success of interior point methods in the 1990's to solve semidefinite programs (SDP) has spurred the interest in SDP as a modeling tool in various mathematical fields. In the context of combinatorial optimization, it turned out that SDP is particularly effective, if the underlying 0-1 formulation of the problem involves quadratic terms. In this talk, several SDP relaxations of NP-hard combinatorial optimization problems will be discussed. We also address relaxations based on the cone of completely positive matrices as a more recent tool.

These relaxations can be used either theoretically, to get approximations with an a priori upper bound on the error. They can also be used computationally to solve the underlying problem to optimality. Some recent developments in both directions will be presented. These cover Max-Clique, Graph Coloring and other Graph partition problems. The resulting SDP are typically of sizes, not accessible by interior point methods. We therefore also discuss some very recent algorithmic developments to solve these relaxations.

### ■ TB-03

Tuesday 09:35-11:05

Reger

#### Keynote T3

Stream: Keynote Talks

Keynote session

Chair: *Peter Letmathe*, Chair of Value Chain Management, University of Siegen, Hoelderlinstr. 3, 57076, Siegen, Peter.Letmathe@uni-siegen.de

Chair: *Roman Slowinski*, Institute of Computing Science, Poznan University of Technology, Laboratory of Intelligent Decision Support Systems, Street Piotrowo 2, 60-965, Poznan, Poland, roman.slowinski@cs.put.poznan.pl

#### 1 - Using allocated costs for decision making: reconciling theory with practice

*Ramji Balakrishnan*, University of Iowa, W262A PBB, Tippie College of Business, 52246, Iowa City, ia, United States, Ramji-balakrishnan@uiowa.edu

Firms spend considerable resources in devising product costing systems. These systems divide up a firm's capacity costs (e.g., the cost of machinery and buildings) into pieces attributable to individual products and customers. Overwhelming evidence shows that managers worldwide use allocated costs for making product pricing and capacity planning decisions. For example, firms routinely drop product lines that do not recover their full (allocated) cost. Economists question this practice. They argue that the costs being allocated comprise of a firm's committed /sunk costs. Thus, these costs or their allocations are irrelevant from a decision making perspective. I aim to summarize recent research that seeks to reconcile theory with practice, and offer avenues for additional work.

The core idea of this research stream is the notion that a firm's product- and capacity-planning problem is computationally complex. A conceptually correct formulation is multi-period stochastic optimization problem with complex linkages across periods (e.g. inventory) and constraints (e.g., multiple resources used by the same product). Accounting researchers argue that this problem is not solvable. They argue that product cost data can serve as economically sufficient statistics that permit problem decomposition. Such decomposition would permit managers to deal with pricing problems that pertain to individual products and planning problems that deal with each capacity resource. This research, which has many links to operations research, has examined questions under which such problem decomposition is costless and problem features that lead to a loss. Even when product cost is not economically optimal, it is reasonable to think of it as a heuristic that aids "local" decision making. This view raises the question of the magnitude of the economic loss from using heuristics, as well as methods for improving our estimation. In particular, it is of interest to examine the sources of error (e.g., model specification, aggregation and/or measurement) and their implications for the accuracy of product costs. Simulations play a significant role in this research stream that has considerable practical appeal. Finally, current research has begun to examine questions of how the robustness of problem solutions to the error in the estimates.

## 2 - Electre methods: main features and new developments

*Bernard Roy*, LAMSADE, Université Paris-Dauphine, Paris Cedex 16, France, roy@lamsade.dauphine.fr,  
*José Rui Figueira*

After a brief description of the constructivist conception in which ELECTRE method are inserted, we shall present the main features of these methods. They include elements such as, the possibility of modeling by taking into account positive and negative reasons, without any recoding of data; thresholds used to take into account the imperfect knowledge of data; absence of systematic compensation between "gains" and "losses". The main weaknesses will also be presented. Then, some aspects related to new developments will be presented. They are related to new methodological tools, new procedures, axiomatic, and many other aspects. Finally, some concluding remarks will be outlined.

## Tuesday 11:20-12:40

### ■ TC-01

*Tuesday 11:20-12:40*

*Beethoven*

### Some recent advances in 0-1 integer programming

Stream: Combinatorial Optimization

*Invited session*

Chair: *Monique Guignard-Spielberg*, OPIM, University of Pennsylvania, 5th floor, JMHH, 3730 Walnut Street, 191046340, Philadelphia, PA, United States, guignard\_monique@yahoo.fr

#### 1 - New reformulation and hybrid method for the bi-objective max—min knapsack problem

*Raid Mansi*, LAMIH- SIAD, Université de Valenciennes-ISTV2, Le Mont-Houy, 59313, Valenciennes, France, raid.mansi@univ-valenciennes.fr, *Said Hanafi*, *Christophe Wilbaut*

The bi-objective max-min knapsack problem (BKP) is a variant of the classical zero-one knapsack problem, where the values of items differ under two possible scenarios. In this paper, we first show the equivalence between solving the BKP and solving two knapsack problems with an additional constraint, and we provide upper and lower bounds. Next, we present a hybrid method mixing heuristics and mathematical programming to solve efficiently the BKP. The method is compared with existing works and the results show the robustness of the approach, even for difficult instances.

#### 2 - Recent experimental results on the rlt3 lower bound for the quadratic assignment problem

*Peter Hahn*, Electrical and Systems Engineering, University of Pennsylvania, 200 South 33rd Street, 19104-6314, Philadelphia, PA, United States, hahn@seas.upenn.edu, *William Hightower*, *Monique Guignard-Spielberg*, *Matthew Saltzman*

We present a QAP lower bound algorithm, based on a level-3 reformulation linearization technique (RLT3). Our algorithm closely approximates RLT3 bounds and reaches them in some instances. It solves Nugent instances up to  $N=24$  exactly or verifies the optimum. Problems of size  $N>25$  present a challenge, due to memory needs for the RLT3 formulation. We describe steps to significantly conserve memory via the RLT3 formulation symmetries. We report use of this algorithm in a branch-and-bound solver. Our experiments determine the direction for needed research on this promising solution method.

#### 3 - A chr heuristic for solving the gqap problem and extensions

*Monique Guignard-Spielberg*, OPIM, University of Pennsylvania, 5th floor, JMHH, 3730 Walnut Street, 191046340, Philadelphia, PA, United States, guignard\_monique@yahoo.fr, *Aykut Ahlatcioglu*

The CHR (Convex Hull Relaxation) approach can be used as a heuristic for nonconvex quadratic 0-1 programming problems (for convex problems, it also provides a valid bound). By starting the algorithm from different 0-1 points, one can force the inner simplicial decomposition algorithm to produce different paths and end at possibly different feasible 0-1 solutions. Each run is so quick that one can afford to use multiple starts. We will present results on GQAP problems from the literature, and on some practical problems that have recently been shown to be special cases of the GQAP.

## ■ TC-02

Tuesday 11:20-12:40

Schumann

### Metaheuristics for Transportation Planning I

Stream: Transportation Planning

*Invited session*

Chair: *Karl Doerner*, Department of Business Studies, University of Vienna, Bruenner Strasse 72, 1210, Vienna, Vienna, Austria, karl.doerner@univie.ac.at

#### 1 - Heuristics for the multi-period orienteering problem with multiple time windows

*Fabien Tricoire*, Department of Business Administration, University of Vienna, Chair for Production and Operations Management, Brünner Straße 72, 1210, Vienna, fabien.tricoire@univie.ac.at, *Martin Romach*, *Karl Doerner*, *Richard Hartl*

We present the Multi-Period Orienteering Problem with Multiple Time Windows, a new routing problem combining objective and constraints of the Team Orienteering Problem (TOP) and original constraints from a real-world application. Specific route duration constraints result in a route feasibility subproblem. We propose an exact algorithm for this subproblem, and we embed it in a Variable Neighborhood Search method to solve the whole routing problem. We also adapt our method to standard benchmark TOP instances, and provide comparative tables with state-of-the-art algorithms.

#### 2 - Solving a multi-objective covering tour model with stochastic demands for disaster relief

*Walter Gutjahr*, Department of Statistics and Decision Support Systems, University of Vienna, Universitaetsstrasse 5/3, 1010, Vienna, Vienna, Austria, walter.gutjahr@univie.ac.at

In a humanitarian logistics application, a population has to be supplied by goods delivered by vehicles. The vehicles stop at distribution centers (DCs) which are to be selected in advance. Demands are random variables with a known distribution. A distance-depending share of customers from a population node walk to the next DC to be provided with the goods. DCs as well as vehicles are capacitated. The first objective measures opening and routing cost, the second is expected uncovered demand. Mathematical programming techniques and metaheuristics are used to compute Pareto-optimal solutions.

#### 3 - Vehicle routing and the value of postponement

*Luc Muyldermans*, Business School, Nottingham University, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, luc.muyldermans@nottingham.ac.uk, *Gu Pang*

We study Capacitated Vehicle Routing Problems in which the client demands occur over time and the collector or distributor performing the service can decide when to visit the clients. It has been reported in the literature that postponement of collection or delivery services may decrease the overall routing cost. We investigate this issue in greater detail and report on experiments in different routing settings to uncover the impact of postponement on routing efficiency. We compare the results by a local search procedure with those obtained from an analytical Continuous Approximation model.

## ■ TC-03

Tuesday 11:20-12:40

Reger

### Network optimization

Stream: Network Optimization

*Invited session*

Chair: *Frits Spieksma*, of Operations Research and Business Statistics, Katholieke Universiteit Leuven, Naamsestraat 69, B-3000, Leuven, Belgium, frits.spieksma@econ.kuleuven.be

#### 1 - Combining profit maximization and risk management for creating end-to-end bandwidth guaranteed services

*Aparna Gupta*, Lally School of Mgmt, Rensselaer Polytechnic Institute, Troy, NY, United States, guptaa@rpi.edu

A spot-pricing framework for end-to-end (e2e) bandwidth guaranteed services using path-vector approach is employed, where an ISP combines its intra-domain contract links with service contracts from neighboring ISPs to construct e2e contract paths. We first obtain a nonlinear pricing model under static network condition, that maximizes the ISP's profits, followed by extending the model for stochastically varying user demands and network conditions. Detailed risk assessment and management strategies are studied to cope with the inherent risks under different network setups and market conditions.

#### 2 - The impact of different transportation cost measurements on hybrid hub and spoke network design

*Anne Paul*, Department of Business Policy and Logistics, University of Cologne, Albertus-Magnus-Platz, 50923, Köln, Germany, anne.paul@wiso.uni-koeln.de

Hybrid hub and spoke networks have proven to be both a cost-efficient and service-oriented structure for less than truckload operations. Transportation costs on the different arcs of the network are an important influence factor for network design. However, they can be measured variously, especially regarding their practical applicability for a logistics service provider. Thus, we analyze and discuss different cost measurements as to their impact on network design. Our findings are of importance for strategic managerial decisions as we illustrate based on a large scale transportation network.

#### 3 - Charlemagne's challenge: the periodic latency problem

*Frits Spieksma*, of Operations Research and Business Statistics, Katholieke Universiteit Leuven, Naamsestraat 69, B-3000, Leuven, Belgium, frits.spieksma@econ.kuleuven.be, *Sofie Coene*, *Gerhard J. Woeginger*

Given is a single server traveling at unit speed, and a set of clients with a known distance for each pair of clients. For each client, a periodicity is known, that is the maximum amount of time that is allowed to pass between two consecutive visits of the server. The goal is to find a repeatable route for the server serving as many clients as possible without violating the periodicities of the served clients. We derive hardness results for different version of this problem, and we give algorithms for different topologies.

## ■ TC-04

Tuesday 11:20-12:40

Liszt

### Genetic Algorithms

Stream: Scheduling

*Invited session*

Chair: *Eva Vallada*, Estadística e Investigación Operativa Aplicadas y Calidad, Universidad Politécnica de Valencia, Cno. Vera s/n Edificio I-3, 46022, Valencia, Spain, evallada@eio.upv.es

#### 1 - A genetic algorithm for inventory constrained scheduling on a single machine

*Dirk Briskorn*, Department for Production and Logistics, University of Kiel, Olshausenstrasse 40, 24098, Kiel, Germany, briskorn@bwl.uni-kiel.de

We consider inventory constraints in a single machine environment. Here, jobs add and remove items to an inventory and from an inventory, respectively. Jobs removing items cannot be processed if the required amount of items is not available. We consider problems on a single machine with the objective functions common in machine scheduling and develop a GA framework to solve them. We outline concept of the algorithm as well as computational results.

#### 2 - A genetic algorithm to minimise the maximum lateness on a single machine family scheduling problem

*Lai-Soon Lee*, Laboratory of Applied and Computational Statistics, Universiti Putra Malaysia, Institute for Mathematical Research, Universiti Putra Malaysia, 43400, UPM Serdang, Selangor, Malaysia, lee@math.upm.edu.my, *Habibeh Nazif*

We consider a Single Machine Family Scheduling Problem where jobs are partitioned into families and setup time is required between these families. For this problem, we propose a genetic algorithm using an optimised crossover operator designed by an undirected bipartite graph to find an optimal schedule that minimises the maximum lateness of the jobs in the presence of the sequence independent family setup times. Comprehensive results are presented and the proposed approach is shown to be competitive when compared with other competing local search algorithms.

#### 3 - A genetic algorithm approach for the single machine earliness/tardiness scheduling problem with job-independent penalties

*Jorge Valente*, Faculdade de Economia - LIAAD - INESC Porto L.A., Universidade do Porto, Rua Dr. Roberto Frias, 4200-464, Porto, Portugal, jvalente@fep.up.pt, *Saurabh Bharti*, *Kunal Prasad*

We consider the single machine early/tardy scheduling problem with job-independent penalties, and no machine idle time. Several genetic algorithms are proposed, and compared with the best existing heuristic procedure. The computational results show that the performance of the genetic versions is improved by the addition of a local search procedure, the initialization of the first population and the use of an elitist mutation strategy. The genetic versions, particularly those that incorporate the local search procedure, clearly outperform the best existing heuristic.

#### 4 - Cooperative and multicore genetic algorithms for the permutation flowshop problem

*Eva Vallada*, Estadística e Investigación Operativa Aplicadas y Calidad, Universidad Politécnica de Valencia, Cno. Vera s/n Edificio I-3, 46022, Valencia, Spain, evallada@eio.upv.es, *Gema Escrivá*

In this work a genetic algorithm for the permutation flowshop problem with the objective to minimize the total tardiness is proposed. The genetic algorithm is based on the island model and uses the most recent technologies, where more than one core is available in the processor of the computer. Each core runs the algorithm in parallel and communications through messages are allowed. A comparative evaluation against the serial counterparts and some of the best methods available in the literature is carried out. Results show that the cooperative multicore algorithm outperforms all other methods.

## ■ TC-05

Tuesday 11:20-12:40

Haydn

### Bioinformatics IV

Stream: Computational Biology, Bioinformatics and Medicine

*Invited session*

Chair: *Milena Radenkovic*, School of Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, Nottinghamshire, United Kingdom, mvr@cs.nott.ac.uk

#### 1 - Metaheuristics for peptide assembly problem

*Marcin Borowski*, Institute of Computing Science, Poznan University of Technology, 60-965, Poznan, Poland, mborowski@cs.put.poznan.pl, *Jacek Blazewicz*, *Piotr Formanowicz*, *Tomasz Glowacki*

Determining amino acid sequences of protein molecules is one of the most important issues in molecular biology. These sequences determine protein structure and functionality. Unfortunately, direct methods for reading amino acid sequences can be used for reading short sequences only. That is the reason which makes peptide assembly algorithms an important complement of those methods. The genetic algorithm solving the problem of short amino acid sequence assembly problem has been designed and tested in computational experiment and compared with an existing tabu search method for the same problem.

#### 2 - Extended model of building phylogenetic trees

*Pawel Kedziora*, Poznan Institute of Technology, 60-965, Poznan, Poland, pkedziora@cs.put.poznan.pl

The classical phylogenetic tree is constructed for a group of individuals which are represented by the leaves of the tree. This paper presents the extension of the method of building phylogenetic trees, where species are observed in different points of time. Because in different points of time there can be present species which are in the ancestor/descendant relation, in our model ancestors are represented by the internal nodes of the tree. Species from earlier points of time do not have to have descendant in the observed set of species, thus these species can be also represented by leaves.

#### 3 - Network analysis of differential expression for the identification of disease-causing genes

*Daniela Nitsch*, KU Leuven, B-3000, Leuven, Belgium, dnitsch@esat.kuleuven.be

Genetic studies identify chromosomal regions involved in a disease with many candidates. Prioritization methods have been proposed, but they are often not applicable when little is known about the phenotype. We replace this knowledge by experimental data on differential gene expression. We assess a candidate by considering the level of differential expression in its neighborhood under the assumption that strong candidates will tend to be surrounded by differentially expressed neighbors. We score candidates by aggregating the differential expression of neighbors weighted as a function of distance.

#### 4 - Gene prioritization in platelets

*Francisco Bonachela Capdevila*, KU Leuven, campus Kortrijk, B-8500, Kortrijk, Belgium,  
Francisco.BonachelaCapdevila@kuleuven-kortrijk.be,  
*Patrick De Causmaecker, Hans Deckmyn*

Blood platelets can form a thrombus leading to e.g. myocardial infarction or stroke. Effective and safe platelet inhibitors are needed. Proteomics and genomics have identified thousands of proteins expressed by blood platelets, a number that exceeds the analytical capacity. Thus a gene ranking is needed. To perform such a ranking we used Endeavour with a new database called Haematlas which is a gene expression atlas for blood cells. We also applied a clustering preprocessing step, previous to the prioritization, to obtain a more homogeneous training set, using the clustering algorithm CLOPE.

## TC-06

Tuesday 11:20-12:40

Koch

### Real life applications of MCDM/MCDA

Stream: OR and Real Implementations

Invited session

Chair: *Pekka Salminen*, School of Business and Economics, University of Jyväskylä, P.O.Box 35, FI-40014, Jyväskylä, Finland, Pekka.Salminen@econ.jyu.fi

#### 1 - Multi-criteria benefit-risk analysis of viagra, levitra, and cialis

*Tommi Tervonen*, Faculty of Economics and Business, University of Groningen, PO Box 800, 9700AV, Groningen, t.p.tervonen@rug.nl, *Douwe Postmus, Hans Hillege*

Regulatory agencies require drugs entering the market to have sufficient benefit-risk ratio in comparison to other drugs within the same therapeutical group. To provide more transparent and traceable decision making in line with principles of public European institutions, a more structured decision making process will be an advantage. In this presentation, we show how MCDA can be applied to drug benefit-risk analysis in a way that takes into account different domains of clinical data. We analyze the therapeutical group of erectile dysfunction drugs consisting of Viagra, Levitra, and Cialis.

#### 2 - MCDM tools in metsähallitus

*Veikko Hiltunen*, Forestry, Kainuu, Metsähallitus, Viestitie 2, 87700, Kajaani, Finland, Veikko.Hiltunen@metsa.fi

In multiple use management of state-owned lands, forests and waters in Finland a participatory planning process on regional level is applied. Plans are compiled for a ten year period by assessing production possibilities of the region and generating optional management strategies. Strategies are evaluated with help of MCDM tools. AHP, SMART and voting methods have been applied during the last 15 years. They have improved transparency of the processes, as well as acceptance of the results.

#### 3 - A multi-criteria evaluation of household energy efficiency in South Africa

*Ian Durbach*, Department of Statistical Sciences, University of Cape Town, Room 3.04 PD Hahn North building, University of Cape Town Rondebosch, 7701, Cape Town, Western Cape, ian.durbach@uct.ac.za, *Stephen Davis*

Using a combination of systems dynamics and multi-criteria analysis, we build a simulation model of household energy consumption for a community in a small town in South Africa where an energy efficiency intervention took place. Longitudinal data collected from the community provides an empirical basis for the model as well as guiding numerical inputs to the simulation. The model is used as a basis for evaluating different energy-saving strategies and awareness campaigns.

#### 4 - Decision support for centralizing cargo at a moroccan airport hub using stochastic multicriteria acceptability analysis

*Risto Lahdelma*, Department of Energy Technology, Helsinki University of Technology, PL 4100, 02150, Espoo, Finland, risto.lahdelma@hut.fi, *Abdellah Menou, Abdelhanine Benallou, Pekka Salminen*

We evaluate different alternatives to centralize multimodal cargo at a Moroccan airport hub. Some of the evaluation criteria are measured cardinally, while for others only ordinal assessment is feasible. Significant uncertainty is present in both the criteria measurements and the preferences. We apply Stochastic Multicriteria Acceptability Analysis (SMAA). SMAA allows the representation of a mixture of uncertain, imprecise and partially missing information in a consistent way. The results describe the conditions that make each alternative the most preferred one, or give it a particular rank.

## TC-07

Tuesday 11:20-12:40

GSI - S 29

### Network and Route Design

Stream: Optimization in Public Transport

Invited session

Chair: *Hilmi Berk Celikoglu*, Department of Civil Engineering, Technical University of Istanbul, Faculty of Civil Eng., Division of Transportation, Ayazaga Campus, Maslak, 34469, Istanbul, Turkey, celikoglu@itu.edu.tr

#### 1 - Improving the efficiency of swedish paratransit: an application of the dial-a-ride problem

*Carl Henrik Häll*, Dept of Science and Technology, Linköping University, Linköping University, Dept of Science and Technology (ITN), 60174, Norrköping, carha@itn.liu.se, *Jan T. Lundgren, Anders Peterson*

We study a Swedish application of the dynamic dial-a-ride problem where a major part of the requests is known in advance. Based on these requests we use a tabu search heuristic to find an efficient preliminary schedule. An insertion heuristic is then used for the remaining requests and local search procedures can improve the solution successively. These procedures are based on extraction and reinsertion of different subsets of all planned requests. Tests are made using data from the municipality of Norrköping in Sweden, having some 600 requests to be served each day.

#### 2 - A stochastic reduction approach for public transport network design using ant colony optimisation and genetic algorithm

*Bernhard Alt*, Institute for Transport Planning and Systems (IVT), ETH Zurich, Wolfgang-Pauli-Str. 15, 8093, Zurich, Switzerland, alt@ivt.baug.ethz.ch

For public transport network design a new approach is proposed being able to use a more realistic transport model without increasing computing times too much. Its core is a reduction process, which requires comparatively few network evaluations. The reduction process starts with a shortest routes network. Lines are deleted, merged or shortened sequentially using ant colony optimization. A genetic algorithm optimizes frequencies and vehicle sizes. For evaluation, mainly time costs and operating costs are considered. The used assignment is a headway based stochastic multiple route assignment.

### 3 - Equilibrium traffic assignment models calibration and o-d matrix estimation by aggregate data

*Michele Ottomanelli*, DIASS, Technical University of Bari, Via De Gasperi, 74100, Taranto, m.ottomanelli@poliba.it, *Leonardo Caggiani*, *Domenico Sassanelli*

A Generalized Least Square (GLS) estimator is presented to solve the simultaneous assignment model calibration and O-D matrix estimation based on aggregate data. The calibration problem is specified as an optimization problem using a fixed point formulation assuming the congested network case (equilibrium programming).

## ■ TC-08

Tuesday 11:20-12:40  
GSI - S 30

### Integrated vehicle scheduling

Stream: Optimization in Public Transport  
Invited session

Chair: *Leo Kroon*, Rotterdam School of Management, Erasmus University Rotterdam, P.O. Box 1738, 3000 DR, Rotterdam, Netherlands, lkroon@rsm.nl

#### 1 - Integrating timetabling and vehicle scheduling

*Neele Hansen*, ITWM Fraunhofer, Fraunhofer Platz 1, 67663, Kaiserslautern, Germany, neele.hansen@gmail.com, *Sven Krumke*

We consider the task to construct an optimal vehicle schedule in a variable timetable. We are given tours to be covered by vehicles and for each tour a finite set of possible shifts. Depending on the selection of shifts, it may be possible to combine tours. However, choosing shifts influences the transit times of customers at the changeover station which is reflected in the model by a penalty value. The goal is to minimize the sum of the penalty values and the cost of serving of all tours. We provide hardness results for various cases and computational results on real-world data.

#### 2 - Modeling a simultaneously line network and schedule optimization in public transport

*Michael Rittner*, Chair for Traffic Flow Science, TU-Dresden, Faculty of Transport and Traffic Science, Hettnerstr. 1, 01069, Dresden, Saxony, michael.rittner@tu-dresden.de, *Karl Nachtigall*

To create a competitive offer in public transport, it is necessary to use the limited financial resources of the transport companies in an optimal way to ensure a high quality transport for the passenger. In this paper a mixed model for simultaneous line network and schedule optimization in public passenger transport is presented, which is modeled as a mixed integer linear problem. One of the major challenges is to maintain a linear model by adding the precise operating costs, the interchange waiting times, and the special schedule restrictions.

### 3 - A framework for a flexible vehicle scheduling system

*Jozsef Bekesi*, University of Szeged, H-6725, Szeged, Hungary, bekesi@jgypk.u-szeged.hu, *Miklos Kresz*, *David Pash*, *Andrej Brodnik*

A flexible framework for vehicle scheduling is presented which was developed for public bus transportation systems. The framework builds upon the theoretical foundation that has been established in this area and extends it to incorporate additional real-world constraints. We have applied our approach to the urban bus system of two middle-sized cities, and computed substantially better schedules than the previous ones prepared by-hand. Finally, we present some preliminary results in improving the computational time through the use of a parallel computing environment.

## ■ TC-09

Tuesday 11:20-12:40  
GSI - S 5

### Production Systems

Stream: Supply Chain Management  
Invited session

Chair: *Yamani Massim*, ICD (CNRS FRE 2848) LOSI,, Universite de Technologie de Troyes, 10000, Troyes, France, yanimassim@yahoo.fr

#### 1 - The integration of kanban principles in campaign production systems

*Jürgen Strohhecker*, Management Research Centre, Frankfurt School of Finance & Management, Sonnemannstraße 9-11, 60314, Frankfurt am Main, Germany, Germany, j.strohhecker@frankfurt-school.de, *Rainer Sibbel*, *Marcel Dick*

Centralized planned campaign production is the predominant production system in the process industry. In this paper we investigate, if a decentralized KANBAN system, which has given proof of its advantages in other industries, can be integrated in a campaign production environment. For this purposes we use a research methodology, which combines model- and case-study-based elements. We find that a KANBAN campaign production system can be favourable; however, using a pilot scheme cannot be recommended, when the campaign sizes for other products seizing the same equipment are too high.

#### 2 - An integrated simulation based nonlinear integer programming approach for minimization of surplus inventory in selective assembly

*Erdal Emel*, Industrial Engineering Department, Uludag University, Faculty of Engineering and Architecture, Gorukle Campus, 16059, Bursa, Turkey, erdal@uludag.edu.tr, *Mehmet Akansel*, *Volkan Hacıoglu*

A simulation optimization model is developed to minimize the surplus inventory of two matching parts. A nonlinear integer mathematical model is used to obtain process means of parallel workstations feeding selective assembly. Only process mean of part with smaller variance can be shifted. Using calculated means in a simulation model, average inventory levels are obtained at the end of a given production time. Optimal production time before shifting means is then calculated by EOQ model with average costs obtained from simulation with varying production times using response surface methods.

### 3 - A fuzzy programming approach for an integrated production and distribution planning problem with uncertain conditions

*Bilge Bilgen*, Industrial Engineering, Dokuz Eylul University, Tinaztepe Campus, Buca, 35160, Izmir, Turkey, bilge.bilgen@deu.edu.tr

This paper applies fuzzy sets to the production and distribution planning problem in a supply chain system that involves the allocation of production volumes among the different production lines in the manufacturing plants and the delivery of the products to the distribution centers. The proposed fuzzy attempts to minimize the total supply chain cost considering production, vehicle capacity, setup and demand restrictions. An industrial case is presented to demonstrate the feasibility and applicability of the model.

### 4 - Efficient combined immune-decomposition algorithm for optimal buffer allocation in production lines for throughput and profit maximization

*Yamani Massim*, ICD (CNRS FRE 2848) LOSI, Université de Technologie de Troyes, 10000, Troyes, France, yamanimassim@yahoo.fr, *Farouk Yalaoui*, *Lionel Amodeo*, *Eric Chatelet*, *Abdelkader Zebilah*

The optimal allocation of buffers in transfer lines is crucial to the optimization of line throughput and work in process inventory (WIP) and is subject to specific constraints, associated costs, and revenue projections. In this paper, we implement an efficient combined artificial immune system optimization algorithm in conjunction with a decomposition method to optimally allocate buffers in transfer lines with unreliable machines. Results of extensive series of tests carried out to compare the performance of the proposed method and those of other algorithms are presented.

## ■ TC-10

Tuesday 11:20-12:40

GSI - S 6

### Educational Timetabling

Stream: Timetabling and Rostering

*Invited session*

Chair: *Wolfgang Brüggemann*, Inst. f. Unternehmensforschung, Universität Hamburg, Von-Mell-Park 5, 20146, Hamburg, Germany, brueggemann@uni-hamburg.de

#### 1 - Scheduling college classes at two universities using operations research techniques

*Terri Friel*, Walter E Heller College of Business Administration, Roosevelt University, 430 S. Michigan Avenue, 60605, Chicago, IL, tfriel@roosevelt.edu, *Barry King*

This paper outlines successful efforts taken at Butler University to construct semester class schedules using a mixed integer linear programming problem to develop a schedule of classes and an assignment procedure to assign faculty to the schedule. The work at Butler University was performed in SAS using SAS's OPTMILP mixed integer linear program solver and the MPS modeling language and SAS's ASSIGN solver for the assignment phase. The paper also discusses an improved version at Roosevelt University for scheduling classes using the AMPL modeling language and the Ipsolve mixed integer solver.

#### 2 - A multiobjective mathematical model for exam-timeslot-room assignment problem

*Mujgan Sagir*, Industrial Engineering Dept., Eskisehir Osmangazi University, Bademlik, 26030, Eskisehir,

Turkey, mujgan.sagir@gmail.com, *Zehra Kamisli Ozturk*

Assigning exams to time slots is a time consuming problem educational institutions face a few times in each term. Room assignments are either considered within the exam scheduling or can be solved separately. Here, a multi objective mathematical model, with room splitting, is developed for exam-timeslot-room assignments. A real case application is provided. The outcome is compared with the current schedule. The proposed approach gives better solutions will increase overall performance of the educational systems from the point of students view as well as efficient use of resources.

#### 3 - Optimal preference-based assignment of university students to parallel offered teaching groups

*Wolfgang Brüggemann*, Inst. f. Unternehmensforschung, Universität Hamburg, Von-Mell-Park 5, 20146, Hamburg, Germany, brueggemann@uni-hamburg.de, *Henrik Heitmann*

In a university-course timetabling problem, there may be many parallel sections of the same class or tutorial which do not necessarily need to be scheduled simultaneously. Then each student must subsequently be assigned to one of these groups. Students' preferences can be used as the objective of the resulting mixed-integer optimization problem with the additional constraints that time clashes have to be avoided on an individual basis. The structure of possible preferences is explored by survey data and first results for artificial test instances of this problem are discussed.

## ■ TC-11

Tuesday 11:20-12:40

GSI - S 17

### Algorithmic Decision Theory I

Stream: Multiple Criteria Decision Analysis

*Invited session*

Chair: *Alexis Tsoukiàs*, CNRS - LAMSADE, Université Paris Dauphine, 75775, Paris Cedex 16, France, tsoukias@lamsade.dauphine.fr

#### 1 - Additive conjoint measurement with ordered categories

*Denis Bouyssou*, CNRS-LAMSADE, France, bouyssou@lamsade.dauphine.fr, *Thierry Marchant*

Conjoint measurement studies binary relations defined on product sets. The central model is the additive value functions model. Building a recommendation on the basis of a preference relation between alternatives is not always adequate since the model is relative. This calls for methods having a more absolute character. They lead to build a partition of the set of alternatives into ordered categories. This paper studies additive representations. Our main result will give sufficient conditions for the existence of an additive representation of a threefold ordered partition.

#### 2 - What is a decision problem?

*Alexis Tsoukiàs*, CNRS - LAMSADE, Université Paris Dauphine, 75775, Paris Cedex 16, France, tsoukias@lamsade.dauphine.fr, *Alberto Colomi*

In this paper we propose a general framework enabling to define as decision problem a variety of situations both in a human or in an artificial setting. We define the concept of "problem statement" and then specify a number of characteristics which characterise different decision problems and the methodology to handle them. The framework allows to define both traditional Operational Research problems as well as problems arising in Computer Science and Artificial Intelligence.

### 3 - Reaching a decision is great, but it's even better if it is justified

Wassila Ouerdane, LAMSADE- Université Paris Dauphine, Place du Marechal de Lattre de Tassigny, 75016, PARIS, wassila.ouerdane@lamsade.dauphine.fr

We propose, in this work, to specify in argumentative terms the steps involved in an evaluation stage of a decision aiding process, a sort of dialogue between a decision maker and an analyst. To do that, we make use of the popular notion of argument schemes, and specify the related critical questions. A hierarchical structure of the schemes allows to decompose the process into several distinct steps and for each of them the underlying premises are made explicit, which allows in turn to identify how these steps can be dialectically defeated via critical questions.

### 4 - Questioning about weights and the strength of coalitions of criteria

Marc Pirlot, Mathematics and Operational Research, Faculté Polytechnique de Mons, Rue de Houdain 9, B-7000, Mons, Belgium, marc.pirlot@fpms.ac.be, Ersek Eda, Philippe Fortemps

We consider the problem of determining which coalitions are sufficiently strong in a multiple criteria aggregation procedure of the ELECTRE type (especially in the non-compensatory sorting model of Bouyssou and Marchant). Since we do not assume that the strength of a coalition can be represented by additive weights, the problem amounts to determine an antichain in the set of all subsets of criteria, namely, the antichain of minimally sufficient coalitions. We propose an algorithm for guiding a questioning process dynamically and another for finding an optimal questioning strategy.

## TC-12

Tuesday 11:20-12:40

GSI - S 18

### Risk and Dynamics

Stream: Stochastic Programming

Invited session

Chair: *Silvia Vogel*, Mathematics and Natural Sciences, Ilmenau University of Technology, Postfach 100565, 98684, Ilmenau, Thuringia, Germany, Silvia.Vogel@tu-ilmenau.de

Chair: *Ralf Wunderlich*, Group of Mathematics, University of Applied Sciences, PSF 201037, 08056, Zwickau, Germany, ralf.wunderlich@fh-zwickau.de

### 1 - Multiperiod optimization with stochastic dominance criterion

Milos Kopa, Department of Probability and Mathematical Statistics, Charles University in Prague, Faculty of Mathematics and Physics, Sokolovská 83, CZ 186 75, Prague, Czech Republic, kopa@karlin.mff.cuni.cz

This paper deals with multi-period portfolio selection model under stochastic dominance (SD) criteria. Following the SD efficiency ideas in one-period portfolio selection problem, the efficient investment strategy is defined. Second-order stochastic dominance (SSD) rule is considered as a criterion of efficiency. The algorithm for testing SSD efficiency of a given multi-period strategy is derived. Theoretical results are illustrated on a financial empirical example.

### 2 - Time consistency for multiperiod risk measures: a reasonable concept?

Raimund Kovacevic, Statistics and Decision Support Systems, University Vienna, Universitätsstr. 5, 1010, Wien, Wien, raimund.kovacevic@univie.ac.at

Time consistency of dynamic and multiperiod risk or acceptability functionals is a frequently discussed subject in financial risk analysis. We summarize related notions in a simple framework and analyze their basic properties. Special care is taken of partially conflicting concepts like information monotonicity and of applicability within the framework of multistage stochastic programming.

### 3 - Dynamic portfolio optimization with bounded shortfall risks

Ralf Wunderlich, Group of Mathematics, University of Applied Sciences, PSF 201037, 08056, Zwickau, Germany, ralf.wunderlich@fh-zwickau.de, Jörn Sass

We consider the optimal selection of portfolios for utility maximizing investors under joint budget and shortfall risk constraints. The shortfall risk is measured in terms of the expected loss. Stock returns satisfy a stochastic differential equation with an unobservable drift process leading to a market model with partial information. Under general conditions on the corresponding drift process we provide the optimal trading strategy using martingale method and Malliavin calculus. For a hidden Markov model (HMM) for the drift we present numerical results.

## TC-13

Tuesday 11:20-12:40

GSI - S 31

### Location and GIS

Stream: Location Analysis

Invited session

Chair: *Dolores R. Santos-Peñate*, Métodos Cuantitativos en Economía y Gestión, University of Las Palmas de Gran Canaria, Campus de Tafira. Edificio Dptal de Ciencias Económicas y Empresariales D-4-22, 35017, Las Palmas de Gran Canaria, Canarias, Spain, drsantos@dmc.ulpgc.es

### 1 - Choosing a suitable map projection for GIS purposes

Osman Sami Kirtiloglu, Geodesy and Photogrammetry, Selcuk University, Division of Cartography, 42031, Konya, Selcuklu, okirtiloglu@selcuk.edu.tr, I.Bulent Gundogdu

The goal of studying map projections is to create mathematical basis for the production of maps prepared on a flat surface. This transforming operation always results in some unexpected distortion like, area, shape, distance and directions, of the original attributes of the earth. Some map projections minimize distortion in one property at the expense of another, while others strive to balance the overall distortion. In this study, a new approach to choose an appropriate map projection for the best cartographic display of thematic maps according to subject has been investigated.

### 2 - Gis-based spatial interaction allocation using stochastic optimization

Eric Delmelle, Geography and Earth Sciences, University of North Carolina at Charlotte, 9201 University BLVD, UNCC, 28223, Charlotte, NC, Eric.Delmelle@uncc.edu

Optimally locating transportation infrastructure is deemed vital to successful planning, as they represent a potential to alleviate congestion. GIS facilitates location modeling by concurrently integrating geographic information and optimization solvers. A spatial interaction based location allocation model is proposed, which -unlike the MCLP or P-median- simultaneously considers distance decay, coverage range and partial regional service. A stochastic optimization is suggested to solve this non-linear model. A case study illustrates the approach using GIS and bus stop locations.

### 3 - A gis-based decision support system for competitive facility location

*Burcin Bozkaya*, Faculty of Management, Sabanci University, Orhanli, Tuzla, 34956, Istanbul, Turkey, [bbozkaya@sabanciuniv.edu](mailto:bbozkaya@sabanciuniv.edu), *Seda Yanik*

Competitive facility location problems involve decisions regarding location of new facilities (e.g. stores, bank branches) in the presence of competitors. Potential customers patronize facilities in relation to the attractiveness of each facility, in accordance with an extended version of Huff model. We present a novel DSS we have developed based on these premises. Users can specify problem parameters, review location decisions generated via optimization, create solutions manually and compare them with the proposed solution. We illustrate the system on a real dataset from the City of Istanbul.

### 4 - A multi-criteria gis based procedure to solve a network competitive location problem

*Rafael Suarez-Vega*, Metodos Cuantitativos en Economia y Gestion, Universidad de Las Palmas de Gran Canaria, Edificio Departamental de Ciencias Economicas y Empresariales, Campus Universitario de Tafira, 35017, Las Palmas de Gran Canaria, Las Palmas, Spain, [rsuarez@dmc.ulpgc.es](mailto:rsuarez@dmc.ulpgc.es), *Dolores R. Santos-Peñate*, *Pablo Dorta-González*

In this paper a competitive network location problem is treated. We consider a proportional choice rule derived from the Huff model, where facility location and other attributes, such as size and service quality, are considered. This problem is solved using Geographical Information Systems. Later, the obtained layer with the Huff capture is considered as a criterion to determine the most promising zones on the island of Gran Canaria to localize a new hypermarket using a multi-criteria GIS based model.

## ■ TC-14

Tuesday 11:20-12:40

GSI - S 32

### Supply Chain Inventories

Stream: Inventory Management

*Invited session*

Chair: *Jörn Grahl*, Information Systems & Business Administration, University of Mainz, Jakob Welder-Weg 9, 55099, Mainz, [grahl@uni-mainz.de](mailto:grahl@uni-mainz.de)

#### 1 - Inventory planning in standard business software

*Thomas I. Maindl*, University of Cologne, Cologne, Germany, [maindl@yahoo.com](mailto:maindl@yahoo.com), *Sascha Herpers*

This paper gives an overview of the inventory planning capabilities of standard business software, namely the SAP Business Suite and is intended to bridge the domains of supply chain management theory and the business software industry including Enterprise Resource Planning and Advanced Planning Systems.

#### 2 - An integrated approach to safety stock optimization in serial supply networks

*Daniel Dittmar*, Schumpeter School of Business, University of Wuppertal, WINFOR - Business

Computing and Operations Research, Gaußstr. 20, 42097, Wuppertal, [ddittmar@winfor.de](mailto:ddittmar@winfor.de), *Steffen Klosterhalfen*, *Stefan Minner*

Safety stock is a widely used means to cope with demand uncertainty in supply chains. In the literature, basically two competing approaches are available for optimizing safety stocks in multi-echelon networks, the Guaranteed Service Approach (GSA) and the Stochastic Service Approach (SSA). We introduce a combination of both approaches, the so-called Hybrid Service Approach (HSA), which exploits their respective advantages. For serial supply chains, we present the HSA optimization model and show how it can be solved to optimality by a dual-state dynamic programming algorithm.

### 3 - Multiple sourcing in multi-echelon inventory systems

*Steffen Klosterhalfen*, Department of Logistics, University of Mannheim, Schloss S 233, Mannheim, 68131, Mannheim, Baden-Wuerttemberg, Germany, [klosterhalfen@bwl.uni-mannheim.de](mailto:klosterhalfen@bwl.uni-mannheim.de), *Stefan Minner*, *Sean Willems*

Multiple sourcing is very common in practice, but there are only few scientific contributions considering multiple suppliers or transportation modes in large multi-echelon systems. We show how to include multiple sourcing in the guaranteed-service framework. With respect to the inventory control policy, we assume that each stage splits its orders across multiple sources according to certain supply fractions. For serial systems, we show that the optimal policy still satisfies the all-or-nothing property. This property is exploited in the development of a solution algorithm.

### 4 - Lower bounds for the cost of strategic safety stocks in multiple echelons

*Jörn Grahl*, Information Systems & Business Administration, University of Mainz, Jakob Welder-Weg 9, 55099, Mainz, [grahl@uni-mainz.de](mailto:grahl@uni-mainz.de)

We consider multi-stage safety stock optimization in the guaranteed service framework. Two techniques are presented for bounding minimal cost from below. The first lower bound constructs a suggorate problem instance whose optimum is known and cheaper than that of the original problem instance. The second lower bound is based on marginal costs arising from service time allocations. Both bounds are evaluated in experiments. First steps towards approximation algorithms are presented also.

## ■ TC-15

Tuesday 11:20-12:40

Einstein

### Exact Approaches for Routing Problems

Stream: Vehicle Routing

*Invited session*

Chair: *Andrea Tramontani*, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, [andrea.tramontani@unibo.it](mailto:andrea.tramontani@unibo.it)

#### 1 - An exact method for the vehicle routing problem with time windows

*Roberto Roberti*, DEIS, University of Bologna, Via Sacchi, 3, 47023, Cesena, Italy, [roberto.roberti6@unibo.it](mailto:roberto.roberti6@unibo.it), *Roberto Baldacci*, *Aristide Mingozzi*

We present an exact algorithm for the Vehicle Routing Problem with Time Windows based on the set partitioning formulation. A valid lower bound is computed combining different dual ascent procedures and a pricing and cut method. The final dual solution is used to generate a reduced problem containing the routes that can belong to any optimal solution. The final problem is solved by a general purpose integer programming solver. Computational results show that the proposed method solves to optimality all but one Solomon instances and outperforms the best known methods.

## 2 - An integer programming approach for the time dependent travelling salesman problem

*Juan Jose Miranda Bront*, Computer Science Department, University of Buenos Aires, Av. Cantilo s/n, Pabellon I, Cdad. Universitaria, C1428EGA, Ciudad Autonoma de Buenos Aires, [jmiranda@dc.uba.ar](mailto:jmiranda@dc.uba.ar), *Isabel Méndez-Díaz*, *Paula Zabala*

The Time-Dependent Travelling Salesman Problem (TDTSP) is a generalization of the traditional TSP where the travel cost between two cities depends on the moment of the day the arc is taken. In this paper, we focus in the case where the travel time between two cities depends not only on the distance between them, but also on the position of the arc in the tour. We consider the formulation proposed in Picard and Queyranne (1978) and derive some valid inequalities. We also present computational results for a Branch and Cut algorithm that incorporates these inequalities.

## 3 - An extended formulation for the traveling salesman problem with time windows

*Andrea Tramontani*, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, [andrea.tramontani@unibo.it](mailto:andrea.tramontani@unibo.it), *Sanjeeb Dash*, *Oktay Gunluk*, *Andrea Lodi*

We address the Traveling Salesman Problem with Time Windows (TSPTW). We present an extended integer programming formulation for TSPTW, based on a relaxed discretization of time windows. The proposed formulation yields strong lower bounds and leads to strong valid inequalities which can be effectively separated. The resulting branch-and-cut algorithm is tested on hard asymmetric benchmark instances from the literature. The results show that the proposed formulation is effective for tackling TSPTW. Interestingly, several unsolved benchmark instances are here solved for the first time.

## ■ TC-16

Tuesday 11:20-12:40

Koenig

### Multicriteria Routing 1

Stream: Multi-Objective Optimization and Decision Theory 1

*Invited session*

Chair: *José Santos*, Department of Mathematics, University of Coimbra, Department of Mathematics, FCTUC, Apartado 3008, 3001-454 Coimbra, 3001-454, Coimbra, Portugal, [zeluis@mat.uc.pt](mailto:zeluis@mat.uc.pt)

#### 1 - Multi-criteria shortest paths in road networks with sharc

*Daniel Delling*, ITI Wagner, Universität Karlsruhe (TH), Am Fasanengarten 5, 76128, Karlsruhe, [delling@ira.uka.de](mailto:delling@ira.uka.de), *Dorothea Wagner*

Up to now, research on speed-up techniques for Dijkstra's algorithm focused on single-criteria scenarios. In this work, we study multi-criteria search in road networks. We present a multi-criteria variant of our SHARC algorithm. Unlike other speed-up techniques for Dijkstra's algorithm, SHARC uses a unidirectional query making it the first choice for adapting a technique to a multi-criteria scenario. It turns out that multi-criteria SHARC yields speed-ups of a factor of up to 15000 over a generalized version of Dijkstra's algorithm. This is even more than in a single-criteria setup.

#### 2 - A solution approach for the multicriteria shortest path problem with soft constraints

*Luigi Di Puglia Pugliese*, Dipartimento di Elettronica, Informatica e Sistemistica, Università della Calabria, Via Bucci, 87030, Rende, [ldipuglia@deis.unical.it](mailto:ldipuglia@deis.unical.it), *Francesca Guerriero*, *Janusz Granat*

The multicriteria single-origin single-destination shortest path problem is considered. Moreover, each criterion value belongs to a specified range. The considered problem can be formulated as a constrained multicriteria shortest path problem. Generally, the optimal solution could not exist. Thus, the main aim is to find a solution for which each criterion is very close to the bound interval. The problem is formulated using the reference point methodology and a Branch & Bound algorithm is developed for its solution. The behaviour of the proposed approach is experimentally evaluated.

#### 3 - Parameters to assess the computational effort involved in the multi-criteria shortest path problem

*José Santos*, Department of Mathematics, University of Coimbra, Department of Mathematics, FCTUC, Apartado 3008, 3001-454 Coimbra, 3001-454, Coimbra, Portugal, [zeluis@mat.uc.pt](mailto:zeluis@mat.uc.pt), *José Paixão*

In the multi-criteria shortest path problem there is no, in general, a single solution that minimizes all criteria, addressing us to find the Pareto optimal solutions (POS) set. The computational effort to compute the POS between the initial and terminal nodes depends on the total number of POS to the remainder nodes. However, this fact does not explain alone all this effort especially when comparing results among different types of network. In this work we propose new parameters to assess the computational effort with a correlation coefficient greater than other parameters from the literature

#### 4 - The bicriterion stochastic knapsack problem

*Kim Allan Andersen*, CORAL, Department of Business Studies, Aarhus School of Business, Fuglesangs Alle 4, 8210, Aarhus V, Denmark, [kia@asb.dk](mailto:kia@asb.dk), *Matthias Ehrgott*, *Lars Relund Nielsen*, *Daniele Pretolani*

We have a known capacity of a resource, and a set of projects. Each project requires some units of the resource which is given by a discrete probability distribution. The resource requirements become known when a project has been selected. In that case two rewards are received, which only depend on the project chosen. The goal is to design a set of resource adaptive strategies for choosing the projects such that the total expected value of the two objective functions is maximized.

We describe a two-phase method for solving the problem. Preliminary computational results are presented.

## ■ TC-17

Tuesday 11:20-12:40

Rheinaue

### Cutting and Packing 5

Stream: Cutting and Packing

*Invited session*

Chair: *Reinaldo Morabito*, Dept. of Production Engineering, Federal University of São Carlos, CP 676, 13565-905, São Carlos, Sao Paulo, Brazil, morabito@ufscar.br

#### 1 - 3d bin packing problem with fuzzy information

*Ugur Eliiyi*, Department of Statistics, Dokuz Eylul University, Tinaztepe Kampusu, Buca, 35160, Izmir, Turkey, ugr.eliiyi@ogr.deu.edu.tr

We review alternative solution approaches for the 3D Bin Packing Problem in literature. The problem involves the packing of 3D objects in a minimum number of containers. Relevant industrial and scientific application areas are reviewed, as well as the main features of the optimization software applications for handling the problem. We redefine and model the problem in the presence of fuzzy information, which corresponds to fuzzy dimensions for the objects and/or the container. Heuristic algorithms for efficiently solving this hard problem and possible application areas are discussed.

#### 2 - A mip approach for solving the stowage problem on board the international space station

*Giorgio Fasano*, Space Infrastructures & Transportation, Thales Alenia Space Italia, Str. Antica di Collegno 253, 10146, Turin, Italy, giorgio.fasano@thalesalieniaspace.com, *Claudia Lavopa*, *Maria Chiara Vola*, *Davide Negri*

A challenging issue related to the International Space Station concerns the stowage on-board, giving rise to strong impacts to productivity, habitability and safety. Very demanding packing problems must be solved efficiently, with high cost-effectiveness to optimize the stowage, increasing habitability and crew productivity. The volume exploitation has to be maximized with the given accommodation rules. A MIP-based heuristic tackles the issue by a sequence of sub-problems, formulated in terms of knapsack, bin packing and three-dimensional single bin packing with additional conditions.

#### 3 - A fast heuristic for a three-dimensional non-convex domain loading problem

*Antonio Sforza*, Dipartimento di Informatica e Sistemistica, Università di Napoli, via Claudio 21, 80125, Napoli, Italy, sforza@unina.it, *Maurizio Boccia*, *Claudio Sterle*

A three-dimensional non-convex domain loading problem is presented. We have to load homogenous boxes into a non-convex domain. The boxes have size  $dx \times dx \times md$ , with  $n$  and  $m$  integer values. This problem has never been treated in literature, neither with exact nor with heuristic methods. We present a fast heuristic based on an approximate representation of the non-convex domain and on the decomposition of the whole problem in several two-dimensional sub-problems. It shows good performances in terms of quality of solution and computation times. The results on several real test cases are shown.

#### 4 - Optimization models for container loading problems with cargo stability and other considerations

*Reinaldo Morabito*, Dept. of Production Engineering, Federal University of São Carlos, CP 676, 13565-905, São Carlos, Sao Paulo, Brazil, morabito@ufscar.br, *Leonardo Junqueira*, *Denise Yamashita*

In this paper we present 0-1 integer linear programming models for the container loading problem, considering cargo stability and load bearing strength of the boxes. In order to validate the models, we generated a number of instances and solved them using commercial software. Although the models are limited to solve to optimality only problems of moderate size, these models can be useful for future research exploring decompositions, relaxations, heuristics and others.

## ■ TC-18

Tuesday 11:20-12:40

Lenné

### Nonlinear Optimization and Applications

Stream: Mathematical Programming

*Invited session*

Chair: *Ana I. Pereira*, Polytechnic Institute of Braganca, Campus de Sta Apolonia, Apartado 134, 5301-857, Braganca, Portugal, apereira@ipb.pt

Chair: *Edite M.G.P. Fernandes*, Production and Systems, University of Minho, School of Engineering, Campus de Gualtar, 4710-057, Braga, Portugal, emgpf@dps.uminho.pt

#### 1 - Minimizing wastewater treatment plant costs through a heuristic pattern search augmented Lagrangian algorithm

*Isabel Espírito Santo*, Production and Systems, Minho University, Campus de Gualtar, 4710-057, Braga, Portugal, iapinho@dps.uminho.pt, *Edite M.G.P. Fernandes*

To reduce costs of a wastewater treatment plant, it is crucial to obtain its optimal design through the efficient modeling of the unitary processes and subsequent optimization. A non-differentiable nonlinear optimization problem then arises. The equality and inequality constraints of the problem are handled by an augmented Lagrangian based penalty technique. The bound constrained problem is solved by a heuristic pattern search method. It combines the exploratory moves with a random derivative-free approximate descent direction. The method is tested with data gathered from four small plants.

#### 2 - Modified differential evolution for constrained nonlinear programming problems

*Md. Abul Kalam Azad*, Production and Systems, University of Minho, Portugal, School of Engineering, Algoritmi R&D, 4710-057, Braga, Braga, Portugal, akazad@dps.uminho.pt, *Edite M.G.P. Fernandes*

Real world optimization problems involve inequality and/or equality constraints with bounds on variables. Various methods exist to handle constrained optimization problems. Differential evolution is a population based heuristic approach that has been shown to be very efficient when solving continuous bound constrained problems. We propose a modified differential evolution for general nonlinear optimization problems based on tournament selection which makes pair-wise comparisons from current and previous generations. We test our method with economic dispatch problems.

#### 3 - Filter and interior point approaches for an electric power market optimization problem

*M. Teresa Torres Monteiro*, Systems and Production Department, University of Minho, Campus de Gualtar, Engineering School, 4710-357, Braga, Portugal, tm@dps.uminho.pt, *Helena Sofia Rodrigues*

The electric power market is represented by a Stackelberg game with two firms. Initially, this optimization problem is formulated as a Mathematical Program with Complementarity Constraints (MPCC). Then, it is reformulated into a nonlinear optimization problem (NLP) in order to take advantage of NLP solvers robustness. Some NLP solvers based on Filter and Interior Point approaches are used to solve the problem. A performance comparative analysis is reported.

#### 4 - Optimal control with nonlinear programming

*Helena Sofia Rodrigues*, Escola Superior de Ciências Empresariais, Instituto Politécnico de Viana do Castelo, Av. Miguel Dantas, 4930-678, Valença, Portugal, [sofiarodrigues@esce.ipv.pt](mailto:sofiarodrigues@esce.ipv.pt), *M. Teresa Torres Monteiro*, *Delfim F. M. Torres*

In general solving an optimal control problem is not easy. One way to address the question consists to look to an optimal control problem as an infinite-dimensional extension of a Nonlinear Programming (NLP) problem. In this work we investigate the use of NLP techniques to solve some classical and recent challenging problems of optimal control.

### ■ TC-19

Tuesday 11:20-12:40

Haber

#### Tabu search

Stream: Metaheuristics

*Invited session*

Chair: *Nihan Karaca*, Industrial Engineering, Istanbul Kultur University, Osman Yilmaz Mah.Millet Cad. Mimoza Apt. Gebze/Kocaeli/Turkey, 41400, Kocaeli, Turkey, [karacanihan@gmail.com](mailto:karacanihan@gmail.com)

#### 1 - Fast tabu search implementations for atspes defined on complete graphs

*Diptesh Ghosh*, Production and Quantitative Methods, Indian Institute of Management, Ahmedabad, Vastrapur, Ahmedabad, Gujarat, India, [diptesh@iimahd.ernet.in](mailto:diptesh@iimahd.ernet.in), *Sumanta Basu*

Using appropriate data structures, it is possible to implement tabu search (TS) to solve asymmetric traveling salesman problems (ATSPs) defined on sparse graphs much faster than conventional TS implementations. In this paper we use such data structures to speed up TS implementations to solve ATSPs defined on complete graphs. We first pre-process ATSPs defined on complete graphs to obtain ATSPs defined on sparse graphs. We then use TS to solve the pre-processed instances without significant deterioration in solution quality. We report our computational experience on benchmark ATSPs.

#### 2 - Improving slicing layouts with bottom left positioning of departments

*Daniel Scholz*, FB 01 FG Operations Research, TU Darmstadt, Hochschulstr. 1, 64289, Darmstadt, Germany, [scholz@bwl.tu-darmstadt.de](mailto:scholz@bwl.tu-darmstadt.de)

The facility layout problem is concerned with determining a layout of departments within a building that minimizes the costs of interdepartmental flow of material. In contrast to many previous approaches, the presented approach incorporates unequal areas and fixed or flexible width to length ratios of departments. We present a MILP based heuristic which improves initial slicing layouts with all departments positioned at the bottom left of their sites. These initial layouts were generated by a Slicing Tree and Tabu Search (STaTS) approach.

#### 3 - Assembly line balancing with sequence dependent setup times using tabu search algorithm

*Nihan Karaca*, Industrial Engineering, Istanbul Kultur University, Osman Yilmaz Mah.Millet Cad. Mimoza Apt. Gebze/Kocaeli/Turkey, 41400, Kocaeli, Turkey, [karacanihan@gmail.com](mailto:karacanihan@gmail.com), *Rifat Gürçan Özdemir*

This paper presents a study of assembly line balancing with the extension of sequence dependent setup times. We define this innovative problem by formulating as a mixed-integer nonlinear programming model. The paper also develops a tabu search metaheuristic algorithm in order to solve optimal or near optimal task scheduling. The proposed methodology is implemented in an air-condition manufacturer considering sequence dependent setup times with task scheduling of the assembly line balancing problem. The results show that the approach has significant relevance in realworld systems.

### ■ TC-20

Tuesday 11:20-12:40

Mann

#### DEA Methodology IV

Stream: DEA and Performance Measurement

*Invited session*

Chair: *Dimitris Despotis*, Department of Informatics, University of Piraeus, 80, Karaoli & Dimitriou Street, 18534, Piraeus, Greece, [despotis@unipi.gr](mailto:despotis@unipi.gr)

#### 1 - Ranking decision making units with stochastic data

*Mohammad Hassan Behzadi*, Statistics, Islamic Azad University Science & Research Branch, Department of Statistics, Science & Research Branch, P.O.Box 14515-775, Therhran Iran, 98, Thehran, Iran, Islamic Republic Of, [mhbehzadi@yahoo.com](mailto:mhbehzadi@yahoo.com), *Farhad Hosseinzadeh Lotfi*, *Mohsen Rostamy-malkhalifeh*, *Mahnaz Mirbolouki*, *Zohreh Moghaddas*

DEA is data-oriented performance evaluation method. Cooper et al. have proposed a model with stochastic data and defined the stochastic efficient DMUs. While a suitable model for ranking stochastic efficient DMUs has not been proposed yet. In this paper we have proposed a model, based on modified MAJ with different step lengths, for ranking stochastic efficient the resultant model is a quadratic programming that in which the objective function is a function of level of confidence. An illustrative example is incorporated to demonstrate the result.

#### 2 - The error reduction method for ranking units with stochastic data

*Mohammad Hassan Behzadi*, Statistics, Islamic Azad University Science & Research Branch, Department of Statistics, Science & Research Branch, P.O.Box 14515-775, Therhran Iran, 98, Thehran, Iran, Islamic Republic Of, [mhbehzadi@yahoo.com](mailto:mhbehzadi@yahoo.com), *Mahnaz Mirbolouki*, *Gholam Reza Jahanshahloo*, *Farhad Hosseinzadeh Lotfi*, *Mohsen Rostamy-malkhalifeh*, *Zohreh Moghaddas*

In many applications, managers encounter with stochastic data and the necessity of having a method for ranking and evaluating the efficiency of DMUs has been under consideration. In our method DMUs have been assessed while considering a probability for occurrence of not predicted states. Using level of error causes the efficiency to have the essence of probability. In this ranking method, a DMU will have a higher rank, if in level of error which is less than that of the managers have determined, it remains stochastic efficient. We have proved the resultant theorems and applied this model on an example

### 3 - Specialisation versus diversification in dea: a new model for non-homogeneous DMUs

*Cecilio Mar-molinero*, Kent Business School,  
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DEA requires that all DMUs must share the same inputs and the same outputs; e.g., it is not possible to compare research institutes, with teaching only institutions, and with traditional universities: traditional universities use a full set of inputs and outputs; research institutes do not have inputs and outputs specific to teaching; and teaching only institutions do not have inputs and outputs that are specific to research. We present a new model that makes it possible to compare, within a unified DEA framework, DMUs that use a full set of inputs and inputs with DMUs that specialise.

### 4 - Ranking based on inefficient frontier in presence of dmv variables

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mohsen\_rostamy@yahoo.com, *Zohreh Moghaddas*

Traditional DEA can be deemed to identify efficient performers in the most favorable setting which is considered as a optimistic point of view. In real world applications traditional DEA models, reveal that how inefficient a DMU is in the most favorable setting, which does not fit to the real world applications. Inefficient DMUs are those which are in undesirable state that needs to be improved. This paper addresses the issue of ranking in presence of variable which have a nonlinear impact on efficiency based upon comparison to the inefficient frontier.

## ■ TC-21

Tuesday 11:20-12:40

Hauptmann

### Dualization of Monotone Boolean Functions and its Applications

Stream: Boolean Programming

Invited session

Chair: *Khaled Elbassioni*, Department 1: Algorithms and Complexity, Max-Planck-Institut für Informatik, Campus E1 4, 66123, Saarbrücken, Saarland, elbassio@mpi-inf.mpg.de

#### 1 - Monet: algorithmic state of the art (a guided algorithmic tour including practicability stopovers)

*Matthias Hagen*, Faculty of Media / Media Systems,  
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We give an overview of state-of-the-art algorithmic research on MONET—given an irredundant, monotone DNF and an irredundant, monotone CNF, decide if they are equivalent—and its computational variant. Note that MONET currently is not classified as polynomial or NP-coNP-hard—a theoretically very interesting issue. Furthermore, MONET solving algorithms are also very important from the point of view of practical applications as equivalent problems are ubiquitous in various fields. We focus on lower bounds for several algorithms and try to shed some light on practical performance.

#### 2 - Polynomial-time dualization of r-exact hypergraphs with applications in geometry

*Imran Rauf*, Department 1: Algorithms and Complexity, Max-Planck-Institut für Informatik,

Stuhlsatzenhausweg 85, 66123, Saarbrücken,  
Germany, irauf@mpi-inf.mpg.de, *Khaled Elbassioni*

A hypergraph is called  $r$ -exact for an integer  $r > 0$ , if any of its minimal transversal and hyperedge intersect in at most  $r$  vertices. We show that the class includes several interesting examples from geometry, e.g., circular-arc hypergraphs ( $r=2$ ), hypergraphs defined by sets of axis-parallel lines stabbing a given set of  $\alpha$ -fat objects ( $r=4\alpha$ ), and hypergraphs defined by sets of points contained in translates of a given cone in the plane ( $r=2$ ). For constant  $r$ , we show that all minimal hitting sets for  $r$ -exact hypergraphs can be generated in output-sensitive polynomial time.

### 3 - Modeling biological signaling networks using ip, sat and monotone boolean functions

*Utz-Uwe Haus*, FMA-IMO and MaCS,  
Otto-von-Guericke Universität Magdeburg,  
Universitätsplatz 2, 39106, Magdeburg, Germany,  
haus@imo.math.uni-magdeburg.de, *Kathrin  
Niermann*, *Klaus Truemper*, *Robert Weismantel*

Motivated by the question how a reaction in a metabolic network can be blocked, we showed that this question can be answered by computing the transversals of the hypergraph of elementary modes of the network. In a different application, the study of logical models for signaling networks, we show that the question to compute all maximal feasible submodels can be reduced to the computation of the maximal solutions of a monotone boolean function, despite the original model's non-monotonicity. Each maximal feasible submodel corresponds to a possible time resolution of the infeasibility.

## ■ TC-22

Tuesday 11:20-12:40

Arndt

### Operations of Closed Loop Supply Chains (I)

Stream: OR and Environmental Management

Invited session

Chair: *Erwin van der Laan*, RSM Erasmus University,  
P.O.Box 1738, 3000DR, Rotterdam, Netherlands,  
elaan@rsm.nl

#### 1 - Network configuration and capacity choice in hybrid manufacturing/remufacturing systems

*David Francas*, Department of Logistics, University of  
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francas@bwl.uni-mannheim.de, *Stefan Minner*

We study hybrid systems with uncertain demand and return where manufacturing and remanufacturing processes are conducted in the same facility or each process is dedicated to separate facilities. With respect to different prioritizations of the two processes, we analyze the optimal capacity decisions for both network configurations. Furthermore, we provide analytical results for the sensitivity of capacity choice and network performance to changes in price, cost, demand, and return characteristics. Our analysis shows that shared facilities may be preferred due to the benefits of pooling risks.

#### 2 - Dynamic buy-back for product recovery in end-of-life spare parts management

*Tobias Schulz*, Chair for Production and Logistics,  
Otto-von-Guericke University Magdeburg,  
Universitätsplatz 2, Postfach 4120, 39016, Magdeburg,  
Germany, tobias.schulz@ovgu.de, *Rainer Kleber*,  
*Guido Voigt*

The efficient supply of spare parts is of prime concern for OEMs. Next to the traditional spare parts sources final order and remanufacturing, the option to buy back broken products prevents the OEM from fulfilling his spare parts availability obligation in the end-of-life phase. For different settings regarding information availability as well as pricing and communication constraints we propose simple MILP models that are able to find optimal buy-back strategies. A numerical study analyzes for which parameter settings the buy-back option can substantially improve the OEM's performance.

### 3 - Maintaining an effective inventory

*Manbir Sodhi*, Industrial & Manufacturing Engineering, University of Rhode Island, Kingston, RI, United States, [sodhi@egr.uri.edu](mailto:sodhi@egr.uri.edu)

The lifetime of many machines and consumer devices can be extended considerably by planned upgrades of components or parts, contributing to increased sustainability and reduced ownership costs. This concept of operations can require the coordination of a large inventory of entities and components in different states. This talk will examine models that help determine optimal modular upgrade solutions. An analysis of modular replacement decisions for a single machine consisting of several components over an extended time horizon is based on a mixed integer formulation.

## ■ TC-23

Tuesday 11:20-12:40

Planck

### Pricing

Stream: Demand, Pricing and Revenue Management

*Invited session*

Chair: *Demet Cetiner*, Mercator School of Management, University of Duisburg-Essen, Lotharstrasse 65 LB 212, 47057, Duisburg, Germany, [demet.cetiner@uni-due.de](mailto:demet.cetiner@uni-due.de)

#### 1 - Price matching and strategic consumer behaviour in dynamic pricing

*Yossi Aviv*, Olin School of Business, Washington University, Campus Box 1133, 1 Brookings Drive, 63130, Saint Louis, MO, United States, [aviv@wustl.edu](mailto:aviv@wustl.edu), *Yuri Levin*, *Mikhail Nediak*

We consider a two-period model of duopolistic capacitated dynamic pricing competition when each firm's strategy can include price matching, and consumer response is strategic. We study the properties of equilibrium strategies, and whether price matching can be an effective tool in countering strategic consumer behavior. Finally, we present the results of an empirical study of the effect of price matching on strategic consumer behaviour.

#### 2 - A study on discount pricing policy for perishable products with reference price effects

*Takeshi Koide*, University of Marketing and Distribution Sciences, 3-1, Gakuen-Nishimachi, Nishi, 6512188, Kobe, Japan, [koide@umds.ac.jp](mailto:koide@umds.ac.jp), *Hiroaki Sandoh*

We consider the discount pricing problem of a monopolist firm which sells daily perishable products. When the products would be unsold, they will be marked down at the end of day and the discount sale raises daily revenue for the firm. The discount sale, however, drops consumers' reference prices, with which the consumers judge if a selling price is a gain or a loss, and lowers revenue in the future. We have formulated the discount pricing problem with reference price effects to show that the number of predicted unsold products significantly influences the optimal policy.

### 3 - Dynamic switching times from season to single tickets in sports and entertainment

*Serhan Duran*, Industrial Engineering, Middle East Technical University, ODTU Endustri Muhendisligi Bolumu, Ankara Turkey, 06531, Ankara, [sduran@ie.metu.edu.tr](mailto:sduran@ie.metu.edu.tr), *Julie Swann*

Revenue management can be used in many industries where there is a limited, perishable capacity and the market can be segmented. We focus on the sales of event tickets in the Sports and Entertainment industries, where tickets are sold exclusively as season tickets initially or only as single events later in the selling horizon. We specifically study the optimal time to switch between these market segments dynamically as a function of the state of the system. We find the optimal switching time is a set of time thresholds that depends on the remaining inventory and time left in the horizon.

## ■ TC-24

Tuesday 11:20-12:40

GSI - S 20

### Optimization under randomness or fuzziness

Stream: Semi-Infinite Optimization

*Invited session*

Chair: *Monga Kalonda Luhandjula*, Decision Sciences, University of South Africa, P O Box 392 UNISA, Pretoria, 0003, Pretoria, Gauteng, South Africa, [luhanmk@unisa.ac.za](mailto:luhanmk@unisa.ac.za)

#### 1 - Interactive decision making based on level sets and stochastic programming model for fuzzy random two-level linear programming problems

*Kosuke Kato*, Graduate School of Engineering, Hiroshima University, 1-4-1, Kagamiyama, 739-8527, Higashi-Hiroshima, [kosuke-kato@hiroshima-u.ac.jp](mailto:kosuke-kato@hiroshima-u.ac.jp), *Masatoshi Sakawa*

In this paper, we focus on fuzzy random two-level linear programming problems (FRLLPPs) with cooperative decision makers (DMs). First, we reformulate a FRLLPP as a stochastic TLLPP (STLLPP), in which the degree of realization of the problem is guaranteed to be greater than or equal to alpha. Second, introducing fuzzy goals for objective functions, we transform the STLLPP into a deterministic TLLPP based on stochastic programming model. Finally, we propose an interactive decision making algorithm to derive a satisfactory solution through interactions with the upper-level DM for the problem.

#### 2 - Embedding theorem for fuzzy random variables and its application to fuzzy stochastic optimization

*Monga Kalonda Luhandjula*, Decision Sciences, University of South Africa, P O Box 392 UNISA, Pretoria, 0003, Pretoria, Gauteng, South Africa, [luhanmk@unisa.ac.za](mailto:luhanmk@unisa.ac.za), *Stanislas Sakera Ruzibiza*

In this paper, we show that the set of fuzzy random variables can be embedded into a suitable Banach space isomorphically and isometrically. In this way we extend the classical Radstrom Embedding Theorem to fuzzy random variables. A modeling methodology for Fuzzy stochastic Optimization problems based on this fuzzy random version of Radstrom Embedding Theorem is also described. A computational Optimization tool for solving the resulting problem is proposed and numerical examples supplied for the sake of illustration.

### 3 - Possibilistic-probabilistic optimization: models, methods, applications

Alexander Yazenin, Applied Mathematics Department, Tver State University, Zhelyabova, 33, 170100, Tver, alexander.yazenin@tversu.ru

In the paper optimization tasks with fuzzy random parameters are investigated in the possibility-probability context. Combined presentation of uncertainty is explicated with the help of fuzzy random variable model. Approaches for determining second level moments of fuzzy random variables are analyzed. Fuzzy random variables calculus is proposed. As an application example-portfolio analysis tasks that have a fuzzy random variable as a profit model are considered. These tasks are immersed in the possibility-probability context, which allows modelling of investment possibilities more sufficiently.

### 4 - On infeasibility and pareto-optimality in fuzzy goal programming

Mariano Jimenez-Lopez, Economía Aplicada I, University of the Basque Country, Plaza de Oñati 1, 20018, San Sebastian, Spain, mariano.jimenez@ehu.es, Bilbao-Terol Amelia

The problem of solving a Multiobjective Programming (MOP), by assuming that the Decision Maker (DM) has fuzzy goals, is addressed. We present a method in order to overcome two possible drawbacks in Fuzzy Goal Programming (FGP): infeasibility and saturation. In case of infeasibility the DM does not know the amount by which the tolerance thresholds are surpassed. We supply this information and resolve the infeasibility. In the event of saturation, a fuzzy-efficient solution may not be Pareto-optimal. Our method supplies a solution that is efficient of the MOP and also fuzzy-efficient of the FGP.

## ■ TC-25

Tuesday 11:20-12:40  
GSI - S 25

### Cooperative Games with Interval Data

Stream: Cooperative Game Theory

Invited session

Chair: *Sırma Zeynep Alparslan Gök*, Scientific Computing, Institute of Applied Mathematics, Middle East Technical University, Institute of Applied Mathematics, Middle East Technical University, 06531, Ankara, Turkey, alzeynep@metu.edu.tr

#### 1 - Robust allocation rules in dynamic cooperative games

Dario Bauso, Dipartimento di Ingegneria Informatica, Università di Palermo, Viale delle Scienze, 90128, Palermo, dario.bauso@unipa.it, Judith Timmer

Classical cooperative game theory is no longer a suitable tool for those situations where the values of coalitions are not known with certainty. We consider a dynamic context where at each point in time the coalitional values are unknown but bounded by a polyhedron. However, the average value of each coalition in the long run is known with certainty. We design "robust" allocation rules for this context, which are allocation rules that keep the coalition excess bounded while guaranteeing each player a certain average allocation (over time).

#### 2 - Monotonicity properties of interval solutions for convex interval games

Mariana Rodica Branzei, Faculty of Computer Science, "Alexandru Ioan Cuza" University, 16,

Berthelot St., 700483, Iasi, Romania, branzeir@info.uaic.ro, Stef Tijs, Elena Yanovskaya

We examine several monotonicity properties of classical single-valued solutions on the class of convex games and their impact on the existence of corresponding interval game solutions. It turns out that the obtained value-type interval solutions on the class of convex interval games inherit most of these monotonicity properties.

### 3 - The interval Shapley value: an axiomatization

Sırma Zeynep Alparslan Gök, Scientific Computing, Institute of Applied Mathematics, Middle East Technical University, Institute of Applied Mathematics, Middle East Technical University, 06531, Ankara, Turkey, alzeynep@metu.edu.tr

We study properties of the interval Shapley value on the class of size monotonic interval games, and axiomatically characterize its restriction to a special subclass of cooperative interval games by using the properties of additivity, efficiency, symmetry and dummy player.

## ■ TC-26

Tuesday 11:20-12:40  
GSI - S 35

### Graphs and Networks

Stream: Discrete Optimization

Contributed session

Chair: *Agnieszka Rusinowska*, CNRS - University of Lyon 2, GATE, 93 Chemin des Mouilles, BP 167, 69131, Ecully, rusinowska@gate.cnrs.fr

#### 1 - A game-theoretic approach to combinatorial optimization

Thorsten Krempasky, Numerische und Angewandte Mathematik, Georg August Universität Göttingen, Lotzestraße 16-18, 37083, Göttingen, Germany, krempask@math.uni-goettingen.de, Anita Schoebel

The idea of this work is to combine game theoretical concepts with aspects of optimization. Following this idea, game theoretical methods are applied to optimization problems in order to get a heuristic solution. The results are compared by using the concept of the price of anarchy defined by Roughgarden. Some graph-theoretic problems and the quality of their equilibria are discussed. It turns out that some general statements about games on stable sets and especially on matroids can be proven which give a game theoretical interpretation of well known graph-theoretic concepts.

#### 2 - Connected (n,m)-graphs with maximum zeroth order general Randić index

Ljiljana Pavlovic, Department of Mathematics, Faculty of Natural Sciences and Mathematics, Radoja Domanovica 12, 34000, Kragujevac, Serbia, Serbia, pavlovic@kg.ac.rs, Mirjana Lazic

Let  $G$  be a graph and  $d(u)$  denote the degree of a vertex  $u$  in  $G$ . The zeroth-order general Randić index of the graph  $G$  is defined as sum of  $d(u)$  raised to the power of  $\alpha$ , where the summation goes over all vertices of  $G$  and  $\alpha$  is a real number. We found for  $\alpha$  less than 0 extremal connected graphs with  $n$  vertices and  $m$  edges for which this index attains maximum value. Extremal are the fanned pineapple of type 1 graphs.

#### 3 - Random combinatorial optimization problems on hypergraph matchings: limiting optimal values and convergence rates

Pavlo Krokmal, Mechanical and Industrial Engineering, University of Iowa, 3131 Seamans

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krokhmal@engineering.uiowa.edu

We discuss asymptotical behavior of random combinatorial optimization problems on hypergraph matchings, such as multidimensional assignment problems (Linear MAP, Bottleneck MAP, etc.), whose assignment costs are iid random variables. We investigate convergence of the optimal values of such problems as functions of the problem dimensions. For a broad range of probability distributions of the assignment costs, we demonstrate convergence in L1 and almost surely, establish the convergence limits and the corresponding convergence rates.

#### 4 - Applying relation algebra and relview to measures in a social network

Agnieszka Rusinowska, CNRS - Univesity of Lyon 2,  
GATE, 93 Chemin des Mouilles, BP 167, 69131,  
Ecully, rusinowska@gate.cnrs.fr, Rudolf Berghammer,  
Harrie De Swart

We present an application of relation algebra to measure players' strength in a network with influence. We deal with power, success, and influence of a player as measured by the Hoede-Bakker index, its generalization and modifications, and by the influence indices. We also apply relation algebra to determine followers of a coalition and the kernel of an influence function. This leads to specifications, which can be executed with the help of the BDD-based tool RelView after a simple translation into the tool's programming language. As an example we consider the present Dutch parliament.

### ■ TC-27

Tuesday 11:20-12:40

GSI - S 21

## Knowledge Discovery and Data Mining 2

Stream: Knowledge Discovery and Data Mining

Invited session

Chair: *Nuno Miguel Cavalheiro Marques*, Dep. Informática, Faculdade Ciências e Tecnologia-Universidade Nova de Lisboa, Campus FCT-UNL, Dep. Informática, 2829-516, Caparica, nmm@di.fct.unl.pt

#### 1 - Web access log analysis using a multi-agent approach

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Web access logs are large repositories of important data, where we can discover user's visiting patterns and recommend them other Web pages to follow. This problem is similar to the basket case problem with the difference that a quick real-time response is needed. Agents have embedded data mining algorithms that try to fulfill user's needs. Each agent may specialize itself in a segment of clients and may share knowledge with other agents. They also manage their own financial resources, paying to place recommendations in Web pages and being rewarded when they are followed.

#### 2 - Evaluation of segments of credit cards holders

Cristina Martins, Habber Tec Portugal, Rua Serpa  
Pinto, 14A, 2º, 1200-445, Lisboa,  
mcris.martins@gmail.com, Margarida Cardoso

This work presents the segmentation of credit cards holders of a Portuguese financial institution. It is focused on the evaluation of the obtained solution via cross-validation. The proposed approach specifically handles a large data set with mixed (numerical and categorical) variables. It both provides the evaluation of the segmentation solution and helps characterizing the segments. Furthermore, it provides classification rules for new credit card holders. Finally, this work presents the profiles of the credit card holders' segments, helping to support ongoing and future strategic decisions.

#### 3 - Encoding knowledge in neural networks with probabilistic values

Nuno Miguel Cavalheiro Marques, Dep. Informática,  
Faculdade Ciências e Tecnologia- Universidade Nova  
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Propositional core method NeSy neural networks are difficult to train with probabilistic representations of symbols. A standard NeSy network requires 9500 back-propagation iterations to learn an AND truth table with input TRUE values represented by 0.4, while a random initialization of the same network only needs 2700 iterations. We show that by extending the NeSy network with an additional hidden layer, mapping 1:1, only 1700 iterations are needed in this problem. Applications to text and data mining using domain knowledge in neural networks are discussed, namely using neural tagging systems.

### ■ TC-28

Tuesday 11:20-12:40

GSI - S 1

## Modelling Large MIPs

Stream: Modelling large MIPs

Contributed session

Chair: *Oliver Bastert*, FICO, Maximilianstr. 35, 80539,  
Munich, Germany, oliverbastert@fico.com

#### 1 - Solution strategies for hard mip problems

Oliver Bastert, FICO, Maximilianstr. 35, 80539,  
Munich, Germany, oliverbastert@fico.com

In this talk we describe strategies for solving hard Mixed Integer Programming problems (MIPs). We show how problems which seem intractable can be solved by using different techniques implemented within Xpress. Good strategies for one class of problems may not work on other problem classes and choosing the best strategy is often the key to solving hard MIPs.

#### 2 - Schemes of decomposition and parallelisation in modeling: how to go about solving really large problems?

Susanne Heipcke, Xpress team, FICO, 54 rue  
Balthazar de Montrou, 13004, Marseille,  
susanneheipcke@fico.com

This talk presents possibilities for problem decomposition and concurrent solving from a modelling point of view (that is, excluding "parallel MIP" and other solver-internal options). We provide examples of problem classes suitable for the different approaches and hint at their implementation with Xpress-Mosel, using Mosel's capacity of handling multiple models and as a new feature, handling of multiple problems within a single model. Some remarks on the "doability" for less expert modellers close the discussion.

#### 3 - Matrix approach to enterprise performances optimization

Marko Hell, Faculty of Economics, Matice hrvatske  
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Zeljko Garaca

The Balanced Scorecard (BSC) is a popular concept for performance measurement. The Linear programming (LP) is a mathematical technique for optimization of linear objective functions. The question is: "How to use LP for Enterprise Performances optimization (EPO)?" Answer on this question is contained in this paper. The first step is a matrix presentation of the enterprise performances. The presentation is designed accordingly to BSC concept. Thus formalised recording of enterprise performances will provide the application of LP for EPO.

## ■ TC-29

Tuesday 11:20-12:40

GSI - S 2

### Credit Risk Modelling

Stream: Financial Modelling

*Invited session*

Chair: *Ronald Hochreiter*, Statistics and Decision Support Systems, University of Vienna, Universitaetsstrasse 5, 1010, Vienna, Austria, ronald.hochreiter@univie.ac.at

#### 1 - A coupled Markov chain approach to cdx pricing and optimization

*Ronald Hochreiter*, Statistics and Decision Support Systems, University of Vienna, Universitaetsstrasse 5, 1010, Vienna, Austria, ronald.hochreiter@univie.ac.at,  
*David Wozabal*

Financial companies still hold structured credit products like CDOs and CDXs with unknown risk exposure. A Coupled Markov Chain approach is used to model rating transitions. Heuristics are applied to find ML estimators. The model is used to simulate scenarios for joint rating changes and payment streams generated by CDXs or portfolios of contracts. This allows for assessing the risk of current positions and for designing portfolios which are optimal relative to risk preferences. We solve classical mean-risk models to obtain optimal portfolios of CDOs written on CDXs.

#### 2 - A stochastic model for constant proportional debt obligations

*Viviana Fanelli*, DSEMS, University of Foggia, Largo Papa Giovanni Paolo II, 1, 71100, Foggia, Italy, Italy, viviana.fanelli@gmail.com, *Silvana Musti*

In this paper we propose a model describing the structural mechanism of a Constant Proportional Debt Obligation (CPDO). CPDOs are structured credit products aiming at paying high coupons, that have high and rated likelihood of payment, by taking leveraged exposure to a notional risky portfolio of credit indices. At each step, the portfolio is rebalanced according to mark-to-market changes in credit spreads so that its current value fulfils the future obligations. A numerical algorithm is presented to implement the model and a pricing scheme for CPDOs is developed.

#### 3 - Optimization heuristics for determining internal rating grading scales

*Johannes Paha*, Economics, Justus-Liebig-University Giessen, Licher Strasse 62, Lehrstuhl VWL I, 35394, Giessen, Hessen, Germany, johannes.paha@wirtschaft.uni-giessen.de

Basel II requires banks to hold regulatory capital which may be computed from pooled probabilities of default (PD). These pooled PDs can be calculated by clustering credit borrowers into different buckets and computing the mean PD for each bucket. Real-world side constraints make the clustering problem very complex. For tackling this problem we propose a Threshold Accepting algorithm that is found to outperform alternative methodologies proposed in the literature. We extend the analysis by introducing new methods to determine the optimal number of buckets in which to cluster banks' clients.

## ■ TC-30

Tuesday 11:20-12:40

GSI - S 26

### Knowledge Discovery for Decision Support II

Stream: Knowledge Discovery for Decision Support

*Contributed session*

Chair: *Milos Jovanovic*, Business Decision-Making, University of Belgrade - Faculty of Organizational Sciences, 11000, Belgrade, Serbia, milosj@fon.rs

#### 1 - Continuous time Bayesian networks for diagnosis of heart disease

*Elena Gatti*, Department of Informatics, Systems and Communication (DISCO), Università degli Studi di Milano Bicocca., Viale Sarca, 336, 20126, Milan, Italy, elena.gatti@disco.unimib.it, *Enrico Fagioli*,  *Davide Luciani*, *Fabio Piolini*, *Fabio Stella*

Several research programs have been developed to assist physicians in reasoning about cardiovascular disorders. In this contribution a Continuous Time Bayesian Network for reasoning about cardiac disorders is presented. The main advantage of Continuous Time Bayesian Networks is that they allow to model systems where there is no natural time granularity and where the states of some variables vary over time, according to different time scales. Several diagnostic queries are submitted to the Continuous Time Bayesian Network model to emphasize the relevance of the proposed approach.

#### 2 - Business intelligence model for electronic documents archive

*Dragana Becejski-Vujaklija*, IT, Faculty of organizational sciences, Jove Ilica 154, 11000, Belgrade, draganab@fon.rs, *Boris Delibasic*, *Milos Jovanovic*

In the situation where base of electronic archiving documents is large, the user needs to know how many different types of documents are in the database, which of them are mostly present, etc. This kind of report is possible to get from an existing database, but it requires the inclusion of IT specialists. Therefore, there is an idea to build a new intelligent system which will allow user to analyze documents without intermediaries and to make managerial decisions. The result is BI system for the analysis of archived electronic documents, based on data warehouse.

#### 3 - A "white box" data mining platform for decision support in decision tree induction algorithm design

*Milos Jovanovic*, Business Decision-Making, University of Belgrade - Faculty of Organizational Sciences, 11000, Belgrade, Serbia, milosj@fon.rs, *Boris Delibasic*, *Milan Vukicevic*

Applications of data mining models are largely influenced by available software. Abundance of algorithms are implemented to solve various data mining tasks. However, end users are deprived of the decision support for choosing the right algorithm for the problem at hand. Opposed to the prevalent "black box" approach, we present a framework and software support to enable composing of algorithms by combining patterns as solutions for sub-problems within the specific problem that is data and user driven. We provide performance evidence for the platform on decision tree induction algorithms.

#### 4 - Data quality provisioning for uncertain decision support

*Sebastian Olbrich*, Augustaanlage 34, 68165, Mannheim, BW, sebastian.olbrich@arcor.de, *Peter Chamoni*

In many applications, imprecise sensor data is analyzed by data mining to guide business decisions. To compute the impact of sensor quality problems on uncertain decision making, we present an architecture for data quality (DQ) management in sensor data warehouses. It supports transfer of DQ information in sensor streams and the quality storage in the target warehouse. We show how DQ information can be used to guide the mining of imprecise sensor data and estimate the quality of mining results at the example of uncertain decision trees

## ■ TC-31

Tuesday 11:20-12:40

GSI - S 34

### Applications of Noncooperative Games

Stream: Noncooperative Games

*Invited session*

Chair: *Juan Tejada*, Estadística e Investigación Operativa I, Complutense University of Madrid, Universidad Complutense de Madrid, Plaza de Ciencias, 3, 28040, Madrid, Spain, [jtejada@mat.ucm.es](mailto:jtejada@mat.ucm.es)

#### 1 - A game theoretic model for channel allocation problems in mobile communication systems

*Joaquin Sánchez-Soriano*, Centro de Investigación Operativa, Universidad Miguel Hernández, Elche, Alicante, Spain, [joaquin@umh.es](mailto:joaquin@umh.es), *Javier Gozalvez*, *Alberto Rodríguez-Mayol*

Channel allocation schemes are responsible for deciding which available channel is assigned to an incoming call. This work studies a non-cooperative game-theoretic model for channel assignment problems, particularly for FCA (Fixed Channel Allocation) networks. We analyse forward strategies and proof several results about their stability in the sense of Nash equilibria and its refinements. Furthermore, we provide an application example carried out by simulation.

#### 2 - Risk measures of auction models in an electricity market

*Juan Tejada*, Estadística e Investigación Operativa I, Complutense University of Madrid, Universidad Complutense de Madrid, Plaza de Ciencias, 3, 28040, Madrid, Spain, [jtejada@mat.ucm.es](mailto:jtejada@mat.ucm.es), *Estrella Alonso*

We have previously obtained a revenue equivalence result of an extensive parametric family of auction models for a simplified duopolistic electricity market. This family contains the classical auction models as well as other new ones. We model the market as a two-person game with incomplete information under the assumption that bidders are symmetric, risk neutral and have independent values. In this communication we explore the behaviour of these auction models regarding some risk measures such as variance, VaR or CVaR. We look for the auction models that minimize the above measures.

#### 3 - A patrolling game for optimising randomised patrols.

*Katerina Papadaki*, Operational Research, London School of Economics and Political Science, Houghton Street, WC2A 2AE, London, United Kingdom, [k.p.papadaki@lse.ac.uk](mailto:k.p.papadaki@lse.ac.uk), *Alec Morton*, *Steve Alpern*

We describe a class of patrolling games on graphs, motivated by the problem of patrolling a facility (museum, airport). The Attacker can choose to attack any node of the graph within a given time interval and requires  $m$  consecutive periods there, uninterrupted by the Patroller, to commit his act (and win). The patrolling game is a zero-sum game, where the Value is the probability that the Patroller successfully intercepts an attack. We determine analytically optimal (minimax) patrolling strategies for various classes of graphs, and present numerical results for some intractable cases.

## ■ TC-32

Tuesday 11:20-12:40

GSI - S 4

### DMKD advanced applications

Stream: Data Mining and Knowledge Discovery

*Invited session*

Chair: *Yannis Theodoridis*, Dept of Informatics, University of Piraeus, 18534, Piraeus, Greece, [ytheod@unipi.gr](mailto:ytheod@unipi.gr)

#### 1 - A temporal text mining application in competitive intelligence

*Haralampos Karanikas*, National & Kapodistrian Univ. of Athens, 18534, Athens, Greece, [bkaranikas@phs.uoa.gr](mailto:bkaranikas@phs.uoa.gr), *Ioannis Kopanakis*

In this paper we describe an application of our approach to temporal text mining in Competitive Intelligence for the biotechnology and pharmaceutical industry. The main objective is to identify changes and trends of associations among entities of interest that appear in text over time. By introducing the term Temporal Text mining our approach combines Information Extraction and Data Mining techniques upon textual repositories and incorporates time and ontologies' issues.

#### 2 - Knowledge discovery in marketing databases using rough sets theory and self organizing maps.

*Renato Sassi*, Industrial Engineering Pst Graduation, Universidade Nove de Julho, Rua Jardimirim, 15, Jardim do Colégio (zona norte), 02431020, São Paulo, São Paulo, [rjsassi@gmail.com](mailto:rjsassi@gmail.com)

Real world databases contain a huge amount of data within which several relations are hidden. These relations are difficult to discover by means of traditional methods such as worksheets and operational informative reports. Therefore, the knowledge discovery systems (KDD) appear as a possible solution to extract, from such relations, knowledge to be applied. This research presents the application and analysis of a hybrid architecture formed by the combination of the Rough Sets Theory with an artificial neural net named Self-Organizing Maps to discover knowledge in marketing databases.

#### 3 - Mining a large xml based event logging system: a case study in telecom

*Sara Safari Vahed*, #4, Saami Alley, North Tavanir Street,, Tehran, IRAN, 1435743467, Tehran, Iran, Islamic Republic Of, [sara.safari.v@gmail.com](mailto:sara.safari.v@gmail.com)

XML as a standard for data representation is widely accepted among application developers. One of its applications is in event logging system where each event is represented in the form XML instance using different elements. These XML instances then will be stored in XML files for future use. In Telecom industry where we have millions of transactions every day these XML files will form a huge amount of raw data each day. In this paper we will discuss Data Mining methods for turning these raw data into information useful for applications such as security, marketing and tariff planning.

**4 - Suppliers development, a comprehensive model**

Zahra Sharafi, Research and Development, MAPNA Group, No. 231, Mirdamad Blvd., 1918953651, TEHRAN - IRAN, 19395/6448, Tehran, Iran, Islamic Republic Of, z.sharafi.a@gmail.com, *Jamshid Parvizian*

Supplier development involves a decision making problem by which buying firms define priorities to invest on improvement of suppliers. A model is developed to define the strategic importance of a supplier for the buying firm. Data mining techniques are used to cluster the suppliers and determine eligibility of them for developing. The buyer's requirements and improvement themes are determined by FAST diagram and a roadmap is then developed for each cluster to fill the gap between the current and desired level. The research includes a case study for an Iranian Car Company and its suppliers.

**TC-33**

Tuesday 11:20-12:40

GSI - S 7

**Flow Problems**

Stream: Linear Optimization

*Contributed session*

Chair: *Hendrik Lambrecht*, IAF, Hochschule Pforzheim, Tiefenbronner Str. 65, 75175, Pforzheim, Germany, hendrik.lambrecht@hs-pforzheim.de

**1 - Using linear programming to support the investment planning of stochastic flow lines**

*Katja Schimmelpfeng*, Lehrstuhl für Rechnungswesen und Controlling, BTU Cottbus, Postfach 10 13 44, 03013, Cottbus, Germany, katja.schimmelpfeng@tu-cottbus.de, *Stefan Helber*

This contribution is based on a linear programming approach to simultaneously analyze and optimize flow lines with limited buffer capacities and stochastic processing times. The basic idea is to solve a huge but simple linear program that models an entire simulation run of a multistage production process in discrete time, to determine a production rate estimate. We extend this modelling approach to the investment problem of designing lines such that the net present value of the investment is maximized.

**2 - Solving factorized path problems**

*Marc Pouly*, Department of Informatics, University of Fribourg, Bd. de Perolles 90, 3280, Fribourg, marc.pouly@unifr.ch

This article shows how local computation can be used to compute path weights in graphs. The approach is based on the observation that large graphs are more naturally given as decompositions and that only a subset of all paths are required. Starting from a graph decomposition, we continuously compute path weights in small regions using an arbitrary path algorithm and deduce the required total paths from these results. Thus, we considerably reduce the input size of the applied algorithm: the decisive complexity factor is no more the total number of nodes but the induced treewidth of the problem.

**3 - Security constrained optimal dispatch via network flow model**

*Aurelio Oliveira*, Computational & Applied Mathematics, State University Of Campinas, DMA IMECC UNICAMP, C. P. 6065, 13081-970, Campinas,

SP, Brazil, aurelio@ime.unicamp.br, *Luciana Casacio, Christiano Lyra*

In this work, short term hydroelectric scheduling considering security constraints is formulated as a network flow model and solved by interior point methods. The resulting matrix structure is explored leading to very fast iterations since it avoids computation and factorization of impedance matrices. For each time interval, the linear algebra reduces to the solution of a linear system with dimension given by the number of buses whose matrix is invariant and can be factored off-line. Numerical results for IEEE and Brazilian power systems are obtained using a MATLAB implementation.

**TC-34**

Tuesday 11:20-12:40

GSI - S 8

**Linear and nonlinear regression**

Stream: Computational Statistics

*Invited session*

Chair: *Pakize Taylan*, Mathematics, Dicle University, 21280, Diyarbakir, Turkey, ptaylan@metu.edu.tr

**1 - Outlier problems in linear regression**

*Pakize Taylan*, Mathematics, Dicle University, 21280, Diyarbakir, Turkey, ptaylan@metu.edu.tr, *Ahmet Kaya*

The outlier problem in statistics is oldest and important. Outliers can be defined as observations which may affect model specification and parameter estimation problem. These may lead to taking some wrong models for estimation models. Thus, it is very important in practice to detect, diagnose and remove their effect from observation which are used for statistical modelling. In our study to obtain the best linear model, detection, diagnosis and removing stages will be presented on one example and some conclusions will be given.

**2 - Outlier analysis for quality assurance of data**

*Secil Yalaz*, mathematics, dicle university, dicle üniversitesi fen edebiyat fakültesi matematik bölümü, 21280, diyarbakır, Turkey, syalaz@dicle.edu.tr, *Ahmet Kaya*

Real data and databases which have to be reliable for estimation process may include some faulty parts. Situations like these events damage the characteristics of data which are called "aberrant condition" and the values which cause these condition are called outliers. The outliers can be defined as observations which affect the estimation and forecasting process in a great extent. In order to take healthy data they are set properly, and is an obligation to destroy or to eliminate the effects of them from observation sets

**3 - Combining regression and exponential smoothing methods for predicting iron ore product grades**

*Jim Everett*, Business School, University of Western Australia, 49 Goldsmith Rd, 6009, Nedlands, WA, Australia, jim.everett@uwa.edu.au

Selecting the mix of iron ore sources to mine and crush requires predicting the resulting grades of lump and fines products to match them to target. Prediction is based on blasthole grades of candidate ore sources, ore type and recent production history. A WLS regression model predicts lump and fines grades. Regression errors are serially correlated across multiple days. An exponential smoothing method removes the serial correlation and greatly reduces the compounded error when stockpiles and cargos are built. The method has been successfully adopted as an aid to iron ore mining in Australia.

#### 4 - Experiments with robust techniques for regression models with minimal assumptions

*Magderie van der Westhuizen*, School of Computer, Statistical and Mathematical Sciences, North-West University, Private Bag X6001, 2520, Potchefstroom, South Africa, magderie.vanderwesthuizen@nwu.ac.za, *Giel Hattingh*, *Hennie Kruger*

Decision-making in business often relies heavily on the process of fitting models to observed data. This process preferably has to be executed in a robust way that circumvents some unreliable data points and uncertainties concerning modeling assumptions. This paper considers the use of non-linear regression with minimal assumptions. Results of experiments exploring robustness based on mixed integer linear programming applications are given.

#### ■ TC-35

Tuesday 11:20-12:40

GSI - S 9

#### Energy Prices and Consumption

Stream: Value and Risk in Incomplete Markets

*Invited session*

Chair: *Stefan Schmidt*, mathematics, Ruhr University Bochum, Universitätsstraße 150, z.Hd. Gebäude GC 1/59, 44780, Bochum, Germany, smiedo@t-online.de

Chair: *Martin Rainer*, ENAMEC, Glockengasse 15, D-97070 Würzburg, 97070, Würzburg, Germany, martin.rainer@enamec.de

##### 1 - Dealing with uncertainty in energy models using optimization modeling in AIMMS

*Ovidiu Listes*, AIMMS, Paragon Decision Technology, Schipholweg 1, 2034 LS, Haarlem, Netherlands, o.listes@aimms.com

Inherent uncertainty in energy models can be addressed by techniques like parametric analysis, scenario analysis, stochastic programming or robust optimization. We illustrate how AIMMS modeling system supports such techniques based on a representative energy model. AIMMS can implement the deterministic model and its extensions for dealing with uncertainty in an integrated manner, allowing for evaluation and comparison of solutions. AIMMS support for decision making under uncertainty is further enhanced by powerful graphical representations of both input and output data.

##### 2 - Modeling uncertainty of natural gas consumption

*Stefan Schmidt*, Fakultät für Wirtschaftswissenschaft, Ruhr-Universität Bochum, Lehrstuhl für Betriebswirtschaftslehre, insb. Unternehmensforschung und Rechnungswesen, Universitätsstraße 150, Gebäude GC, 44780, Bochum, Nordrhein Westfalen, stefan.schmidt@rub.de

Several enactments in energy policy such as the opening of energy markets or the pricing of CO2 emission cause a high degree of competition and increase the importance of accurate forecasts on gas sales volume. Two approaches for this problem will be elaborated and compared. The first idea is a two-step model which applies a stochastic temperature process. The translation of temperature into sales volume is being realized by means of spline functions which are fitted using the least squares method. The second approach disregards influence of temperature and models the sales process directly.

##### 3 - Marginal costs and optimality for cogeneration power systems

*Nadia Maïzi*, Center for Applied mathematics, Ecole des Mines de Paris, Rue C. Daunesse, BP 207, 06904,

Sophia-Antipolis, France, nadia.maizi@ensmp.fr, *Marc Bordier*

A given set of cogeneration units are operated through a heat-match mode : the priority is to satisfy a heat demand; the excess of electricity is exported to the grid, while the lack of electricity is bought from an electricity market. We establish the best operating mode minimizing the cost of operation for the overall set of cogeneration units. It relies on the merit ordered sequence of marginal costs associated with the different operational modes for each unit. This indicates that the optimal operation of the cogeneration power plant is achieved through an economic dispatch mode.

#### ■ TC-36

Tuesday 11:20-12:40

GSI - S 11

#### Call center performance models

Stream: Stochastic Models for Service Operations

*Invited session*

Chair: *Ger Koole*, Mathematics, VU University Amsterdam, De Boelelaan 1081 a, 1081 HV, Amsterdam, Netherlands, koole@few.vu.nl

##### 1 - Queues with waiting-time dependent service

*Thomas Bang Nielsen*, DTU Informatics, Technical University of Denmark, Richard Petersens Plads, DTU - Bygning 321, 2800, Kgs. Lyngby, Denmark, tbn@imm.dtu.dk, *Ger Koole*, *Bo Friis Nielsen*

Queues where the service depends on the time customers have spent in queue are common in call centers and also seen in health care. Scenarios as these can be hard to deal with analytically as the used thresholds are often deterministic. A level-crossing approach and an Erlangian approximation are presented from which the waiting-time distribution of customers is obtained.

##### 2 - Analysis of two-level support systems with time-dependent overflow

*Michael Manitz*, Department of Supply Chain Management and Production, University of Cologne, Universität zu Köln, Seminar für Supply Chain Management und Produktion, 50923, Köln, Germany, manitz@wiso.uni-koeln.de, *Raik Stolletz*

We analyze the performance of call centers with two levels of support and a time-dependent overflow mechanism. Waiting calls from the front-office queue flow over to a back office, if a waiting-time limit is reached and at least one back-office agent is available. The analysis of such a system is reduced to a continuous-time Markov chain with state-dependent overflow probabilities. To analyze a time-dependent overflow, some waiting-based performance measures are modified. Numerical results demonstrate the reliability of this Markovian performance approximation for different parameter settings.

##### 3 - Control techniques for call centers with abandonments and retrials

*Sandjai Bhulai*, Department of Mathematics, VU University Amsterdam, De Boelelaan 1081a, 1081HV, Amsterdam, Netherlands, sbhulai@few.vu.nl, *Dennis Roubos*

We develop techniques for the control of call centers with abandonments and retrials in the presence of time-varying arrivals. First, we show that increasing the dimensionality of the state space leads to better control policies. Second, we deal with time-varying parameters by adding them to the state space with a parameterization. These techniques are then applied to the optimal admission control to a call center with a retrial queue with abandonments and time-varying parameters. The numerical experiments show that our techniques have near to optimal performance.

**4 - On service level issues for inbound call centers**

Alex Roubos, Department of Mathematics, VU  
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The Erlang C formula and its generalizations have quite commonly been used to find the required number of agents such that some service level (SL) criterion is fulfilled. The premise with these formulas is that the system has reached stationarity; something that is not true in reality where SLs are aggregated over intervals not longer than 24 hours. In such small intervals the SL is a random variable. We propose a simple formula for the standard deviation of the SL and use this together with a normal approximation to show highly accurate results.

**TC-37**

Tuesday 11:20-12:40

GSI - S 12

**Multi-Criteria Decision Aids - 1**

Stream: Decision Analysis

Contributed session

Chair: Halil Sen, Industrial Engineering, Sakarya  
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**1 - A better alternative to weighted sum scoring**

Chris Tofallis, Business School, University of  
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The weighted sum is the most common method for creating rankings using multiple criteria. As criteria may be measured in different units and have very different magnitudes, they are normalized before being combined. Various ways of normalizing are used. But even when the same (e.g. equal) weights are used, these options lead to different rankings! The reasons for this will be explained. We look at the multiplicative method of aggregation. Here normalization is not required - the problem is avoided. We illustrate with data on universities and compare features with weighted sum scoring.

**2 - Fleet replacement policies in theory and practice**

Patrick Tobin, School of Arts and Sciences (Vic),  
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This paper draws on a case study where a fleet of vehicles were needing a reliable and cost efficient turnover policy. It was expected that this would be a direct tradeoff between rising costs and replacement costs. In undertaking the work some surprising results emerged on maintenance matters which meant that criteria other than direct economic balancing needed to be dealt with. This paper examines the issue and a resolution strategy.

**3 - Mcd a group preferences modeling under incomplete information:**

Halil Sen, Industrial Engineering, Sakarya University,  
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Today's decision making problems are discrete, multicriteria, and involve multiple decision maker (DM). Organizations use the GDM techniques because of the problem's complexity. One of the key questions in this type of problems is how the preferences of the DMs can be modelled. DMs are able to provide only incomplete information, because of time pressure, lack of knowledge, and their limited expertise related to the problem domain. In these type of situations the DSS should allow modelling of the incomplete preference information. In this study we use an interactive DSS for the MES selection problem.

**TC-38**

Tuesday 11:20-12:40

GSI - S 13

**Bilevel programming: applications**

Stream: Variational Inequalities and Bi-Level Problems

Invited session

Chair: Diana Fanghaenel, Institut für Informatik,  
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**1 - A heuristic algorithm for optimizing frequencies in a transit network**

Ricardo Garcia, Escuela Superior de Informatica,  
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Sánchez-Herrera

This paper dealt with the problem of optimizing frequencies in a transit network in a context of medium-term planning. It is assumed that the size of the fleet can be a variable and requires to be decided. The model is formulated as a bi-level optimization problem. An heuristic algorithm for the integer bilevel model has been proposed. It is based on the optimality conditions of Karush-Kuhn-Tucker (KKT). A computational experience on the rapid transit network of Seville has been carried out. The convergence of the algorithm is shown in the numerical tests

**2 - A hierarchical approach for water system planning**

Carmen Galé, Métodos Estadísticos, Universidad de  
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Herminia I. Calvete, Pedro Mateo

A usual situation facing water resource planners is to determine which of alternative configurations for the water system has to be implemented. Difficulties arise to establish measures of the system performance which take into account the different interests of the water system users. Moreover, planners can use their influence to modify the users' behavior favoring sustainable use of water by fixing taxes. In order to analyze the impact of alternative configurations, we formulate a bilevel model which deals with the hierarchical framework involved and develop an algorithm to solve it.

**3 - Optimization methods with convex and concave support functions in bilevel programming**

Oleg Khamisov, Applied Mathematics, Institute of  
Energy System, Siberian Branch of the Russian  
Academy of Sciences, Lermontov street, 130, 664033,  
Irkutsk, khamisov@isem.sei.irk.ru

In our presentation we describe how a global optimization approach with convex and concave support functions can be applied to solving bilevel programming problems in optimistic sense. The approach is based on the branch and bound scheme. Different lower bounding procedures and convergence conditions are described and discussed. Preliminary computational results are given.

**4 - Piecewise linear and piecewise quadratic finite-element approximation of hemivariational inequalities**

Nina Ovcharova, Institute of Mathematics, Department  
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We present a convergence analysis for piecewise linear and piecewise quadratic finite-element approximation of hemivariational inequalities, arising in Mechanics and Engineering in connection with non-convex energy functionals or non-monotone possibly multivalued friction laws. First we give an existence result for an abstract coercive nonlinear variational problem. Then, using smoothing approximation via convolution we investigate the discretization of the nonlinear functional through different quadrature rules. At the end, we present computational results.

## ■ TC-39

Tuesday 11:20-12:40

GSI - S 14

### Mergers and acquisitions in the banking sector in Europe

Stream: Operational Research and Quantitative Models in Banking

*Invited session*

Chair: *Alain Chevalier*, FINANCE, ESCP-EAP, 79, Avenue de la République-PARIS-75011-FRANCE, 75011, PARIS, PARIS, France, chevalier@escp-eap.net

#### 1 - Consolidation in the European pharmaceutical industry

*Gupta Jyoti*, FINANCE, ESCP-EAP, 79 Avenue de la République, 75011, Paris, Paris, France, gupta@escp-eap.net

The paper analyzes some questions related to M&A activity in the European pharmaceutical sector: What are the characteristics of this industry and its importance in the European economy? What factors affect the profitability of the sector? What are the consolidation forces? Does the consolidation in the sector leads to a decrease in R&D output? Two M&A cases (Bayer-Schering, Sanofi-Aventis) are used to illustrate the forces behind the consolidation process. An attempt is made to assess whether value was created by the acquisition and to investigate the existence of abnormal returns.

#### 2 - A systemic approach of the bank crisis in Europe

*Alain Chevalier*, FINANCE, ESCP-EAP, 79, Avenue de la République-PARIS-75011-FRANCE, 75011, PARIS, PARIS, France, chevalier@escp-eap.net, *Pierre Kunsch*

The sub-prime crisis in the USA has triggered a bank crisis of till now unknown gravity around the world and particularly in Europe. In this article a systemic analysis is proposed of the genesis of the crisis, its consequences, and the adequacy of measures taken by the European governments to avoid the collapse of major banks, and to protect investors, clients, borrowers, and shareholders. A specific case will be highlighted to illustrate the analysis.

#### 3 - Value creation, quality improvement and motivation optimisation: the case of the beer industry concentration in Europe

*Alain Chevalier*, FINANCE, ESCP-EAP, 79, Avenue de la République-PARIS-75011-FRANCE, 75011, PARIS, PARIS, France, chevalier@escp-eap.net, *Pierre Kunsch*

Beer producers in Western Europe were selling nationally or regionally before M&A created increasingly capital intensive and competitive multinational firms. The claim for better quality increased. Cases are presented and analysed by means of a systemic framework integrating multi-criteria decision-making. It is shown that, after an acquisition, a merger may be superfluous, in case improvements in both quality and staff motivation are made. These findings are in line with observations in other industries and world regions.

#### 4 - The role of the payment methods in m&a deals: the bnp paribas case study

*Alain Chevalier*, FINANCE, ESCP-EAP, 79, Avenue de la République-PARIS-75011-FRANCE, 75011, PARIS, PARIS, France, chevalier@escp-eap.net, *Etienne Redor*

Many theories have been developed to explain the choice of the payment method in mergers and acquisitions (cash, stock or mixed offer of cash and stocks). The BNP-Paribas-Société Générale deal constitutes an ideal example to explore this choice, because Société Générale and BNP have both used stocks and then a mix of cash and stocks in their tender offers. This deal also allows us to study the role of a payment method that is less frequently used in M&A deals: the contingent value right.

## ■ TC-40

Tuesday 11:20-12:40

GSI - S 27

### Business Process Modelling and Simulation

Stream: Simulation Based Decision Support

*Invited session*

Chair: *Miro Gradisar*, Univ. of Ljubljana, Faculty for economy, Kardeljeva ploscad 17, 1000, Ljubljana, Slovenia, miro.gradisar@ef.uni-lj.si

#### 1 - Business process modeling and simulation requirements in project oriented small and medium enterprises (smes)

*Igor Perko*, Faculty of Economics and Business, Razlagova 14, 2000, Maribor, Slovenia, igor.perko@uni-mb.si

For the projects implementation in the project-oriented SMEs the partners, and the human, material, and financial resources are used. The time component of the internal and external resources use is especially important. New methods and technologies in the field of business processes modeling and simulation (BPMS) support the accurate planning and enable the dynamics in using the resources. In the paper the BPMS requirements in the project-oriented SMEs are elaborated and compared to the R&D state in the field of BPMS to determine the application potentials and the open research issues.

#### 2 - Simulation approach for measuring benefits of business process renovation

*Jure Erjavec*, Informatics, Faculty of Economics, Kardeljeva ploščad 17, 1000, Ljubljana, jure.erjavec@ef.uni-lj.si, *Miro Gradisar*, *Peter Trkman*

Business process renovation has often been used as an approach for reducing costs, lead-times and increasing the quality of the processes. However, the companies have difficulties in assessing the benefits of the renovation (both ex ante and ex post) due to either lack of time and resources or simply because of the inherent complexity of the processes. Using a case study of a manufacturing process renovation we show how business process simulations can be used to assess the benefits of renovation and thus optimizing it. On the basis of the simulations further renovation suggestions are made.

### 3 - Simulation approach for measuring benefits of cutting stock optimization

*Mihael Cesar*, Business Informatics, Faculty of Economics, Kardeljeva pl. 17, 1000, Ljubljana, mcesar@gmail.com

A one-dimensional cutting stock problem occurs in different industrial processes. Many exact and heuristic methods have been developed in order to solve the problem where heuristic methods are often used to resolve medium to big-size instances. However, in a case of low ratio between stock and order lengths (if a ratio between the longest stock length and the shortest order length is less than 4) finding the solution is difficult. We substantiate this using a case study. Furthermore, newly developed method is tested and on the basis of the simulations further suggestions are made.

### 4 - Use of simulation in the public sector: a case study

*Andrej Kovacic*, Kardeljeva plocad 17, 1231, Ljubljana, Slovenia, andrej.kovacic@ef.uni-lj.si, *Bojan Pecek*

Methods and techniques of business process management as known in the private sector are being used more and more in the public sector. This paper demonstrates their applicability to systems where the human factor is more important. It describes a case study of filling unoccupied capacities in an old people's home. The simulation techniques are used as a replacement for the exact deterministic planning. Our research shows that by using the simulation it is possible to predict the effects of the renovation and the duration of the processes and bottlenecks and to thereby avoid bad decisions.

## ■ TC-41

Tuesday 11:20-12:40

GSI - S 28

### Stochastic Project Scheduling

Stream: Scheduling

Contributed session

Chair: *Zohar Laslo*, Industrial Eng. & Management, Sami Shamoon College of Engineering, Bialik/Bazel Sts., 84100, Beer Sheva, Israel, zohar@sce.ac.il

#### 1 - A repairing heuristic procedure to multi-mode resource-constrained project scheduling problem

*Sonda Elloumi*, Quantitative Methods, Faculty of Economic and Management Sciences, 3 Rue Ibn Khaldoun, Route de Gremda Km4, 3062, Sfax, Tunisia, elloumi\_sonda@yahoo.fr, *Taicir Loukil*, *Philippe Fortemps*

A common practice in project scheduling field was of solving deterministic problems where possible disturbance occurrences are not considered. In this study, the multi-mode resource-constrained project scheduling is considered. When the project is online, a mode of a not yet executed job has to be changed. This change would also necessitate other job mode changes to save the schedule feasibility. We propose a quick repairing heuristic that provides a feasible schedule, which should be as close as possible to initial baseline schedule to maintain stability.

#### 2 - Robust resource allocations in temporal networks

*Wolfram Wiesemann*, Department of Computing, Imperial College, London, South Kensington Campus, SW7 2AZ, London, United Kingdom, wwiesema@doc.ic.ac.uk, *Daniel Kuhn*, *Berc Rustem*

We consider workflows of time-consuming tasks whose processing order is constrained by precedences. Often, the task durations can be influenced by the assignment of resources. This leads to the problem of selecting an optimal resource allocation, where optimality is measured by network characteristics such as the makespan. In this talk, we study a robust resource allocation problem where the impact of resource assignments on task durations is uncertain. After discussing the complexity of the problem, we provide an iterative solution method and present an application in digital circuit design.

#### 3 - Optimizing the modifications regularity in a multi-project system

*Zohar Laslo*, Industrial Eng. & Management, Sami Shamoon College of Engineering, Bialik/Bazel Sts., 84100, Beer Sheva, Israel, zohar@sce.ac.il

We deal with controlling and modifying multiple project systems under inadequate information about real-time conditions and the payoff outcomes of actions in a dynamic environment. Since the single project has no control over the system's constrained resources, project programs' modifications should be synchronized. Time commitments, budgets, resource capacities and possibilities of adjusting them to the projects' expected requirements during the course of their life-cycle, determine the most expedient modifications regularity that is found via a system dynamics framework of simulations.

## ■ TC-42

Tuesday 11:20-12:40

GSI - S 3

### Topics in Macroeconomic Modelling

Stream: Mathematical Models in Macroeconomics

Invited session

Chair: *Claus Neidhardt*, Mathematik und Technik, FH Koblenz - RheinAhrCampus Remagen, Südallee 2, 53424, Remagen, neidhardt@rheinahrcampus.de

#### 1 - Equilibrium states in market simulation

*Claus Neidhardt*, Mathematik und Technik, FH Koblenz - RheinAhrCampus Remagen, Südallee 2, 53424, Remagen, neidhardt@rheinahrcampus.de

In an oligopoly or a polypoly two natural types of equilibrium states occur, the first being the Nash equilibrium, the other being the social optimum.

In a simple model, both equilibrium types can be generated in a computer simulation. The type that is eventually attained depends on the modeling of the decision process.

It is even possible to generate mixed states, where some firms attain the Nash equilibrium while others attain a modified social optimum. An interesting question is, which percentage of the firms is necessary to tilt the whole market towards the Nash equilibrium.

#### 2 - The impact of estimation risks on capital allocation

*Gabriel Frahm*, Statistics & Econometrics, University of Cologne, Meister-Ekkehart-Straße 9, 50937, Cologne, frahm@statistik.uni-koeln.de

Capital market theories, like the Capital Asset Pricing Model or the Arbitrage Pricing Model, presuppose, that the investor has complete information about the probability distribution of asset returns. But the investors are actually exposed to estimation risks or even to model risks. In this talk we will show important results in portfolio optimization in consideration of estimation risk, and we will discuss potential implications with regard to the validity of the conventional capital market theories.

#### 3 - Keen economics

*Jürgen Kremer*, FB Mathematik und Technik, FH Koblenz RheinAhrCampus Remagen, Südallee 2,

53424, Remagen, Germany,  
kremer@rheinahrampus.de

A cornerstone of standard economics, the theory of the firm, is usually derived erroneously. If the errors are corrected, nearly nothing of substance remains.

Some results of Steve Keen are emphasized with model calculations and a connection to game theory is established.

#### 4 - Property rights, real options and social asymmetries

*Dirk Löhr*, Umwelt-Campus Birkenfeld, Fachhochschule Trier, Postfach 1380, 55761, Birkenfeld, Rheinland-Pfalz, stbloehr@aol.com

Normally externalities are considered as being the most important reasons for market failure. Asserting this, economic textbooks forget an even more important aspect: the costs of lost flexibility in an uncertain world, if investments have a real option structure. This kind of costs sets an additional hurdle for the profitability of investments. If the costs of lost flexibility do not go hand in hand with an advantage for the investor, economy might be kept away from welfare optimum. These aspects matter for assets such as money, land, patents etc.

### ■ TC-43

Tuesday 11:20-12:40

GSI - S 10

#### Building sustainable communities

Stream: Sustainable living: Cognitive, Social, Economical, Ecological and World View

*Invited session*

Chair: *Ali Gökmen*, Department of Chemistry, Middle East Technical University, 06531, Ankara, Turkey, agokmen@metu.edu.tr

Chair: *Inci Gokmen*, Chemistry, Middle East Technical University, METU Department of Chemistry, 06531, Ankara, Turkey, igokmen@metu.edu.tr

#### 1 - Solutions through community participation

*John Croft*, Institute of Sustainability & Technology Policy, Murdoch University, South St., Murdoch, WA 6150, Perth, Western Australia, jdcroft@yahoo.com, *Ali Gökmen*

The global economic crisis is the worst since 1929. Peak oil threatens oil dependent transport. Of the 6.8 tonnes of CO2 emission/capita we can sustain only 2. Population grows nearly 100 million/yr, straining forests, fisheries and water supplies. Many want government or corporate solutions, but without community mandate little can be done. Mobilizing community creativity, liberating the power to make a difference, is needed. METU Turkey has created 8 projects using a system pioneered in Australia. Used in USA, Africa and Europe, if allowed to grow, this can build true sustainability.

#### 2 - Transformation of a traditional village in Turkey to a economically sustainable community

*Ali Gökmen*, Department of Chemistry, Middle East Technical University, 06531, Ankara, Turkey, agokmen@metu.edu.tr, *Inci Gokmen*

In Ankara 9000 tons of vegetables are consumed daily and most of these are transported from other regions. The yearly food transportation to Ankara generates about 100-thousand tons of CO2. Instead, the villages nearby Ankara may provide healthy food for Ankara with the awareness created among rural and urban people, empowering village woman and young people as well as man. The project consists of four steps: a dreaming circle, planning, doing and celebration. A project team with participation of all the actors is formed for transforming a village to an economically sustainable community.

#### 3 - Education for creating sustainable communities

*Inci Gokmen*, Chemistry, Middle East Technical University, METU Department of Chemistry, 06531, Ankara, Turkey, igokmen@metu.edu.tr, *Ali Gökmen*

Ecovillages are communities living ecologically in harmony with nature. Global Ecovillage Network extending from Europe to the whole world. There is exchange of information and training in network. Global Ecovillage Educators for Sustainable Earth has initiated the Gaia Education with curricula in the ecovillage design education (EDE) and sustainable community development. EDE covers social, economy, ecology and world-view. International Workshop on Sustainable Living and Planning for Sustainability were organized. Trainees of these workshops are creating new networks of sustainability.

### ■ TC-44

Tuesday 11:20-12:40

GSI - S 16

#### Climate, Energy and Uncertainty

Stream: Uncertainty and Environmental Decision Making

*Invited session*

Chair: *Olivier Bahn*, GERAD and HEC Montréal, 3000 Chemin de la Côte-Sainte-Catherine, H3T 2A7, Montréal, Qc, Canada, olivier.bahn@hec.ca

#### 1 - A stochastic game approach to the optimal timing of regional climate policies

*Olivier Bahn*, GERAD and HEC Montréal, 3000 Chemin de la Côte-Sainte-Catherine, H3T 2A7, Montréal, Qc, Canada, olivier.bahn@hec.ca, *Laurent Drouet*, *Alain Haurie*, *Roland Malhamé*, *Julien Thénié*

The elaboration of efficient climate policies must involve many countries. However, climate policies must also take into account the inherent uncertainty associated in particular with possible technological breakthrough to abate efficiently GHG emissions. We propose here a stochastic game model as a paradigm for the design of optimal timing of abatement. The presentation is organized as follows. First, we present our approach for a single world player. Second, we present an extension for  $m$  regions. Strategic behavior of these regions is studied using different dynamic game formalisms.

#### 2 - The endogenous price dynamics of emission permits in the presence of technology change

*Marc Chesney*, Swiss Banking Institute, University of Zurich, 8032, Zurich, Switzerland, chesney@isb.uzh.ch, *Luca Taschini*

Characterizing relevant companies with endogenous pollution processes, this paper extends Chesney and Taschini(2008). We assess how relevant companies decide to undertake pollution-reduction investments in a permit market. The equilibrium price of emission permits is derived by introducing different abatement alternatives and modeling explicitly the strategic interaction of relevant companies. By investigating investment-behaviors and analytically specifying trading strategies, we state formally under which conditions a market for permits delays or hastens firms' abatement investments.

### 3 - Integrating behavioral pattern uncertainties in techno-economic energy and environmental planning models

*Gustave Nguene*, HEG, 7 route de Drize, 1227, Carouge, Geneva, Switzerland,  
gustave.nguene@epfl.ch, *Emmanuel Fragniere*, *Roman Kanala*, *Denis Lavigne*, *Francesco Moresino*

In the classical framework of MARKAL, energy technologies are competing to reach cost objectives and environmental constraints. Recent international studies indicate that practical sustainable development scenarios will be feasible if essentially grounded on human behavioral involvement. Consequently, we propose a new MARKAL formulation (SOCIAL MARKAL) that embeds both technological and behavioral contributions to the environment. We will present the first results of a MARKAL scenario integrating comprehensive social patterns. Reporting issues for decision makers will also be discussed.

### 4 - The simulation and optimization of technology to address climate change

*Gary Howorth*, Energy-Redefined, 1626 Colonial Hills Drive, 22102, Mclean, VA, United States,  
gary.howorth@verizon.net

Climate change when coupled with the interaction of politics is an incredibly complex system. Optimization or control of such a system using conventional techniques is difficult and fraught with a myriad of issues. The paper will consider a number of models that the author has explored in Industry to help frame key questions in the current climate debate. This has involved consideration of policy, technology and the modeling of carbon emissions. The author's current approach uses a combination of methods including complexity approaches. Initial results from the model will be presented.

## ■ TC-45

Tuesday 11:20-12:40

GSI - S 33

## II : A Societal Complexity and Sustainable Development

Stream: Methodology of Societal Complexity

*Invited session*

Chair: *Fernanda Strozzi*, Quantitative Methods Institute, Cattaneo University-LIUC, Corso Matteotti, 22., 21053, Castellanza, Varese, Italy, fstrozzi@liuc.it

### 1 - Ethical aspects of societal complexity: the contribution of discourse ethics

*John Mingers*, Kent Business School, Kent University, CT2 7PE, Canterbury, Kent, United Kingdom,  
j.mingers@kent.ac.uk

With globalization, environmental problems and significant failures in corporate governance, ethics is perceived to be of increasing importance. This paper argues that Habermas's discourse ethics (DE) can make a significant contribution. After outlining some major ethical theories, the paper describes DE. DE is different from other approaches to ethics as it is grounded in actual debates between those affected by decisions. Recognizing that the theory is rather abstract, the final section discusses how it can be pragmatized, with the help of existing soft/critical OR/Systems methodologies.

### 2 - A methodology for sustainable development

*Cathal Brugha*, Management Information Systems, University College Dublin, Quinn School of Business, Belfield, 4, Dublin 4, Ireland, Cathal.Brugha@ucd.ie

We show that sustainable development requires balance between one's subjective position and objective realities, and between one's inner world and outer world. These form a meta-structure based on four dimensions that operate embedded within one another: Adjusting Self within Adjusting World, within Convincing, within Committing. We use the model to show that for development to be sustainable it must follow reverse processes: adapting in the face of objective realities as in conflict resolution, evincing appropriate world views, and inducing what is best for long term success.

### 3 - Manmade project: diagnosing vulnerability, emergent phenomena, and volatility in manmade networks

*Fernanda Strozzi*, Quantitative Methods Institute, Cattaneo University-LIUC, Corso Matteotti, 22., 21053, Castellanza, Varese, Italy, fstrozzi@liuc.it,  
*Eugenio Gutierrez*, *David Arrowsmith*

MANMADE is an EU funded project (1.1.2007-31.12.2009). A general overview of the project as well as some specific results will be presented. The main scope of the project covers the mathematical methods required to understand the dynamics of the network of networks that comprise Europe's critical infrastructure such as electricity grid, supply chain, transport and commercial networks such as the electricity market. The main problems of the interconnected networks considered were vulnerability and risk, resilience, feedback and scaling.

### 4 - Triple loop learning - a complementarist systems approach to management

*Slavica P. Petrovic*, Faculty of Economics, University of Kragujevac, D. Pucara 3, 34000, Kragujevac, Serbia, Serbia, pslavica@kg.ac.yu

In contemporary circumstances, people have to manage increasing diversity of issues by using increasing diversity of theories, methodologies, methods. The key issue refers to a way of choice making between theories, methodologies, methods. Diversity Management (DM), as a complementarist metatheory, tries to provide a base of guidelines for choice making. DM is built into a complementarist methodological idea of Triple Loop Learning (TLL). TLL is focused on managing three issues (about design—how, debate—what, power and legitimacy—why) together in order to enable a responsible action.

## Tuesday 12:55-14:15

### ■ TD-01

Tuesday 12:55-14:15

Beethoven

#### EURO Doctoral Dissertation Award

Stream: EDDA

*Invited session*

Chair: *Denis Bouyssou*, CNRS-LAMSADE, France, bouyssou@lamsade.dauphine.fr

#### 1 - Advances in mip - new tricks for the bag

*Tobias Achterberg*, R&D, ILOG, Ober-Eschbacher Strasse 109, 61352, Bad Homburg, Germany, tachterberg@ilog.de

We give an overview on new solver ingredients that extend the state-of-the-art in mixed integer programming. These components have been incorporated into the constraint integer programming solver SCIP, which has been developed during the PhD research of the author. SCIP is available in source code and free for academic use. The talk focuses on a few highlights of SCIP ingredients and evaluates their computational impact.

#### 2 - Heuristics for stochastic vehicle and inventory routing problems

*Lars Magnus Hvattum*, Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred Getz veg 3, Sentralbygg 1, N-7491 Trondheim, Norway, 7491, Trondheim, lars.m.hvattum@iot.ntnu.no

We first consider a stochastic and dynamic vehicle routing problem from a real world transportation company. Heuristic solution methods are created based on the use of sample scenarios to capture the stochastic elements of the problem. Second, a stochastic inventory routing problem is approached by using scenario trees to approximate infinite horizon Markov decision process formulations. Heuristic solution methods are used to handle the subproblems. Large computational tests are presented to illustrate the performance of the different solution methods.

#### 3 - Interval methods for competitive location problems

*Boglarka G.-Toth*, Differential Equations, Budapest University of Technology and Economics, Egrý József u. 1., 1111, Budapest, Hungary, bog@math.bme.hu

This thesis contributes to several Operations Research fields: global optimization, multiobjective optimization and location science. Shortly, in this thesis general reliable methods both for uni- and biobjective optimization problems are developed and/or accelerated, which can be applied to any continuous optimization problems. To prove the applicability of the methods, several competitive facility location problems have been solved with them. These problems have been modelled very close to reality, which are also results of this thesis contributing to the field of location science.

### ■ TD-02

Tuesday 12:55-14:15

Schumann

#### Metaheuristics for Transportation Planning II

Stream: Transportation Planning

*Invited session*

Chair: *Karl Doerner*, Department of Business Studies, University of Vienna, Bruenner Strasse 72, 1210, Vienna, Vienna, Austria, karl.doerner@univie.ac.at

#### 1 - Ant colony optimization for the order batching problem

*Soeren Koch*, Fakultät für Wirtschaftswissenschaften, Otto-von-Guericke-Universität Magdeburg, Lehrstuhl für Management Science, Universitätsplatz 2, 39106, Magdeburg, Germany, Soeren.Koch@WW.Uni-Magdeburg.DE, *Gerhard Wäscher*

One of the major planning problems in the context of manual order picking is the grouping of customer orders into picking orders, the so-called order batching. In the past mainly constructive heuristics have been suggested to solve this problem. The authors present in detail the application of a metaheuristic, namely Ant Colony Optimization, to the order batching problem. Based on extensive numerical experiments it is shown that the use of this metaheuristic leads to significant improvements in solution quality compared to classical solution approaches.

#### 2 - Tabu search and the attribute based hill climber for the order batching in walk-and-pick order picking systems

*Sebastian Henn*, Faculty of Economics and Management, Otto-von-Guericke University Magdeburg, Universitätsplatz 2, 39106, Magdeburg, sebastian.henn@ovgu.de, *Gerhard Wäscher*

Order picking is a warehouse function dealing with the retrieval of articles from their storage location in order to satisfy a demand specified by customer orders. One of the planning problems in this context is the transformation of customer orders into picking orders, where customer orders are grouped, such that the order picker's total travel time is minimal. It will be presented, how Tabu Search and the Attribute Based Hill Climber Heuristic can be applied to this Order Batching Problem. The talk concludes with a performance comparison of both approaches to existing solution algorithms.

#### 3 - Variable neighborhood search for the dial-a-ride problem

*Karl Doerner*, Department of Business Studies, University of Vienna, Bruenner Strasse 72, 1210, Vienna, Vienna, Austria, karl.doerner@univie.ac.at, *Sophie Parragh*, *Richard Hartl*

In dial-a-ride problems passengers have to be transported between pre-specified pickup and delivery locations under user inconvenience considerations. The problem variant considered in this talk aims at minimizing total routing costs while respecting maximum route duration limits, time windows, and maximum user ride time limits. We propose a competitive variable neighborhood search based heuristic, using four classes of neighborhoods. We report new best results for 15 out of 20 benchmark instances.

#### 4 - Ant colony optimization for the single line train scheduling problem

*Marc Reimann*, Department of Statistics and Operations Research, University of Graz,

Universitätsstrasse 15, A-8010 Graz, 8010, Graz,  
Styria, Austria, marc.reimann@uni-graz.at,  
*Jose-Eugenio Leal*

We study the application of Ant Colony Optimization (ACO) to the Single Line Train Scheduling Problem, where trains may originate in any of the terminal and intermediate stops along the line and travel in both directions. Given some tentative timetable for the trains the objective is to find a conflict-free timetable, with the minimum possible deviation from the tentative one. A conflict arises, when two trains try to occupy the same line segment between two stations at the same time. We apply different versions of ACO and provide some first results on the viability of our approach.

## ■ TD-03

Tuesday 12:55-14:15

*Reger*

### Wireless sensor networks

Stream: Network Optimization

*Invited session*

Chair: *Kadir Ertogral*, Industrial Engineering Department, TOBB University of Economics and Technology, Sogutozu cd. No:43, 06560, Ankara, Turkey, kertogral@etu.edu.tr

#### 1 - Optimal placement, activity scheduling and routing in wireless sensor networks

*I. Kuban Altinel*, Industrial Engineering Dept., Bogaziçi University, Bebek, 34342, Istanbul, Turkey, altinel@boun.edu.tr, *Yavuz Turkogullari*, *Necati Aras*

A wireless sensor network is based on the collaborative effort of distributed autonomous devices called sensors. Sensors have limited energy and capability for sensing, data processing and communication. We develop a mixed-integer linear programming model to maximize network lifetime by optimally determining sensor and sink locations, sensor-to-sink data routes and activity schedules of the deployed sensors over a given horizon subject to coverage, flow conservation, energy consumption and budget constraints. We also propose valid inequalities increasing the quality of the formulation.

#### 2 - Deterministic deployment of wireless sensor networks

*Charl Ras*, Electrical and Electronic Engineering, University of Melbourne, Parkville, 3010, Parkville, Victoria, charl@ee.unimelb.edu.au, *Doreen Thomas*, *Marcus Brazil*

We propose a new heuristic for deterministic deployment of wireless sensor networks when 1-connectivity and minimum cost are the two competing objectives. Given a set of data sources and a base station, our aim is to introduce the minimum number of relays to the network so that every sensor is connected to the base station. Our heuristic is based on the GEOSTEINER algorithms for the Steiner minimal tree problem, and proves to be much more accurate than the current best heuristics for the 1-connected deployment problem, especially in the case of sparse data source distributions.

#### 3 - Evaluating energy efficiency of heuristic base station movement strategies in wireless sensor networks with mobile base stations

*Kadir Ertogral*, Industrial Engineering Department, TOBB University of Economics and Technology, Sogutozu cd. No:43, 06560, Ankara, Turkey, kertogral@etu.edu.tr, *Muhammed Rasit Yildiz*

One of the issues in designing wireless sensor networks is the network survival time, which indicates how long the network keeps functioning. In this study, we introduce a new model for a wireless sensor network in two-dimensional grid with multiple base stations. The model decides both the optimal flow of data and the locations of the base stations, or only the optimal flows for a given set of base station locations, with the objective of maximizing the network survival time. Using this model, we evaluate and analyze the performance of some heuristic movement strategies for base stations.

## ■ TD-04

Tuesday 12:55-14:15

*Liszt*

### Flow-Shop Scheduling Problems

Stream: Scheduling

*Invited session*

Chair: *M. Rosario Moreira*, Faculdade de Economia, Universidade do Porto, Rua Dr. Roberto Frias, s/n, 4200-464, Porto, Portugal, mrosario@fep.up.pt

#### 1 - Minimizing the number of tardy jobs in a flowshop scheduling problem with setup times and time lags constraints

*Emna Dhouib*, Quantitative Methods, Faculté des sciences économiques et de gestion, université de Sfax, Route de mahdia km 8.5, Markez Essebi, chez l'épicier Moncef Ben Amor, 3054, Sfax, emna\_dhouib@yahoo.fr, *Jacques Teghem*, *Taicir Loukil*

We consider the flowshop scheduling problem with sequence dependent setup times and time lags constraints to minimize the number of tardy jobs. Dependent setup times are defined as the work to prepare the machines between two successive jobs. Time lags are defined as an interval of time that must exist between pairs of consecutive operations of the same job. Such constraints arise in various production systems. We propose a mathematical programming formulation and a simulated annealing to solve the problem and we compare both approaches on several instances.

#### 2 - Flowshop rescheduling under different types of disruptions

*Ketrina Katragjini*, INSTITUTO TECNOLÓGICO DE INFORMÁTICA, UPV- Ciudad Politécnica de la Innovación, Camino de Vera s/n-Edif. Bldg. 8G Acc. B, 46022, Valencia, Spain, ketrina@iti.es, *Eva Vallada*, *Ruben Ruiz*

Almost all manufacturing facilities need to use production planning and scheduling systems to increase productivity and reduce production costs. Real-life production operations are subject to a large number of unexpected events like machine breakdowns or new job arrivals. In all these cases, rescheduling is essential for minimizing the impact in the performance of the system. In this work we present reactive rescheduling algorithms that obtain a good trade-off between maximum completion time and stability. Different types of events are used for disrupting and simulating the real schedules.

#### 3 - Attribute based hill climbing for the no-wait flowshop scheduling problem with flow-time objective

*Andreas Fink*, Chair of Information Systems, Helmut-Schmidt-University, Holstenhofweg 85, 22043, Hamburg, Germany, andreas.fink@hsu-hamburg.de

Attribute based hill climbing is a memory-based metaheuristic. Local search moves are enabled depending on solution attributes' aspiration levels. We apply attribute based hill climbing for the no-wait flow-shop scheduling problem with flow-time objective. Computational experiments provide further evidence for the effectiveness of attribute based hill climbing. We analyze the influence of different design decisions on the performance of the algorithm.

#### 4 - Greedy randomized (gr) dispatching heuristics for the single machine scheduling problem with quadratic earliness and tardiness penalties

*M. Rosario Moreira*, Faculdade de Economia, Universidade do Porto, Rua Dr. Roberto Frias, s/n, 4200-464, Porto, Portugal, mrosario@fep.up.pt, *Jorge Valente*

In this paper, we present GR dispatching heuristics for the single machine scheduling problem. The several heuristic differ on the strategies involved in the construction of the GR schedules and on whether they employ only a final improvement step, or perform a local search. They were compared with existing procedures, as well as with optimum solutions for some instance sizes. The computational results show that the proposed procedures clearly outperform their underlying dispatching heuristic, and the best of these procedures provide results that are quite close to the optimum.

## ■ TD-05

Tuesday 12:55-14:15

Haydn

### Bionformatics V

Stream: Computational Biology, Bioinformatics and Medicine

*Invited session*

Chair: *Metin Turkay*, Department of Industrial Engineering, Koc University, Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey, mturkay@ku.edu.tr

#### 1 - Classification of cancers using gene expression signatures

*Youssef Masmoudi*, Sfax University, BP 954, 3042, Sfax, Sfax, Tunisia, youssef\_m\_tn@yahoo.fr, *Metin Turkay*

Biomarker detection is usually by oncologist to detect cancers. For this reason, dimension reduction or variable selection is used to determine some genes to use. In this study, we use all genes expression to classify cancers. Indeed, classification techniques become more and more powerful and with reasonable processing time. One algorithm of Support Vector Machine (SVM) called LibSVM was used and performed with WEKA (a powerful and open source tool for data mining). Some dataset from the literature was used. The misclassification errors arrive to 0% in some dataset.

#### 2 - Mixed-integer model formulation for the image registration problem

*Michael Stiglmayr*, Institute of Mathematics, University of Wuppertal, Gaußstr. 20, 42119, Wuppertal, Germany, stiglmayr@math.uni-wuppertal.de, *Kathrin Klamroth*

Registration of medical images is an important as well as challenging task. We present the use of generalized linear assignment problems for registration and their correspondence to a quadratic assignment problem formulation. These models of the registration problem may, in some cases, be solved to global optimality and are therefore independent of any preregistration. The convergence of the point matching problem to a variant of the Monge-Kantorovich problem is introduced. Computational results are presented as well as an outlook on applications of point matching in medical image analysis.

#### 3 - Protein function prediction from protein-protein interactions. new insights using fuzzy logic algorithms

*Antonio Gómez*, Bioinformatics and Molecular Biología, Institut de Biotecnologia i Biomedicina (IBB) Universitat Autònoma de Barcelona, 08193, Barcelona, Spain, antgomo@gmail.com, *Enrique Querol*, *Juan Cedano*

Functional annotation of proteins is a fundamental problem in the post-genomic era; the availability of protein interaction networks for many species has increased the number of computational methods for interpreting such data to study protein function. In this work, we have developed a simple Fuzzy Logic algorithm that integrates the data from several interaction networks approaches (Module-assisted schemes, Network topology methods, Graph clustering methods) in order to gain knowledge and understanding about the protein function and the network where its included.

#### 4 - Classification of protein-protein interactions with the hyper-box approach

*Ozge Demiryapan*, Industrial Engineering, Koc University, Engineering Facult 210 Koc University Istanbul, Turkey, 34450, Istanbul, Turkey, odemiryapan@ku.edu.tr, *Metin Turkay*

Classification of protein-protein interactions is an important subject for understanding the functions of biological systems. In this talk, we will present the application of hyper-box method for classification of protein interaction types.

## ■ TD-06

Tuesday 12:55-14:15

Koch

### Humanitarian logistics

Stream: OR and Real Implementations

*Invited session*

Chair: *Begoña Vitoriano*, Estadística e Investigación Operativa I, Fac. CC. Matemáticas, Universidad Complutense de Madrid, Plaza de Ciencias, 3, Ciudad Universitaria, 28040, Madrid, Spain, bvitoriano@mat.ucm.es

#### 1 - Mathematical programming in an auction for providing Internet connection in buenos aires city public schools

*Guillermo Duran*, Ingenieria Industrial, University of Chile, Republica 701, 1000, Santiago, Chile, gduran@dii.uchile.cl, *Rafael Epstein*, *Jaime Catalan*, *Flavia Bonomo*, *Javier Marengo*, *Alexis Jawtuschenko*

In this talk we will show the application of an integer programming model to determine the best set of bids in an auction designed to provide Internet connection in the 708 public schools in Buenos Aires City, the largest city in Argentina. Each company must give a general price for the service, discounts for quantity allocations, and the list of schools the company can serve. This model allowed us to find in a few seconds the most convenient set of bids in the auction carried out recently by the Buenos Aires City government.

#### 2 - Yield uncertainty and information asymmetry in influenza supply chain coordination

*Javad Nasiry*, Technology and Operations Management, INSEAD, INSEAD, Boulevard de Constance, 77305, Fontainebleau, Ile de France,

javad.nasiry@insead.edu, *Stephen Chick, Sameer Hasija*

Yield uncertainty in influenza vaccine production affects decision making processes in the vaccine supply chain. Information asymmetry among supply chain participants adds to the complexity, and causes certain inefficiencies. We model information asymmetry in the flu supply chain with yield uncertainty, and design an optimal menu of contracts that the vaccine buyer (the government) can offer to the supplier (the manufacturer) in order to induce efficiency, and produce a system optimal vaccine volume.

### 3 - A fuzzy data-based dss for humanitarian response to natural disasters in developing countries

*J. Tinguaro Rodriguez*, Department of Statistics and Operational Research, Complutense University of Madrid, Plaza de Ciencias, 3, 28040, Madrid, Spain, jtrodrig@mat.ucm.es, *Begoña Vitoriano, Javier Montero*

We present a decision support system (DSS) developed to aid decision makers inside those Non-Governmental Organizations (NGOs) devoted to humanitarian response to natural disasters taking place in developing countries. It combines a fuzzy approach together with a data-based methodology in order to extract and build rules of inference from large databases of historical disaster scenarios. These rules give decision makers the capability to predict the consequences of forthcoming disasters, then allowing NGOs to reduce their response time when facing the strike of a natural disaster.

### 4 - A lexicographical goal programming model for transport of humanitarian aid in developing countries

*Gregorio Tirado*, Estadística e Investigación Operativa I, Universidad Complutense de Madrid, Plaza de Ciencias, 3, 28040, Madrid, Spain, gregoriotd@mat.ucm.es, *M. Teresa Ortuño, Begoña Vitoriano*

Natural and man-made disasters have been affecting increasing numbers of people throughout the world. When a major disaster strikes a country, international community usually respond with an outpouring of assistance, which has to be efficiently managed to give a quick answer under adverse conditions. Organizations are demanding decision support tools for humanitarian logistics taking into account their specific characteristics. A goal programming model focusing on the transport problems to distribute humanitarian aid to the affected population of a disaster in a developing country is presented

## ■ TD-07

Tuesday 12:55-14:15

GSI - S 29

### Robust Optimization I

Stream: Optimization in Public Transport

*Invited session*

Chair: *Sebastian Stiller*, Institut für Mathematik, Technische Universität Berlin, 10623, Berlin, Berlin, Germany, stiller@math.tu-berlin.de

#### 1 - The exact subgraph recoverable robust shortest path problem

*Christina Puhl*, Institut für Mathematik, Technische Universität Berlin, Straße des 17. Juni 136, 10623, Berlin, Berlin, Germany, puhl@math.tu-berlin.de

Recoverable robustness is a concept to avoid over-conservatism in robust optimization by allowing a limited recovery after the full data is revealed.

We consider a new recoverable robust shortest path problem, in which the costs of the arcs are subject to uncertainty, modeled by scenarios. In the Exact Subgraph-RRSP problem we are interested in a sub graph with minimal number of arcs containing for every scenario a shortest path of the original graph.

We show that the problem is not approximable with a factor better than  $m$ , unless  $P=NP$  and that his bound is tight.

#### 2 - Robustness trough branch-and-cut and uncertain set covering problems

*Michele Monaci*, D.E.I., University of Padova, Via Gradenigo 6/A, 35131, Padova, Italy, monaci@dei.unipd.it, *Matteo Fischetti*

We consider optimization problems in which the value of some input data is uncertain and face them by means of a robust optimization approach based on branch-and-cut. Moreover, we consider a variant of the well-known set covering problem for which branch-and-cut is the most natural way to face with the problem. Similar situations arise for the uncertain version of several other combinatorial optimization problems that have a set-covering like formulation. Computational experiments on both instances from the literature and on randomly generated instances are provided.

#### 3 - Computational considerations of the probability-robustness

*Ricardo Garcia*, Escuela Superior de Informatica, Universidad de Castilla La Mancha, Paseo de la Universidad, 4, 130071, Ciudad Real, Ciudad Real, Spain, ricardo.garcia@uclm.es, *Ángel Marín, Juan A. Mesa, Federico Perea, Doroteo Verastegui*

This papers analyzes the computational complexity of finding  $p$ -robust solutions. The concept of  $p$ -robustness was introduced in an earlier paper, and is applied to transportation network designs in which the set of scenarios follows a probability distribution. In this work we address the computational face of this concept, and provide new procedures to find both  $p$ -robust solutions and the  $p^*$ -robustness of a problem.

#### 4 - Linear recovery problems with application in train platforming

*Sebastian Stiller*, Institut für Mathematik, Technische Universität Berlin, 10623, Berlin, Berlin, Germany, stiller@math.tu-berlin.de, *Laura Galli, Paolo Toth, Alberto Caprara*

Recoverable robustness shall remedy the short-comings of classical robust optimization for applications which allow limited recovery. We show that the model stays tractable for linear programming recovery. This yields a general method for network buffering, by which it is easy to extend an existing algorithm for the nominal problem to an algorithm for the robust problem. We exemplify this in a train platforming problem. Trains must be assigned to platforms plus in- and out-paths. Replacing heuristic methods for robustness with our approach, delay reduces on real-world data by about 25%.

## ■ TD-08

Tuesday 12:55-14:15

GSI - S 30

### Lotsizing and Scheduling

Stream: Supply Chain Management

*Invited session*

Chair: *Herbert Meyr*, Chair of Production and Supply Chain Management, Technical University of Darmstadt, Hochschulstr. 1, 64289, Darmstadt, Germany, Meyr@bwl.tu-darmstadt.de

#### 1 - Simultaneous lotsizing and scheduling for multiple production stages

*Florian Seeanner*, Rechts- und Wirtschaftswissenschaften, Fachgebiet Produktion & Supply Chain Management, Hochschulstr. 1, 64289, Darmstadt, Germany, seeanner@bwl.tu-darmstadt.de, *Herbert Meyr*

In consumer goods industries there is typically a large number of final items to be produced on stock. This is often done in a two or three-stage production system, like make&pack, with parallel, sequence-dependent production lines per stage. For the case of shifting bottlenecks, Meyr formulated the General Lotsizing and Scheduling Problem for Multiple production Stages (GLSPMS). In this talk we restate this model and present some reformulations. Finally, heuristic approaches basing on these reformulations are proposed and preliminary computational results are shown.

#### 2 - Product blending and product shipment in an integrated oil company

*Sigrid Lise Nonås*, Finance and Management science, Norwegian School of Economics and Business Administration, Helleveien 30, 5045, Bergen, Norway, sigrid-lise.nonas@nhh.no, *Jens Bengtsson*

We here consider the product blending and product shipment problem in an integrated oil company. We discuss how to better coordinate the blending and shipment of product with the scheduling of the other activities in the supply chain. In the literature known and fixed values are general assumed for the parameters present in the product blending- and shipment models. We here consider how to value and use these to better integrate the product blending- and shipment with the other operations in supply chain. We also briefly discuss how to handle unexpected events in the proposed model.

#### 3 - Lot-sizing within internal supply chains

*Alexander Dobhan*, Lehrstuhl für Produktion und Logistik, Universität Bamberg, Feldkirchenstr. 21, 96045, Bamberg, Germany, Alexander.Dobhan@uni-bamberg.de

The organisation of internal supply chains is determined very often by a combination of hierarchical and heterarchical components. Considering the trend to autonomous factories, hybrid planning strategies seems to be appropriate for intra-organisational multi-site-planning. Therefore, the intention of this paper is to present a new, quantitative, and hybrid approach for intra-organisational multi-site lot-sizing. This approach is developed for avoiding some of the disadvantages of centralised and decentralised planning strategies such as missing optimality or high complexity.

#### 4 - The economic lot and supply scheduling problem: models and solutions

*Heinrich Kuhn*, Chair of Production Management, Catholic University of Eichstaett-Ingolstadt, Auf der

Schanz 49, 85049, Ingolstadt, Germany, heinrich.kuhn@ku-eichstaett.de, *Thomas Liske*

The paper presents an overview on the variety of models concerning the Economic Lot and Supply Scheduling Problem (ELSSP). The ELSSP deals with the simultaneous vehicle routing and production lot-sizing problem assuming continuous demand of the end product items. In distinction from the ELSP, the production of the end items requires end item specific input-materials, which have to be sourced from geographically dispersed suppliers. The talk describes the different cases, formulates the specific models, outlines the solution schemes, and demonstrates numerical results.

## ■ TD-09

Tuesday 12:55-14:15

GSI - S 5

### Quality Management

Stream: Supply Chain Management

*Invited session*

Chair: *Yue Dai*, Management Science, Fudan University, 670 Guoshun Road, 200433, Shanghai, yuedai2002@gmail.com

#### 1 - The management of processes in maintenance

*Slavica Jovetic*, Management and Business Economy, Faculty of Economics, Djure Pucara Starog 3, 34 000, Kragujevac, Serbia, sjovetic@kg.ac.yu, *Nenad Stanisic*

In this paper TQM idea is applied on processes in maintenance in an organization. The paper suggests and develops the methodology of management and improvement (MI) of process in the enterprises which have quality management system (QMS). It consists of the parts that represent the stages of continuous MI in maintenance: defining and documenting of process; statistical, engineering and management methods; managing of financial indicators of the QMS; performance measures, preventive and corrective actions and organization of continuous MI processes in maintenance and their performances.

#### 2 - On the optimization of quality and maintenance decisions using a variable-parameter shewhart chart

*George Nenes*, Mechanical Engineering, Aristotle University of Thessaloniki, University Campus, P.O. Box 461, 54124, Thessaloniki, Greece, gnenes@auth.gr, *Sofia Panagiotidou*

We present a model for the economic design and optimization of a Variable-parameter X-bar Shewhart control chart used in a process where, apart from quality shifts, failures may also occur. Quality shifts result in poorer quality outcome, higher operational cost and higher failure rate. Thus, their removal, besides improving the quality of the outcome and reducing the quality cost, is also a PM action since it reduces the probability of a failure. The proposed model's optimum parameters and minimum cost are compared against the respective parameters and cost of a Fixed-parameter chart.

## ■ TD-10

Tuesday 12:55-14:15

GSI - S 6

### Transport Timetabling

Stream: Timetabling and Rostering

*Invited session*

Chair: *Rodrigo Acuna-Agost*, LIA - Laboratoire de Informatique, Université d'Avignon, 339, chemin des Meinajaries, Agroparc BP 1228, 84911, Avignon, PACA, France, rodrigo.acuna-agost@univ-avignon.fr

#### 1 - Determining railway timetables according to users' desires and fleet size constraints

*Miguel Angel Pozo*, Alcalde Isacio Contreras, N°8, 1°A, 41003, Seville, miguelpozo@us.es, *Juan A. Mesa*, *Francisco A. Ortega*

In this paper, we consider the train timetabling problem for a single railway line, taking into account both operator's and user's interests. For the users, a timetable is suitable if it enhances transfer conditions and fits to their ideal boarding time. Firstly, a fitting function for evaluating riders disarrangements is defined in the paper. Secondly, a preestablished fleet size and a generical origin-destination matrix dependent on time give rise to a demand allocation problem. Transfer synchronization constraints at fixed points in time are also included in the problem formulation.

#### 2 - An ant colony algorithm for the train timetabling problem of mrt

*Jenyu Huang*, Department of Civil Engineering, National Taiwan University, No. 1, Sec. 4, Roosevelt Road, 10617, Taipei, Taiwan, m09303001@chu.edu.tw, *Jau-Ming Su*

The train timetabling problem aims at determining a periodic timetable for a set of trains that doesn't violate track capacities and satisfies some operational constraints. In this paper, we define the train timetabling problem of MRT and propose an algorithm which based on ant colony optimization with local search for solving the problem. A case study using the data of Taipei MRT demonstrates the algorithm's effect and its potential applications. The result indicates a free conflict timetable of MRT can be produced efficiently and the proper proportion of headway of timetable is more than 90%.

#### 3 - Sapi - a new solution scheme in disruption management

*Rodrigo Acuna-Agost*, LIA - Laboratoire de Informatique, Université d'Avignon, 339, chemin des Meinajaries, Agroparc BP 1228, 84911, Avignon, PACA, France, rodrigo.acuna-agost@univ-avignon.fr, *Philippe Michelon*, *Dominique Feillet*, *Serigne Gueye*

In the execution phase, unexpected events disturb the system and may make an original plan suboptimal or infeasible. Disruption management is a methodology that deals with these disruptions in real time. In this talk, we present a new solution scheme called SAPI. This method performs a statistical analysis of propagation of incidents to reduce the problem and concentrate the effort in concerned events. Finally, two applications in railways and commercial aviation (challenge ROADEF 2009) are exposed. The results show that SAPI obtains a good balance between quality solutions and speed.

## ■ TD-11

Tuesday 12:55-14:15

GSI - S 17

### MCDA applications in business and management

Stream: Multiple Criteria Decision Analysis

*Invited session*

Chair: *Michael Doumpos*, Dept. of Production Engineering and Management, Technical University of Crete, University Campus, 73100, Chania, Greece, mdoumpos@dpem.tuc.gr

#### 1 - An integrated quantitative framework for active equity portfolio engineering

*Panagiotis Xidonas*, Electrical & Computer Engineering, National Technical University of Athens, 9 Heroon Polytechniou Str., 15780, Athens, pxid@epu.ntua.gr, *Fotis Petropoulos*, *George Mavrotas*, *Christos Ntanos*, *Konstantinos Nikolopoulos*, *Dimitris Askounis*, *John Psarras*, *Vasilis Assimakopoulos*

We advocate for the necessity of introducing an integrated quantitative framework, fully implemented in a functional window-based information system, to support active investment decisions. The proposed approach combines the THETA forecasting method for selecting the most attractive securities, along with the augmented  $\epsilon$ -constrained (AUGMECON) multiobjective mathematical programming (MMP) method for synthesizing optimal portfolios. Our objective is to engineer equity portfolios that offer consistent outperformance relative to underlying benchmarks, with strict control of portfolio risk.

#### 2 - On artificial intelligence and multicriteria decision analytics to engineer a predictive school classification system

*Nina Kajiji*, National Center Public Education, University of Rhode Island, 80 Washington Street, 02903, Providence, Rhode Island, United States, Nina@uri.edu, *Gordon Dash*, *Elliot Krieger*

This research employs Kohonen (K) and radial-basis-function (R) neural networks to uncover the policies that best explain variation in high school mathematics and English arts proficiency. We interrogate a subjective school classification system by extraction of a 3 by 1 (K) feature map. Next, predictive school performance is sorted by estimating a softmax-based probabilistic Cobb-Douglas production function based on an (R) network. Under AI-MCDA US public school administrators are empowered to more effectively predict and sort expected school performance within statutory regulations.

#### 3 - Evolutionary optimization approaches for building outranking models in credit risk rating

*Michael Doumpos*, Dept. of Production Engineering and Management, Technical University of Crete, University Campus, 73100, Chania, Greece, mdoumpos@dpem.tuc.gr, *Constantin Zopounidis*

Credit risk rating involves the development of classification models that facilitate the assessment of the likelihood of default. Multi-criteria methods have been used in this domain, based mainly on value function models. In this paper, outranking techniques are employed, which enable the development of non-compensatory relational models that take into account veto and incomparability conditions. Evolutionary optimization, namely the differential evolution algorithm, is used for the development of the models based on a set of training data.

## ■ TD-12

Tuesday 12:55-14:15

GSI - S 18

### Approximation and stability

Stream: Stochastic Programming

*Invited session*

Chair: *Georg Pflug*, Department of Statistics and Decision Support Systems, University of Vienna, Universitaetsstrasse 5, A-1010, Vienna, Austria, georg.pflug@univie.ac.at

Chair: *Silvia Vogel*, Mathematics and Natural Sciences, Ilmenau University of Technology, Postfach 100565, 98684, Ilmenau, Thuringia, Germany, Silvia.Vogel@tu-ilmenau.de

#### 1 - Universal confidence sets for constrained decision problems

*Silvia Vogel*, Mathematics and Natural Sciences, Ilmenau University of Technology, Postfach 100565, 98684, Ilmenau, Thuringia, Germany, Silvia.Vogel@tu-ilmenau.de

We investigate a general approach, which derives confidence sets for solutions of decision problems as suitable neighborhoods of solutions of approximate random problems. The method relies on special convergence properties of the objective functions and the constraint sets. In order to determine the radius of the neighborhoods, knowledge about certain characteristics of the unknown true decision problem is needed. We will show how estimates for these characteristics can be included into the considerations.

#### 2 - Stochastic optimization - sample path rate of stability

*Petr Lachout*, Dept. Probability and Statistics, Charles University in Praha, Sokolovská 83, 186 75, Praha, Czech Republic, lachout@karlin.mff.cuni.cz

This talk deals with stochastic optimization problems. We will present results on a rate of stability for "optimal value" and "optimal solutions". Results are derived without measurability assumption and, also, uniqueness is not assumed.

#### 3 - Approximation and optimal scenario generation for stochastic programs

*Georg Pflug*, Department of Statistics and Decision Support Systems, University of Vienna, Universitaetsstrasse 5, A-1010, Vienna, Austria, georg.pflug@univie.ac.at

While typically stochastic programs are defined using general stochastic processes modeling the uncertainty, the solution of such programs is based on simple discrete tree approximations.

By using appropriate distances for the stochastic scenario processes we demonstrate quantitative stability results for optimal values and solutions. These distances incorporate not only the difference in values but also the difference in information of the two processes in one single number.

We also show how these types of stability results may be used for scenario generation.

## ■ TD-13

Tuesday 12:55-14:15

GSI - S 31

### Location in supply chains

Stream: Location Analysis

*Invited session*

Chair: *H.a. Eiselt*, University of New Brunswick, P.O. Box 4400, E3B 5A3, Fredericton, NB, Canada, haeiselt@unb.ca

#### 1 - Contribution to location — allocation problem of supply chain units to the structural industry section

*Pericles Fylakis*, Aristotle University of Thessaloniki, 76 V. Alexandrou, 57200, Lagadas Thessaloniki, Greece, pfylakis@civil.auth.gr

The facility location problem in the sector of heavy structural industry, constitutes an important part of strategic planning in the field of enterprises dealing with the constructional sector. Existence of a supporting tool in the decision making for the above mentioned problem constitutes an inquiry for the managers of this area. Use of overtime employment in the structural projects production is usual and rather imposed for the installation of units with smaller possible capacity. In this paper an effort was made for the most optimal solution to the problem making use of this ability.

#### 2 - Location and policy analysis for intermodal transport in Belgium

*Cathy Macharis*, Department of Mathematics, Operational Research, Statistics and Information Systems for Management, Free University of Brussels, Brussels, Belgium, Belgium, Cathy.Macharis@vub.ac.be, *Ethem Pekin*

We describe a geographic information system-based location model to analyse characteristics of the Belgian intermodal terminal landscape. Based on transportation costs, the model compares intermodal transport with unimodal road transport. It visualises the current intermodal terminal landscape, and simulates various scenarios, like introducing new terminals or effects of subsidies. Highlighting the market areas of inland waterways and rail terminals, the model is used as a policy support tool to obtain integrated visions on future intermodal transport development in Belgium.

#### 3 - Optimizing subsidies for the location of facilities

*H.a. Eiselt*, University of New Brunswick, P.O. Box 4400, E3B 5A3, Fredericton, NB, Canada, haeiselt@unb.ca, *Joy Bhadury*

The presentation deals with a model that has three levels: a regional planner, who attempts to maximize his tax revenue and who can award subsidies, a firm that locates branches in order to maximize its profit, and customers, who have posted a fixed demand. It is demonstrated that this bilevel optimization problem has a computable solution. Tests on U.S. data reveal some interesting properties of the solutions. A variety of extensions is also discussed, including a generalization of the problem to multiple regions, and the value of information.

## ■ TD-14

Tuesday 12:55-14:15

GSI - S 32

### Behavioral Kernels of Inventory Management

Stream: Inventory Management

*Invited session*

Chair: *Mirko Kremer*, SC/IS, The Pennsylvania State University, 460 Business Building, 16802, University Park, PA, United States, muk22@psu.edu

#### 1 - Over- and underreaction in time series forecasting

*Mirko Kremer*, SC/IS, The Pennsylvania State University, 460 Business Building, 16802, University Park, PA, United States, muk22@psu.edu

Demand forecasting as behavioral kernel for inventory (and many other planning) decisions encompasses the daunting challenge of separating stability from change. In a controlled laboratory environment, we investigate human performance in a time series forecasting task. We document fairly predictable patterns of human reactions to the demand signals generated by the underlying demand process.

#### 2 - Supply chain coordination with information sharing in the presence of trust and trustworthiness

*Guido Voigt*, Production and Logistic, Otto-von-Guericke University, Postfach 4120, 39016 Magdeburg, 39016, Magdeburg, Germany, guido-voigt@gmx.de

The strategic use of private information causes efficiency losses in traditional principal-agent settings. Yet, a growing body of studies highlights the importance of communication, trust and trustworthiness in supply chain management. The underlying work links the concepts of communication, trust and trustworthiness to a traditional principal-agent setting. It can be shown that communication and trust can lead to substantial efficiency losses although there is a substantial level of trust and trustworthiness.

#### 3 - Designing contracts for supply chains with irrational but predictable newsvendors

*Michael Becker-Peth*, Seminar für Supply Chain Management und Management Science, Universität zu Köln, Albertus Magnus Platz, 50923, Köln, NRW, Germany, michael.becker-peth@uni-koeln.de, *Ulrich Thonemann*

In contract design, sellers optimize the contract parameters under the assumption that the buyers are placing orders that maximize their expected profits, a decision commonly referred to as rational. However, in various experiments it has been shown that buyers do not determine orders rationally. In our research, we first conduct a number of experiments to analyze the buyers' order behavior. We demonstrate that the orders quantities of buyers are not expected profit maximizing, but that they can be predicted quite accurately and build on this information to design various contracts.

## ■ TD-15

Tuesday 12:55-14:15

Einstein

### Resource-Constrained Project Scheduling

Stream: Project Management and Scheduling

*Invited session*

Chair: *Christian Artigues*, LAAS, CNRS, 7 avenue du Colonel Roche, 31077, Toulouse Cedex 4, artigues@laas.fr

#### 1 - A multi-population genetic algorithm for the resource constrained project scheduling problem

*José Fernando Gonçalves*, LIAAD, Faculdade de Economia, Universidade do Porto, Rua Dr. Roberto Frias, s/n, 4200-464, Porto, Portugal, jfgoncal@fep.up.pt

This paper presents a new multi-population genetic algorithm for the Resource Constrained Project Scheduling Problem, able to provide close to optimal solutions for large instances. The approach combines a serial schedule generation scheme (SGS) with a genetic algorithm. The genetic algorithm is based on random keys and is responsible for evolving the priorities used by the serial-SGS. Forward-backward improvement is applied to every solution. Extensive computational tests on benchmark problems validate the effectiveness of the proposed approach. Supported by FCT project PTDC/GES/72244/2006.

#### 2 - A new fast complete method for resource-constrained project scheduling

*Andrei Horbach*, Institute of Business Administration, University Kiel, Olshausenstrasse 40, D-24098, Kiel, Germany, horbach@bwl.uni-kiel.de

We formulate the resource-constrained project scheduling problem (RCPSP) as series of instances of the satisfiability problem and adapt a satisfiability solver for the specific domain of the problem. Applying our solver we close several benchmark instances of the RCPSP that have never been closed before by proving tighter lower bounds and by finding better feasible solutions. Our solver shows an one to two orders of magnitude better performance on several hard benchmark instances from the library PSPLIB than other existing complete RCPSP solvers from the literature.

#### 3 - Modeling and solving resource-constrained project scheduling problems with ibm ilog cp optimizer

*Philippe Laborie*, ILOG, an IBM Company, 9, rue de verdun, 94253, Gentilly, France, laborie@fr.ibm.com

Since version 2.0, IBM ILOG CP Optimizer provides a new scheduling language supported by a robust and efficient automatic search. We will show how the main features of resource-constrained project scheduling such as work-breakdown structures, optional tasks, different types of resources, multiple modes and skills, resource calendars and objective functions such as earliness/tardiness, unperformed tasks or resource costs can be modeled in CP Optimizer. The robustness of the automatic search will be illustrated on some classical resource-constrained project scheduling benchmarks.

#### 4 - Event-based MILP models for the resource-constrained project scheduling problem

*Christian Artigues*, LAAS, CNRS, 7 avenue du Colonel Roche, 31077, Toulouse Cedex 4, artigues@laas.fr, *Oumar Kone*, *Pierre Lopez*, *Marcel Mongeau*, *Marcel Mongeau*

We make a comparative study of several mixed integer linear programming (MILP) formulations for the resource-constrained project scheduling problem (RCPSp). First, we present standard discrete and continuous time MILP formulations. Second, instead of relying on the traditional discretization of the time horizon, we propose two new MILP formulations based on the concept of event: the Start/End and the On/Off formulations. Experimental results allow us to provide guidelines for the choice of the accurate formulation with respect to the RCPSp instance characteristics.

## ■ TD-16

Tuesday 12:55-14:15

Koenig

### Multiple Criteria Integer Programming

Stream: Multi-Objective Optimization and Decision Theory 1

*Invited session*

Chair: *Ralf Borndörfer*, Optimization, Zuse-Institute Berlin, 14195, Berlin, Germany, borndorfer@zib.de

#### 1 - An exact method to generate the non-dominated set for the moilp problem

*Chergui Mohamed El-Amine*, Recherche Opérationnelle, Université des Sciences et de la Technologie H.B., BP. 32, Bab Ezzouar, 16111, Alger, ALGERIE., Algeria, mohamedelaminec@yahoo.com, *Ait-mehdi Meriem*, *Abbas Moncef*

We describe an exact method to generate the non-dominated set for the MOILP problem. While most of researchers solve initially an ILP problem, the proposed method starts with an optimal point of an LP problem and uses a branching process to find locally an integer point. Then, an efficient cut which deletes only dominated vectors is built. The results show that our method is better than Sylva & Crema's one since it's 15 times faster, makes thrice less simplex iterations and generates almost 4 times fewer nodes on average. As an application, the artificial insemination problem is treated.

#### 2 - An approximation algorithm to generate the extreme supported nondominated points for multiobjective mixed integer programs

*Ozgur Ozpeynirci*, Department of Logistics Management, Izmir University of Economics, 35330, Izmir, Turkey, ozgur.ozpeynirci@ieu.edu.tr, *Murat Koksalan*

We consider finding the extreme supported nondominated (ESN) points for multiobjective mixed integer programming problems. We develop an approximation algorithm (ApA) that generates a representative subset of ESN points. ApA keeps lower and upper bound sets for ESN points and provides a nonincreasing worst case proximity measure between the bound sets. This property allows ApA to provide a performance guarantee. We develop lower bound sets and variations of the algorithm to enhance its computational performance and demonstrate the results on a set of assignment problems.

#### 3 - Multicriteria optimization in public transportation

*Ralf Borndörfer*, Optimization, Zuse-Institute Berlin, 14195, Berlin, Germany, borndorfer@zib.de

This talk discusses multi-criteria versions of Lagrangean relaxation and column generation optimization approaches to optimization problems in public transportation including line planning, vehicle scheduling, and duty scheduling. In this way, we can analyze trade-offs between conflicting objectives such as quality of service, operational stability, and employee satisfaction.

## ■ TD-17

Tuesday 12:55-14:15

Rheinaue

### Cutting and Packing 6

Stream: Cutting and Packing

*Invited session*

Chair: *Socorro Rangel*, DCCE, UNESP, Rua Cristovão Colombo, 2265, 15054000, S.J. do Rio Preto, São Paulo, Brazil, socorro@ibilce.unesp.br

#### 1 - Large scale production planning in the stainless steel industry

*Janne Karelahti*, Accenture, Finlaysoninkuja 21 A, 33210, Tampere, Finland, janne.karelahti@accenture.com, *Pekka Vainiomäki*, *Tapio Westerlund*

We introduce a new formulation for a two-dimensional trim loss problem in the stainless steel industry. In this model, the dimensions of the mother coils are considered variables. To enable reuse of scrap material, the trim loss at the end of a coil is collected into a single coil. Also, the scattering of an order to multiple coils is minimized to facilitate shipping. For numerical solution, the inherently non-linear problem is transformed to a linear one by a decomposition technique. The procedure has been successfully applied in industrial environment at Outokumpu Stainless Tornio Works.

#### 2 - Skiving stock problem

*Martina Stuber*, Uni Bonn, Rheinische Friedrich-Wilhelms-Universität Bonn, Wegeler Str. 10, 53115, Bonn, Germany, martina.stuber@uni-bonn.de

In this talk we will discuss the so-called Skiving Stock Problem. This problem appears by the manufacturing paper rolls and was first described by Eugen Zak. It describes the situation where by technical reasons the customer's orders can not be executed. This means that the desired length of the ordered paper roll is to be cut more than a half the roll length. The technical solution is to cut one jumbo roll into smaller rolls and to skive these rolls to the desired roll length. A mathematical model of this problem will be given and some properties of this model will be discussed.

#### 3 - Arc-flow model for the two-dimensional cutting stock problem

*Rita Macedo*, Departamento de Produção e Sistemas, Universidade do Minho, Universidade do Minho, Escola de Engenharia, Departamento de Produção e Sistemas, Campus de Gualtar, 4710-057, Braga, Portugal, rita@dps.uminho.pt, *Cláudio Alves*, *J. M. Valério de Carvalho*

We describe an exact model for the two-dimensional Cutting Stock Problem with two stages and the guillotine constraint. It is a linear programming arc-flow model, formulated as a minimum flow problem. We explicitly consider all its variables and constraints, apply reduction criteria to reduce the size and symmetry of the model and solve it with CPLEX, considering a new family of cutting planes. We also consider some variants of the original problem. The model was tested on a set of real instances from the wood industry, with promising results.

#### 4 - The two-dimensional cutting stock problem with saw machine set ups

*Socorro Rangel*, DCCE, UNESP, Rua Cristovão Colombo, 2265, 15054000, S.J. do Rio Preto, São Paulo, Brazil, socorro@ibilce.unesp.br, *Gabriela Mosquera*, *Horacio Yanasse*

In this paper we present solution approaches to the two-dimensional cutting stock problem considering both the minimization of the total number of plates and the cutting machine set ups. The relationship between the number of cutting patterns and the number of saw cycles (machine set ups) is studied. Results of a computational study using real data from a Brazilian furniture plant are also presented. Acknowledgement: Brazilian agencies CNPq and FAPESP.

## ■ TD-18

Tuesday 12:55-14:15

Lenné

### Mathematical Programming Problems in Machine Learning

Stream: Mathematical Programming

Invited session

Chair: *Annabella Astorino*, ISTITUTO DI CALCOLO E RETI AD ALTE PRESTAZIONI, CONSIGLIO NAZIONALE DELLE RICERCHE, VIA PIETRO BUCCI 41C, 87030, RENDE, Italy, [astorino@icar.cnr.it](mailto:astorino@icar.cnr.it)

#### 1 - Mathematical programming for multiple kernel learning

*Alexander Zien*, Group Rättsch, Friedrich Miescher Laboratory of the Max Planck Society, Spemannstraße 39, 72076, Tübingen, Germany, [Alexander.Zien@tuebingen.mpg.de](mailto:Alexander.Zien@tuebingen.mpg.de)

Many machine learning problems (e.g. training SVMs) have a mathematical programming (MP) formulation. An important advantage of SVMs is elegant non-linear modelling via kernel functions; however, a proper choice of kernel is crucial for accurate predictions. Multiple kernel learning (MKL) is an extension to SVMs that allows to optimize a linear combination of kernels during training. We review MKL, present its different MP formulations, and investigate their time complexity. Finally we discuss what is key for tuning mathematical programming to achieve the required computational efficiency.

#### 2 - Parallel nonlinear svm regression through gradient-projection methods

*Thomas Serafini*, Department of Physics, INFN - National Research Council, via Campi 213/a, 41100, Modena, Italy, [thomas.serafini@unimore.it](mailto:thomas.serafini@unimore.it), *Gaetano Zanghirati*, *Luca Zanni*

A number of effective supervised learning methodologies are available for the computation of the optimal classifier/regressor of a given data set, which are used in many application areas. However, the increasing amount of the data and of their dimensionality calls for software tools able to exploit the power of modern parallel machines. We present a well parallelizable approach to the solution of the standard nonlinear Support Vector Machine (SVM) regression problem: it is based on a gradient-projection decomposition technique and it is very suitable for distributed-memory systems.

#### 3 - A new look to the primal problem in svm training

*Gaetano Zanghirati*, Department of Mathematics, University of Ferrara, Building B, Scientific-Technological Campus, via Saragat, 1, 44100, Ferrara, Italy, [g.zanghirati@unife.it](mailto:g.zanghirati@unife.it), *Roger Fletcher*

Given two clusters of points, the Support Vector Machine (SVM) is a very powerful method to obtain a separating hypersurface with optimal generalization properties, via the maximum margin principle. The NLP problem it generates is usually faced through its dual, which is a simply constrained, convex QP problem. While the dual has been extensively studied, less is known about the primal SVM problem: we present a new SQP approach to the solution of the latter, which is shown to converge to the optimal solution. Some experiments will be presented and numerical aspects will be discussed.

#### 4 - A two phase approach to semisupervised classification

*Annabella Astorino*, ISTITUTO DI CALCOLO E RETI AD ALTE PRESTAZIONI, CONSIGLIO NAZIONALE DELLE RICERCHE, VIA PIETRO BUCCI 41C, 87030, RENDE, Italy, [astorino@icar.cnr.it](mailto:astorino@icar.cnr.it), *Antonio Fuduli*, *Manlio Gaudioso*, *Enrico Gorgone*, *Diethard Pallaschke*

Pattern classification deals with the identification of the class label for each object of two or more classes. Standard supervised approach uses only the features of objects with known class label. The idea behind the semisupervised learning is to make use also of information coming from unlabelled objects. Typically, the semisupervised approach requires solution of large scale problems. Our objective is to present a preprocessing of the dataset which, on the basis of the concept of separating set, reduces the number of unlabelled objects to be entered in the classification phase.

## ■ TD-19

Tuesday 12:55-14:15

Haber

### Location and Routing with metaheuristics

Stream: Metaheuristics

Invited session

Chair: *Mahmut Ali Gokce*, Industrial Systems Engineering, Izmir University of Economics, Sakarya Cad. No: 155, Balcova/ Izmir TURKEY, 35050, Izmir, Turkey, [ali.gokce@ieu.edu.tr](mailto:ali.gokce@ieu.edu.tr)

#### 1 - Motorcycle-courier routing problems in urban areas

*Tsung-Sheng Chang*, Institute of Global Operations Strategy and Logistics Management, National Dong Hwa University, 1, Sec.2, Da-Hsueh Rd., Shou-Feng, 974, Hualien, Taiwan, [ts@mail.ndhu.edu.tw](mailto:ts@mail.ndhu.edu.tw)

Motorcycles have been becoming one of the major transportation modes for distributing small packages in urban areas. This research intends to help the motorcycle couriers promote their competitive power by efficiently and effectively solving their routing problems. In this study, the motorcycle-courier routing problem is modeled as a multiple traveling salesman problem with workload balancing and time window constraints. Since the problem is NP-hard, our proposed solution algorithm is a heuristic. To our knowledge, this research topic has not been studied in the literature.

#### 2 - New metaheuristics for the reliability p-median problem

*Javier Alcaraz*, Estadística, Matemáticas e Informática, Universidad Miguel Hernández, Av. Universidad s/n, 03202, Elche, Alicante, Spain, [j.alcaraz@umh.es](mailto:j.alcaraz@umh.es), *Mercedes Landete*, *Juan Francisco Monge*

In the P-Median problem, it is assumed that, once the facilities are opened, they may not fail. In practice some of the facilities may become unavailable due to several factors. In the Reliability P-Median Problem some of the facilities could not be operative in some periods. The objective is now to find facility locations that are both inexpensive and also reliable. We present two new hybrid meta-heuristics to solve the problem. We have carried out an extensive computational experiment to study the performance of the algorithms and compare its efficiency solving well known benchmark instances.

### 3 - A new capacitated arc routing problem type: formulation and solution approaches

*Gokhan Kirlık*, Department of Industrial Engineering, Eskisehir Osmangazi University, Kirmizitoprak Mh. Kinacicegi Sk. No:12/5 Demet Apt. 26020, Eskisehir, Turkey, gokhankirlik@gmail.com, *Aydin Sipahioglu*, *Osman Parlaktuna*, *Ahmet Yazici*

Multi-robot coverage problem is a challenging and heavily studied problem. Although it resembles Capacitated Arc Routing Problem (CARP) it has some differences from CARP. For example, a mobile robot consumes energy not only for traversing but also traversing and coverage. That situation requires defining two different arc demands for each arc. In constructing tour of each robot only one arc demand value should be used which makes the problem harder. In this study, a new mathematical model and a genetic algorithm based solution approach is proposed to solve multi-robot coverage problem.

### 4 - A novel GRASP based tabu search with variable neighbourhoods for inventory distribution routing (idr) problem

*Mahmut Ali Gokce*, Industrial Systems Engineering, Izmir University of Economics, Sakarya Cad. No: 155, Balcova/ Izmir TURKEY, 35050, Izmir, Turkey, ali.gokce@ieu.edu.tr, *Ozgur Akgun*, *Berkay Beygo*, *Onur Coskunseda*

Inventory Distribution Routing Problem is a highly practical and theoretically challenging (NP-Hard) problem. We solve the single warehouse-heterogeneous fleet version, in its entirety, with a tabu search heuristic combining GRASP with a variable neighbourhood structure. We also present a constructive hyperheuristic modeling. We present the results of the tabu based heuristic, hyperheuristic and compare it to the optimal results of MILP for a computational study of generated problems.

## TD-20

Tuesday 12:55-14:15

Mann

### DEA Methodology V

Stream: DEA and Performance Measurement

Invited session

Chair: *Joseph Paradi*, Chemical Engineering and Applied Chemistry, University of Toronto, 200 College Street, M5S3E5, Toronto, Ontario, Canada, paradi@mie.utoronto.ca

#### 1 - Finding DEA efficient hyperplanes using molp structure

*Mohammad Reza Mozaffari*, aDepartment of Mathematics, Science and Research Branch, Islamic Azad University, Tehran, Iran, aDepartment of Mathematics, Science and Research Branch, Islamic Azad University, Tehran, Iran, Science and Research Branch, Islamic Azad University, Tehran, Iran, +98,

Tehran, Iran, Islamic Republic Of, mozaffari23@yahoo.com, *Farhad Hosseinzadeh Lotfi*, *Gholam Reza Jahanshahloo*, *Josef Jablonsky*, *Javad Gerami*

In this paper, two methods are proposed to find DEA efficient hyperplanes with variable returns to scale (VRS) technology assumption. In the first method, we try to minimize a vector that is greater than the convex combination of the input vectors of the DMUs, and to maximize a vector that is smaller than the convex combination of the output vectors of the DMUs. In the second method, we propose an MOLP that maximizes the weighted normal vectors corresponding to the inputs and outputs. Finally, we compare the gradients of the efficient hyperplanes obtained by our two proposed methods.

#### 2 - Technical efficiency based on cost gradient measure

*Miki Tsutsui*, Socio-economic Research Center, Central Research Institute of Electric Power Industry, 2-11-1 Iwadokita, Komae-shi, 2018511, Tokyo, Japan, miki@criepi.denken.or.jp, *Kaoru Tone*, *Yuichiro Yoshida*

We propose a new model named cost gradient measure (CGM), which enables us to measure more price-conscious technical efficiency. In the CGM model, projection to the efficiency frontier is defined by the cost gradient direction of each decision making unit (DMU), which is the normal to the cost plane and the steepest ascent direction of total input cost. This will be reasonable for company managers. Furthermore, we can derive CCR model from CGM formula, and it clearly implies CCR is under a strong restriction of proportionality. CGM can overcome shortcomings of traditional models.

#### 3 - A method for finding strong defining hyperplanes of pps with variable returns to scale technology

*Israfil Roshdi*, Department of Mathematics, Science and Research Branch, Islamic Azad University, Tehran, Iran, Rajaei Aveune. Eslamabad alley. No 47. Marand, Iran, 5417733737, Marand, Azarbayjane-Sharghi, Iran, Islamic Republic Of, i.roshdi@gmail.com, *Mostafa Davtalab Olyaei*

It is well known that the optimal solutions of the envelopment formulation for extreme efficient units are often highly degenerate and, therefore, may have alternate optima for the multiplier form. Every optimal solution yields a hyperplane which is a supporting hyperplane at production possibility set (PPS). We will characterize the structure of strong defining hyperplanes of PPS with variable returns to scale technology, and computationally propose an effective algorithm for finding all of these hyperplanes.

#### 4 - A simulation analysis to validate a new DEA model for controlling environmental impacts on efficiency measurements

*Haiyan Zhu*, Chemical Engineering and Applied Chemistry, University of Toronto, 200 College Street, Toronto, Ontario, Canada, M5S 3E5, Toronto, Ontario, haiyan.zhu@utoronto.ca, *Joseph Paradi*

Earlier, an effective and simple Culturally-Adjusted DEA model was developed for controlling the operating environment bias in production efficiency analysis when environmental conditions are partial causes of inefficiency and cannot be presented as inputs or outputs. We show here an effective simulation analysis to validate the CA-DEA model by comparing it to other DEA models used to control exogenous factors. Further tests are taken to model sensitivity to different degrees of environmental differences and different functional relationships between production and environmental variables.

## ■ TD-21

Tuesday 12:55-14:15

Hauptmann

### Satisfiability and Graphs

Stream: Boolean Programming

Invited session

Chair: *Ewald Speckenmeyer*, Institut für Informatik, Universität zu Köln, Pohligstr. 1, 50969, Köln, Germany, esp@informatik.uni-koeln.de

#### 1 - Feedback vertex set heuristics based on Markov chains

*Mile Lemaic*, Institut für Informatik, Universität zu Köln, Pohligstr. 1, 50969, Köln, lemaic@uni-koeln.de

A feedback vertex set (FVS) of a digraph  $G$  is a vertex set  $F$  such that  $G - F$  is acyclic. The minimum feedback vertex set problem asks for a FVS of  $G$  of minimum cardinality. While being one of the classic NP-hard problems [Karp72], it has important applications in many fields. The use of Markov chains for determining low cardinality FVSs has been demonstrated in [Speckenmeyer89]. In this talk, the original algorithm of Speckenmeyer is outlined and, additionally, some new heuristics are presented which also use Markov chains to determine small FVSs.

#### 2 - Level graph formulas

*Bert Randerath*, Institut für Informatik, Universität zu Köln, Hochschuldozentur Diskrete Algorithmen, Pohligstr.1, 50969, Köln, Germany, randerath@informatik.uni-koeln.de

We study the crossing minimization problem on level graphs from a propositional logic perspective. This graph drawing problem turns out to be strongly related to MAXSAT. Although crossing minimization problem on level graphs can be transformed to PARTIAL-MAXSAT, we exploit an example demonstrating that our problem cannot be encoded as MAXSAT subproblem. Apart from this we modify the local search underlying neighbourhood relation accordingly such that we can apply well-known MAXSAT local search heuristics for our problem. (Joint work with E. Speckenmeyer, M. Gärtner, M. Lemaic and S. Porschen.)

#### 3 - Deterministic local search for the k-sat problem: an algorithm and some improvements

*Dominik Scheder*, Institut fuer Theoretische Informatik, CAB G 39. 1, Universitaetstrasse 6, 8092, Zurich, dominik.scheder@inf.ethz.ch

Currently the fastest deterministic algorithms for 3-SAT use the idea of local search. This involves a combination of covering codes and a simple recursive procedure. We improve the latter to obtain the currently best worst-case running time.

## ■ TD-22

Tuesday 12:55-14:15

Arndt

### Operations of Closed Loop Supply Chains (II)

Stream: OR and Environmental Management

Invited session

Chair: *Erwin van der Laan*, RSM Erasmus University, P.O.Box 1738, 3000DR, Rotterdam, Netherlands, elaan@rsm.nl

#### 1 - Integrated production and recycling planning under uncertainty

*Jenny Steinborn*, Institute of Automotive Management and Industrial Production, Technische Universität Braunschweig, Katharinenstraße 3, 38106, Braunschweig, Germany, j.steinborn@tu-bs.de, *Grit Walther*, *Thomas Spengler*

For OEMs, product and component recycling strategies are advantageous. Therefore the integration of recycling processes into production planning is regarded. Within the contribution a master production and recycling model is developed regarding uncertainties of product return and demand. The model is applied on the case of a manufacturer executing the original production process as well as product and component recycling processes simultaneously.

#### 2 - Optimal core acquisition and remanufacturing policies under core quality uncertainty

*Ruud Teunter*, Management Science, Lancaster University Management School, Bailrigg, LA1 4YX, Lancaster, United Kingdom, r.teunter@lancaster.ac.uk, *Simme Douwe Flapper*

The quality of cores acquired by a remanufacturer is typically highly variable and uncertain. Our model incorporates this uncertainty in determining optimal acquisition and sorting/remanufacturing policies for both deterministic and uncertain demand. In a numerical experiment, we highlight the effect of uncertainty in the quality of cores on the optimal acquisition and remanufacturing decisions, and on the total expected cost.

#### 3 - Push and pull remanufacturing with yield uncertainty

*Erwin van der Laan*, RSM Erasmus University, P.O.Box 1738, 3000DR, Rotterdam, Netherlands, elaan@rsm.nl

This paper studies the consequences of product return quality uncertainty for inventory control of a joint manufacturing/remanufacturing environment. Uncertainty regarding the product return quality is resolved through a stochastic disassembly and inspection process (testing) preceding a deterministic reassembly process. We study various scenarios with respect to the timing of the testing process. All scenarios are studied under adaptations of the so-called PUSH and PULL remanufacturing policies. These adaptations are not trivial as the yield of the testing process is not certain.

## ■ TD-23

Tuesday 12:55-14:15

Planck

### Customer Behavior

Stream: Demand, Pricing and Revenue Management

Invited session

Chair: *Niels Becker*, Department of Economics, Ruhr-University Bochum, Lehrstuhl Prof. Dr. B. Werners, GC 1/58, 44780, Bochum, Germany, niels.becker@rub.de

#### 1 - Robust product line design with pricing

*Niels Becker*, Department of Economics, Ruhr-University Bochum, Lehrstuhl Prof. Dr. B. Werners, GC 1/58, 44780, Bochum, Germany, niels.becker@rub.de, *Brigitte Werners*

Product line design models use customers' willingness to pay (wtp) to optimize product lines. But often customers' wtp is uncertain even when determined with Conjoint Analysis. To handle this uncertainty adequately, we introduce a robustness parameter into a deterministic model. By modifying this parameter optimal solutions are determined which are efficient concerning the criteria expected profit and variance. Our results demonstrate that robust product line design outperforms even additional information gathering.

## 2 - Decision theory and fuzzy approaches for customer valuation in revenue management

*Andreas Hilbert*, Fakultät Wirtschaftswissenschaften, Technische Universität Dresden, 01062, Dresden, Germany, [andreas.hilbert@tu-dresden.de](mailto:andreas.hilbert@tu-dresden.de), *Tobias von Martens*

The incorporation of customer value into revenue management is naturally associated with uncertainties that may result in inappropriate control decisions. Consequently, in order to facilitate efficient capacity control decisions despite uncertainties, this paper examines the managerial activities of revenue management regarding uncertainties and applies an extended, fuzzy-based decision model to the capacity control problem. The methodology developed in this article supports customer-value-based revenue management decisions and contributes to the competitive capabilities of service providers.

## 3 - Estimating unconstrained demand rate functions using customer-choice sets

*Alwin Haensel*, Department of Mathematics, VU University Amsterdam, De Boelelaan 1081A, 1081 HV, Amsterdam, [ahaensel@few.vu.nl](mailto:ahaensel@few.vu.nl)

A good demand forecast is at the heart of every Revenue Management model. Yet most demand models focus on product demand and do not incorporate customer choice behavior under offered alternatives. We are using the ideas of customer choice sets to model the choice behavior and develop a demand rate estimation procedure based on the maximum likelihood and the expected maximization method for incomplete data, i.e. in the case that choice sets are overlapping or no-purchase outcomes are not observable due to the unavailability of price classes for bookings.

## 4 - Single-leg airline revenue management with over-booking

*Nursen Aydin*, Industrial Engineering, Sabanci University, Orhanli, Tuzla, 34956, Istanbul, Turkey, [nursenaydin@su.sabanciuniv.edu](mailto:nursenaydin@su.sabanciuniv.edu), *S. Ilker Birbil*, *J.b.g. Frenk*, *Nilay Noyan*

Airline Revenue Management (ARM) problem focuses on finding a seat allocation policy, which results in the maximum profit. Over-booking has been receiving significant attention in ARM. In this study, we propose new models for static and dynamic single-leg problems that consider overbooking and no-shows. In the static case we introduce models that give upper and lower bounds for the optimal expected profit. In dynamic case we propose a dynamic programming model based on two streams for booking and cancellation processes. We also present numerical results to show the effectiveness of our models.

## ■ TD-24

Tuesday 12:55-14:15

GSI - S 20

## Extremal Problems and Applications I

Stream: Nonlinear Programming

*Invited session*

Chair: *Adilson Elias Xavier*, Graduate School of Systems Engineering and Computer Sciences, Federal University of Rio de Janeiro, P.O. Box 68511, Ilha do Fundão - Centro Tecnologia - H319, 21941-972, Rio de Janeiro, RJ, Brazil, [adilson@cos.ufrj.br](mailto:adilson@cos.ufrj.br)

### 1 - Application of nonlinear optimization technique to energy saving problems

*Mikhail Mikhalevich*, Systems Analysis, Ukrainian University of Finance and International Trade, Gonchar str.,65-A,apt.20, 01054, Kiev-54, Ukraine, [mmihalevich@ukr.net](mailto:mmihalevich@ukr.net), *Ludmilla Koshlai*

We consider two types of optimization models for decision support concerning technological changes for energy saving. Models of the first type determine the main directions of technological changes. They have continuous variables; the subgradient methods have been applied for calculations. Models of the second type are combinatorial; they support the choice of projects for technological changes. The multi-extremum nature of problems can be allowed for by running the calculations from different starting points. This approach is realized at the multiprocessor computer.

### 2 - A new predictor-corrector method for optimal power flow

*Roy Wilhelm Probst*, DMA - IMECC, UNICAMP, Caixa Postal 6065, 13083-859, Campinas, SP, Brazil, [roy@ime.unicamp.br](mailto:roy@ime.unicamp.br), *Aurelio Oliveira*

A predictor-corrector interior point method is developed to the AC active and reactive optimal power flow problem. Voltage rectangular coordinates is adopted instead of polar ones, once it allows nonlinear corrections for the primal and dual feasibility conditions and not only for the complementary ones as in the traditional nonlinear programming method. Computational experiments for IEEE systems problems and a real Brazilian system are presented showing the advantages of the proposed approach.

### 3 - The extended hyperbolic smoothing clustering method: computational results

*Adilson Elias Xavier*, Systems Engineering and Computer Sciences Depart., Federal University of Rio de Janeiro, CT Bloco H Sala H319, Ilha do Fundao, 21941-972, Rio de Janeiro, RJ, [adilson.xavier@gmail.com](mailto:adilson.xavier@gmail.com), *Vinicius Layter Xavier*

The minimum sum-of-squares clustering problem is considered. It has a non-differentiable characteristic. To overcome these difficulties, the proposed resolution method, called Hyperbolic Smoothing, adopts a smoothing strategy using a special completely differentiable function. This paper presents an extended method based upon the partition of the set of observations in two non overlapping parts. This last approach engenders a drastic simplification of the computational tasks. A broad set of computational experiments shows the good performance of the new method.

## ■ TD-25

Tuesday 12:55-14:15

GSI - S 25

### The Shapley value

Stream: Cooperative Game Theory

*Invited session*

Chair: *Yukihiko Funaki*, School of Political Science and Economics, Waseda University, Nishi-Waseda 1-6-1, Shinjuku-ku, 1698050, Tokyo, Japan, funaki@waseda.jp

#### 1 - Population normalized balanced contributions property and the per-capita Shapley value

*Takumi Kongo*, Graduate School of Economics, Waseda University, Nishi-waseda 1-6-1, Shinjuku-ku, Tokyo, 1698050, Tokyo, kongo\_takumi@toki.waseda.jp

Three axiomatic characterizations of the per-capita Shapley value (Driessen and Radzik 2002; Int. Trans. in Op. Res. 9) are presented. (i) A characterization via a modification of the balanced contributions property of Myerson (1980; Int. Journal of Game Theory). (ii) A characterization via a modification of the null player property in Shapley's original characterization of the Shapley value. (iii) A characterization via a modification of the consistency property of Hart and Mas-Colell (1989; Econometrica).

#### 2 - Axiomatization and implementation of discounted Shapley values

*Rene van den Brink*, Free University of Amsterdam, 1081HV, Amsterdam, Netherlands, jrbrink@feweb.vu.nl, *Yukihiko Funaki*

We generalize the null player property (satisfied by the Shapley value) and nullifying player property (satisfied by the equal division solution) to the delta-reducing player property, stating that a delta-reducing player (being a player  $i$  such that any coalition containing  $i$  earns a fraction  $\delta$  in  $[0, 1]$  of the worth of that coalition without player  $i$ ) earns a zero payoff. We axiomatize the delta-discounted Shapley value using the corresponding delta-reducing player property, and provide a strategic implementation where  $\delta$  is a discount factor applied if the proposal is rejected.

#### 3 - A coalition formation value for games in partition function form

*Yukihiko Funaki*, School of Political Science and Economics, Waseda University, Nishi-Waseda 1-6-1, Shinjuku-ku, 1698050, Tokyo, Japan, funaki@waseda.jp, *Michel Grabisch*

If forming the grand coalition generates the largest total surplus, a central question is how to allocate its worth to each player, taking into account the whole process of coalition formation. We propose three concepts of scenario-value, process-value and a coalition formation value, which represent the average contribution of players in a scenario, a particular sequence of coalitions within a given coalition formation process, in a process, a sequence of partitions of the society, and all processes, respectively. We give an economic application and an axiomatization.

## ■ TD-26

Tuesday 12:55-14:15

GSI - S 35

### Network Flow Problems

Stream: Discrete Optimization

*Contributed session*

Chair: *Ankit Khandelwal*, Consumer Banking Risk Analytics, Standard Chartered Bank, 51 Bras Basah Road #08-04, Plaza by the Park, 189554, Singapore, Singapore, ankit.khandelwal@gmail.com

#### 1 - Fast estimation of expected maximum flows through reliable networks

*Megha Sharma*, Production & Quantitative Methods, Indian Institute of Management Ahmedabad, D-230 IIM Ahmedabad, Vastrapur, 380015, Ahmedabad, Gujarat, India, meghas@iimahd.ernet.in, *Diptesh Ghosh*

We present a fast evaluation strategy for estimating expected maximum flows through reliable networks. Our strategy saves on computational effort by using the residual network obtained from a network state to evaluate other states. Computational experiments on randomly generated networks with up to 125 nodes and 3500 arcs show that our strategy can reduce computation times by up to 50% on average with a standard deviation of 2%. In terms of the number of Ford Fulkerson iterations the reduction is up to 56% on average with a standard deviation of 3%.

#### 2 - Flow constrained minimum cost flow problem

*Sonia Arora Singh*, Decision Sciences Group, Indian Institute of Management, Prabhndh Nagar, Off Sitapur Road, 226013, Lucknow, India, sonia.arora.singh@gmail.com

The paper studies variants of the Minimum Cost Flow Problem (MCFP) subject to additional flow constraints which is the generalization of transportation problems with restrictions on total flow value. Based on the relationship between the desired flow value and the sum of capacities of source(s) and sink(s) different set of problems are mathematically formulated, irrespective of whether or not the sum of node capacities is zero. In each case an equivalent standard MCFP is formulated whose optimal solution provides the optimal solution to the original flow constrained problem.

#### 3 - Labeling algorithms for the earliest and latest time-varying maximum flow problems

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We consider time-varying network  $G(N, A, b, l)$ . Both  $b(i, j, t)$  and  $l(i, j, t)$  are functions of the departure time  $t$  at the beginning node of arc  $(i, j)$ , where  $t=0, 1, \dots, T$ , and  $T>0$  is a given number. The earliest (or the latest) maximum flow is the maximum flow could be sent from the source node to the sink node in  $G(N, A, b, l)$  within  $T$  with the earliest (or the latest) arrival time. We assume that waiting at any node is prohibited except the source node. The problem is NP-complete. Labeling algorithms are proposed for solving problems in  $O(mnT^3)$  time, where  $m=|A|$  and  $n=|N|$ .

#### 4 - Flow enhancement with cost saving in a min cost network flow problem

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Plaza by the Park, 189554, Singapore, Singapore,  
ankit.khandelwal@gmail.com, *Sonia Arora Singh*

This paper discusses flow enhancement to the maximum possible extent in a minimum cost network flow problem (MCFP) along with a saving in shipment cost. An equivalent standard MCFP is formulated whose optimal solution provides the solution to the flow enhancement problem.

## ■ TD-27

Tuesday 12:55-14:15

GSI - S 21

### Assembly Line Balancing

Stream: Discrete Optimization

Contributed session

Chair: *F. Tevhide Altekin*, Faculty of Management, Sabanci University, Orhanli, Tuzla, 34956, Istanbul, Turkey, altekin@sabanciuniv.edu

#### 1 - Balancing u type assembly lines with heterogeneous workers

*Servet Hasgul*, Industrial Engineering, Eskisehir Osmangazi University, Meselik Campus, 26480, Eskisehir, Turkey, shasgul@ogu.edu.tr, *Banu Guner*

Line balancing studies assume that workers perform their tasks in standard times. However, workers are not able to perform the tasks within standard times due to their different attributes such as experience, skill, age or gender. Therefore, the task time depends on the type of worker performing the task. In this study, the influence of worker's attributes on U type assembly line balancing problem is examined. We present a decision model for U type assembly line balancing problem with heterogeneous resource. The developed model is tested by using of data obtained from real life application.

#### 2 - Constraint programming for solving the complex-constrained assembly line balancing problem

*Seyda Topaloglu*, Industrial Engineering, Dokuz Eylul University, 35160, Izmir, Turkey, seyda.topaloglu@deu.edu.tr, *Latif Salum, Aliye Ayca Supciller*

The assembly line balancing problem basically consists of assigning a set of tasks to a group of workstations while maintaining the tasks' precedence relations using traditional precedence graphs. However, these graphs cannot address alternative ways of assembling a product. In this paper, a constraint programming model (CP) is developed for the complex-constrained assembly line balancing problem that addresses the alternative assembly structures using the well known If-then rules. Additionally, a computational study is carried out to analyze the efficiency of the CP model.

#### 3 - Simultaneous balancing and scheduling of mixed-model assembly lines with task sequencing and general precedence diagram

*Cemalettin Öztürk*, Industrial Systems Engineering Department, Izmir University of Economics, Izmir University of Economics, Industrial Systems Engineering Dept., Balcova, Izmir, Turkey, 35330, Izmir, Turkey, cemalettin.ozturk@ieu.edu.tr, *Semra Tunali, Arslan Ornek*

Mixed model assembly line literature involves two problems: balancing and model sequencing. The general tendency in current studies is to deal with these problems in different time frames. However, in today's competitive market the mixed model assembly line balancing problem has been turned into an operational problem. In this study, we suggest a mathematical model which considers both of these problems within the same formulation along with task sequencing. Moreover, we present the results of experimenting this model on various size problems and discuss some future research directions.

#### 4 - Profit oriented disassembly line balancing with stochastic task times

*F. Tevhide Altekin*, Faculty of Management, Sabanci University, Orhanli, Tuzla, 34956, Istanbul, Turkey, altekin@sabanciuniv.edu

The profit oriented disassembly line balancing problem seeks a feasible assignment of selected disassembly tasks to stations such that the precedence relations among the tasks are satisfied and the profit is maximized. In this study, we extend the profit oriented disassembly line balancing problem for designing paced disassembly lines involving tasks that exhibit significant time variations. The effects of incomplete tasks are explicitly considered and the expected in-completion costs are defined. Computational analysis is conducted and results are compared to the deterministic method.

## ■ TD-28

Tuesday 12:55-14:15

GSI - S 1

### Consumer Behavior and Sales Forecasting

Stream: Demand and Supply in Consumer Goods and Retailing

Invited session

Chair: *Winfried Steiner*, Marketing, Clausthal University of Technology, Institute of Management and Economics, Julius-Albert-Str. 2, 38678 Clausthal-Zellerfeld, 38678, Clausthal-Zellerfeld, Germany, winfried.steiner@tu-clausthal.de

#### 1 - Robust forecasting of aggregated sales from weekly scanner data

*Kathrin Kagerer*, Universität Regensburg, 93053, Regensburg, Germany, Kathrin.Kagerer@wiwi.uni-regensburg.de, *Harry Haupt*

Forecasts of mean sales may have a low accuracy and provide misleading guidance about the underlying market mechanisms, as the latter may vary for high, low, and medium sales, respectively. As sales distributions are considerably skewed and have fat tails, forecasting intervals cannot be usefully based on a point forecast of the conditional expectation of sales. We propose a method for direct estimation of the bounds of prediction intervals, which captures heterogeneity in sales while being robust to deviations from normality.

#### 2 - Random scaling of nonlinear functions: an application to supermarket scanner data

*Peter Wechselberger*, Department of Statistics, University of Innsbruck, 6020, Innsbruck, Austria, Peter.Wechselberger@uibk.ac.at, *Stefan Lang, Winfried Steiner*

Our work is motivated by the situation of a retailer planning a price reduction. For this purpose estimating a price-response-function is important, relating sales to the prices of own and competitive brands. Unobserved heterogeneity is taken into account by allowing the response function to vary between different stores. In addition, price effects are estimated flexibly to account for nonlinearities in sales response. Bayesian inference based on Markov Chain Monte Carlo (MCMC) techniques to estimate price response is presented.

### 3 - Modeling time-dependent effects in consumer choice behavior

*Winfried Steiner*, Marketing, Clausthal University of Technology, Institute of Management and Economics, Julius-Albert-Str. 2, 38678 Clausthal-Zellerfeld, 38678, Clausthal-Zellerfeld, Germany, winfried.steiner@tu-clausthal.de, *Thomas Kneib*, *Bernhard Baumgartner*

We employ flexible multinomial logit models to analyze dynamics in brand choice behavior. Both time-varying preferences and time-varying effects of covariates are modeled based on penalised splines, a flexible yet parsimonious nonparametric smoothing technique. The estimation procedure is fully data-driven, determining the flexible function estimates as well as the corresponding degree of smoothness in a unified approach. Preliminary results suggest that the model considering time-variable parameters outperforms models assuming constant parameters in terms of fit and predictive validity.

## ■ TD-29

Tuesday 12:55-14:15

GSI - S 2

### Commodity Risk Management 1

Stream: Financial Modelling

*Invited session*

Chair: *Rita D'Ecclesia*, Teoria Economica e Metodi Quantitativi per le Scelte politiche, Università di Roma, Piazza Aldo Moro 5, 00185, Roma, Italy, rita.decclesia@uniroma1.it

#### 1 - Energy commodities market correlations and coin- tegration

*Cristina Bencivenga*, Teoria Economica e Metodi Quantitativi, Università di Roma "La Sapienza", Piazza Aldo Moro 5, 00155, Rome, Italy, Italy, c.bencivenga@dte.uniroma1.it, *Rita D'Ecclesia*, *Giulia Sargenti*

This study investigates the relationship between crude oil, natural gas and electricity prices. Recent empirical researches have analyzed the relationship between crude oil and natural gas (Hartley et al. (2007)) and between oil and electricity (Golberg (2001) and Bosco et al. (2006)). A possible integration between oil, gas and electricity prices may exist. Using daily price data we analyze the short and long run relationship between these markets.

#### 2 - Dynamics of CO2 prices and implications for opti- mal producer policies

*Silvana Stefani*, Metodi Quantitativi per le Scienze Economiche e Aziendali, Università Milano Bicocca, Piazza Ateneo Nuovo 1 U7-4023, I-20126, Milano, Italy, silvana.stefani@unimib.it, *Paolo Falbo*, *Daniele Felletti*

In the EU Emissions Trading Scheme CO2 emissions trade allowances were introduced as a new tradeable asset, with the aim of reducing CO2 emissions. Market participants have to manage the risk of fluctuating EUA prices and require appropriate tools to hedge and diversify. The issue is relevant for energy producer companies, who need, for a given output, a specified number of emission certificates that are consumed in the production process. In this paper we introduce the cost of CO2 emission certificates in the optimal policy of an energy conventional/renewable (non monopolist) producer.

### 3 - A new index for electricity spot markets

*Silvana Stefani*, Metodi Quantitativi per le Scienze Economiche e Aziendali, Università Milano Bicocca, Piazza Ateneo Nuovo 1 U7-4023, I-20126, Milano, Italy, silvana.stefani@unimib.it, *Paolo Falbo*

Different daily indexes are now published to describe electricity spot markets. However, the choice of the mathematical formulation is not neutral, since can have significant effects on derivative pricing and hedging performance. We propose a new index (FAST Index) that overcomes theoretically and practically all the mentioned drawbacks. We simulate the hedging strategy on an asian option written on a reference Index. The results, applied to OMEL and EEX markets, are clear cut enough to suggest that the decision to adopt an index to represent properly a market must be taken carefully.

## ■ TD-30

Tuesday 12:55-14:15

GSI - S 26

### Energy, Oil and Gas 1

Stream: Engineering Optimization

*Invited session*

Chair: *Steffen Rebennack*, Industrial and Systems Engineering, University of Florida, 303 Weil Hall, P.O. Box 116595, 32611, Gainesville, Florida, United States, steffen@ufl.edu

Chair: *Przemyslaw Kacprzak*, Institute of Control & Computation Engineering, Warsaw University of Technology, Swiatowida 63/16, 03-144, Warsaw, Poland, P.Kacprzak@elka.pw.edu.pl

Chair: *Niko Iliadis*, PSR / EnerCoRD, Plastira street 4, Nea Smyrni, 171 21, Athens, Greece, nikolaos.iliadis@a3.epfl.ch

#### 1 - Oil production optimization - solved by column gen- eration

*Vidar Gunnerud*, Thomas Angellsgate 5, 7011, Trondheim, vidargu@ntnu.no, *Bjørn Nygreen*, *Ken McKinnon*, *Bjarne Foss*

Upstream petroleum production systems are usually quite complex consisting of many wells, pipelines and processing units. The Troll West oil field infrastructure on the Norwegian continental shelf has a structure which makes it possible to decompose its short term production optimization model. The presentation will start by discussing appropriate well models and pressure drop models for multiphase pipe flow. Further, the focus will be set on how the model can be decomposed into sub-problems for collections of wells. Finally, we present near-optimal results by column generation.

#### 2 - Profit maximization in the liquefied natural gas value chain

*Kristin Tolstad Uggen*, Applied economics and operations research, SINTEF Technology and society,

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We will present a rich MIP model for the LNG value chain. The value chain spans from production trains to consumers including spot markets for natural gas. The focus will be on modeling as much of the real-world constraints as possible and to obtain reasonable computation times. We propose a time-decomposition heuristic to solve this problem. The model includes production, transportation by vessels, consumption and different contract types. Results from real-life cases will be presented.

### 3 - Gas storage valuation: comparison of common valuation approaches

*Bastian Felix*, Lehrstuhl für Energiewirtschaft,  
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Within this paper three approaches for natural gas storage valuation are compared: Recombining Trees (RT), Least Squares Monte Carlo Simulation (LSMC) and the solution via an explicit finite difference scheme. As underlying price process a mean reversion jump diffusion process is assumed. For the valuation via RT and LSMC at first a sufficient number of price paths are simulated. Based on these price paths the recombining tree is constructed. The models are analyzed considering computation time, storage capacity discretization sensitivity as well as withdrawal and injection rate sensitivity.

## ■ TD-31

Tuesday 12:55-14:15

GSI - S 34

### Training Algorithm for Support Vector Machines

Stream: Optimization and Data Mining

*Invited session*

Chair: *Shankar Vembu*, Knowledge Discovery, Fraunhofer IAIS, Schloss Birlinghoven, 53754, Sankt Augustin, [shankar.vembu@iais.fraunhofer.de](mailto:shankar.vembu@iais.fraunhofer.de)

#### 1 - Second-order smo for svm online and active learning

*Christian Igel*, Institut für Neuroinformatik,  
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The LASVM by Bordes et al. iteratively approximates the SVM solution using sequential minimal optimization (SMO). It allows for online and active learning. In each SMO step LASVM uses the most violating pair heuristic for choosing a pairs of variables for optimization. We propose to replace this strategy by a second order method, which greedily maximizes the progress in the dual in each single step. Our algorithm learns faster and finds sparser hypotheses, because even a few unfavorable decisions by the first-order heuristic may impair the course of optimization.

#### 2 - Feature selection combining linear support vector machines and concave optimization

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In this work we consider feature selection for two-class linear models, a challenging task arising in several real-world applications. Feature selection involves two competing objectives: the prediction capability (to be maximized) of the linear classifier, the number of features (to be minimized) employed by the classifier. In order to take into account both the objectives, we propose a feature selection strategy that combines SVMs with a concave optimization approach. We report results of an extensive computational experience showing the efficiency of the proposed methodology.

### 3 - Dc programming and spherical separation

*Antonio Fuduli*, Department of Mathematics,  
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*Annabella Astorino, Manlio Gaudioso*

We present two different approaches for spherical separation of two sets. Both the methods are based on minimizing two respective non-convex nondifferentiable error functions, which are expressible as Difference of two Convex (DC) functions. A DC-Algorithm (DCA) has been adopted and numerical results on classical binary datasets have been obtained. We compare our results with those obtained by running the fixed-center spherical classification method.

### 4 - Probabilistic structured predictors

*Shankar Vembu*, Knowledge Discovery, Fraunhofer IAIS, Schloss Birlinghoven, 53754, Sankt Augustin, [shankar.vembu@iais.fraunhofer.de](mailto:shankar.vembu@iais.fraunhofer.de), *Thomas Gaertner, Mario Boley*

We consider MAP estimators for structured output prediction with exponential family models. In particular we focus on the case that efficient algorithms for uniform sampling from the output space exist. We show that under this assumption (i) exact computation of the partition function remains a hard problem and (ii) the partition function and the gradient of the log partition function can be approximated efficiently. Our main result is an approximation scheme for the partition function based on Markov chain Monte Carlo theory. We also describe application settings in machine learning.

## ■ TD-32

Tuesday 12:55-14:15

GSI - S 4

### DMKD methods and techniques

Stream: Data Mining and Knowledge Discovery

*Invited session*

Chair: *Nikos Pelekis*, Department of Informatics,  
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#### 1 - Inductive generation of foreign exchange forecast models

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An algorithm of the search for a parametric regression model in a model set is described. The model set is a set of superpositions of smooth functions. The model parameters density estimations are used for the search. To illustrate the approach, the problem of a short-term foreign exchange price forecast is considered. The task is to generate models, which make next-minute price forecast. Exchange prices for different currency pairs and some of the indexes were used as data sets. The generated models show impacts on the market. The project is supported by RFBR, 07-07-00181.

## 2 - Interesting patterns using goal programming

*Yasir Imtiaz Khan*, computer science, university of central punjab lahore, 31 main gulberg lahore, 54000, lahore, Pakistan, khialian@hotmail.com, *Asim Raza*, *Syed Hasnain Haider Gilani*

Data mining leads to the discovery of large number of patterns, all of these patterns can not be of interest to user. Therefore mining of interesting patterns from the set of mined patterns is an issue. In this paper we proposed that using goal programming we can find interesting patterns according to the user' requirement at particular time. In order to control the priority of interesting patterns we can attach the deviational variables.

## ■ TD-33

Tuesday 12:55-14:15

GSI - S 7

### Integer Programming

Stream: Linear Optimization

*Contributed session*

Chair: *Hilary Paul Williams*, Operational Research, London School of Economics, Houghton Street, WC2A2AE, LONDON, UK, h.p.williams@lse.ac.uk

#### 1 - The chvatal dual of a pure integer programme

*Hilary Paul Williams*, Operational Research, London School of Economics, Houghton Street, WC2A2AE, LONDON, UK, h.p.williams@lse.ac.uk

We give a graphical way of representing Chvatal functions. Also we give some limited ways in which they can be simplified by removing unnecessary rounding operations. A method of calculating Chvatal functions over a cone will be given. Finally it will be shown that when the rounding operations are removed from a Chvatal function it corresponds to either an extreme or an interior point of the dual LP polytope.

#### 2 - Solving lagrangian relaxations on networks by approximate subgradient methods

*Eugenio Mijangos*, Applied Mathematics, Statistics and Operations Research, University of the Basque Country, P.O. Box 644 – Dept. Matematica Aplicada y E.I.O. (UPV/EHU), 48080, Bilbao, Spain, eugenio.mijangos@ehu.es

The efficiency of the network flow techniques can be exploited in the solution of nonlinearly constrained network flow problems by means of approximate subgradient methods (ASM). The idea is to solve the dual problem by using ASM, where the dual function is estimated by minimizing approximately a Lagrangian function that relaxes the side constraints and is subject only to the network constraints. Some convergence results for ASM are showed. To evaluate the efficiency of these methods their performance has been computationally compared with other well-known codes.

#### 3 - A new pivoting procedure for strengthening gomory mixed-integer cuts

*Franz Wesselmann*, Decision Support & OR Lab, University of Paderborn, Warburger Str. 100, 33098, Paderborn, Germany, wesselmann@dsor.de, *Achim Koberstein*, *Uwe Suhl*

Gomory Mixed-Integer (GMI) cuts play a central role in solving hard mixed-integer programming problems. Different approaches to strengthen these cuts have been proposed. We present a heuristic algorithm which tries to improve the performance of GMI cuts by performing a sequence of pivots on the simplex tableau. Our approach is related to reduce-and-split cuts. We give a detailed description of the algorithm and its implementation. Finally, we report on computational results with our approach and analyze its performance.

## ■ TD-34

Tuesday 12:55-14:15

GSI - S 8

### Business Intelligence for Risk Management in Consumer Credit

Stream: Applications in Business Intelligence and Knowledge Discovery

*Invited session*

Chair: *Lyn Thomas*, University of Southampton, United Kingdom, l.thomas@soton.ac.uk

#### 1 - Collection comparison — differences between in-house collection and agency.

*Anna Matuszyk*, Economic Insurance Cathedral, Warsaw School of Economics, Al. Niepodległości 164, 02-554, Warsaw, Poland, amatuszyk@matuszyk.com, *Lyn Thomas*

In this analysis data on the collection results from both an in house collections group and an agency were examined. This allowed a comparison of the the collections processes and the type of information available. The corresponding LGD distributions in each case could be considered as mixture of distributions but the relative importance of the distributions is different in the two cases. Regression and logistic regression was used to predict the LGD values for the different distribution types in terms of characteristics of the loan, the debt and the borrowers performance before default.

#### 2 - Practical experiences from credit scoring projects for Chilean financial organizations for micro-entrepreneurs

*Sebastian Maldonado*, Department of Industrial Engineering, University of Chile, Santiago, Chile, semaldon@ing.uchile.cl, *Cristian Bravo*, *Richard Weber*

All financial organizations that offer loans to their customers have the problem to determine if the loaned money will be returned. Credit scoring systems have been successfully applied to determine the probability that a certain customer will fail in paying back the received credit.

We have developed credit scoring systems for several Chilean financial organizations for micro-entrepreneurs mapping the KDD process to their special needs. This paper presents our experiences from these projects and explains in detail how we solved the problems in each step of the KDD process.

#### 3 - Model follow-up in credit scoring projects

*Cristian Bravo*, Department of Industrial Engineering, University of Chile, Republica 701, Santiago, 8370439, Santiago, Chile, cribravo@ing.uchile.cl, *Sebastian Maldonado*, *Richard Weber*

Most KDD projects in real — life applications offer only static solutions that over the time lose their capacity to explain the phenomena for which they were constructed. We present a framework for model updating and model follow-up which allows the user to keep a strict control of the model's evolution, its variables, and the relevant changes in the population that can occur since the model was built. In particular we propose to apply statistical techniques in order to determine changes in feature weights and structural changes in the respective universe.

#### 4 - Modelling credit risk in portfolios of consumer loans: how to uncrunch credit

Lyn Thomas, University of Southampton, United Kingdom, l.thomas@soton.ac.uk, Madhur Malik

The failure of the credit rating agencies' models to correctly price consumer based securitized product like RBMS shows the need to improve the modelling of the credit risk of portfolios of consumer loans. This paper describes three ways one can develop dynamic models which can do this using behavioural scores. One is a Markov chain approach akin to "mark to market reduced form models"; the second is a hazard based approach and the third a form of structural model. A comparison of the different approaches is made, including how the models cope with changes in the economic situation.

#### ■ TD-35

Tuesday 12:55-14:15

GSI - S 9

#### Equilibrium Prices

Stream: Value and Risk in Incomplete Markets

Invited session

Chair: *Steffen Hitzemann*, University of Karlsruhe (TH), Gaistalweg 7, 76199, Karlsruhe, steffen.hitzemann@fbv.uni-karlsruhe.de

Chair: *Martin Rainer*, ENAMEC, Glockengasse 15, D-97070 Würzburg, 97070, Würzburg, Germany, martin.rainer@enamec.de

##### 1 - Dynamic behavior of CO2 spot prices

*Steffen Hitzemann*, University of Karlsruhe (TH), Gaistalweg 7, 76199, Karlsruhe, steffen.hitzemann@fbv.uni-karlsruhe.de, *Marliese Uhrig-Homburg*

For traders and CO2 emitting companies it becomes increasingly important to have a valid CO2 spot price model in order to value derivatives or assess production costs and support emissions-related investment decisions. Seifert et al. (2008) have developed a stochastic equilibrium model depending on expected cumulative emissions and maturity for a single trading period. We extend this model, according to the current setting of the EU ETS, to a multi-period model accounting for inter-period banking and later delivery of lacking certificates and show implications on the certificate spot prices.

##### 2 - The randomized multicriteria spatial price network problem

*Laura Scrimali*, DMI, Università di Catania, Viale Andrea Doria 6, 95125, Catania, Italy, scrimali@dm.unict.it, *Fabio Raciti*

We consider the multicriteria spatial price network equilibrium model in which consumers are allowed to weight both the transportation cost and the transportation time associated with the shipment of a given commodity. In particular, we assume that weights are not deterministic but subject to random fluctuations. Therefore, we formulate the problem as a random variational inequality, and compute mean values and variances of solutions for suitable probability distributions.

#### 3 - Equilibria in markets with non convexities

*Gabriella Muratore*, OPAC, Technische Universiteit Eindhoven, Den Dolech 2, P.O. Box 513 Pav E11, 5600 MB, Eindhoven, Netherlands, gabriellamuratore@yahoo.com

In this paper we address the issue of finding efficient partial equilibria in markets with non-convexities. This is a problem that has intrigued generation of economists. Beside its theoretical importance this issue is fundamental in energy markets which do not give the right price signals and incentives to maintain existing and invest in new generating capacity. The theoretical results can be used to find an ex-post optimal policy in energy markets, able to restore incentives..

#### ■ TD-36

Tuesday 12:55-14:15

GSI - S 11

#### Stochastic Modelling 2

Stream: Stochastic Modelling

Contributed session

Chair: *Cherkez Aghayeva*, Statistics, Yasar University, Selcuk Yasar Kampus Universite Caddesi, N 35-37, Bornova, 232, Izmir, Turkey, cher.agayeva@rambler.ru

##### 1 - Risk-sensitive average cost optimality in Markov decision chains

*Karel Sladky*, Department of Econometrics, Institute of Information Theory and Automation, Academy of Sciences of the Czech Republic, Pod Vodarenskou vezi 4, 18208, Prague 8, Czech Republic, sladky@utia.cas.cz

Employing properties of a collection of nonnegative matrices constructed from Markov reward (cost) chains fulfilling "product property" common in Markov programming, we shall characterize policies yielding minimal risk-sensitive costs in discrete-time Markov decision chains, i.e. if the stream of one-stage costs is evaluated by an exponential utility function. Conditions guaranteeing independence of optimal values on starting state will be given. Policy and value iteration algorithms for finding optimal policies, along with bounds on current and optimal values, will be discussed.

##### 2 - Simulation of rare and extreme events using nonlinear stochastic differential equations

*Bronislovas Kaulakys*, Institute of Theoretical Physics and Astronomy of Vilnius University, A. Gostauto 12, LT-01108, Vilnius, Lithuania, kaulakys@itpa.lt

We derive and analyze nonlinear stochastic differential equations simulating processes which exhibit bursts and extreme events, characterized by power-law distributions, including 1/f noise, q-exponential and q-Gaussian distributions [1]. The proposed model may simulate self-organized critical, long-memory and other systems revealing avalanches, bursts or clustering of events. 1. B. Kaulakys and M. Alaburda, J. Stat. Mech. P02051 (2009); B. Kaulakys et al, AIP Conf. Proc. to be published (2009).

##### 3 - Using service life in modeling human mortality

*Otilija Sedlak*, Quantitative methods for economics, Faculty of Economics Subotica, Segedinski put 9-11., 24000, Subotica, Vojvodina, zotisz@tippnet.rs, *Dragan Stojic*

We propose a model for human mortality based on service life bathtub-shaped hazard rate. We let the parameters modeling longevity be fuzzy numbers capturing uncertainty. We also look into pricing rules for life annuities and insurance by letting the interest rate be a fuzzy random variable as well. We use both triangular and trapezoidal fuzzy numbers and compare the level of reserves needed to cover benefits when the number of claims follows both Poisson process as well as Poisson process with a drift.

#### 4 - The necessary condition of optimality for variable structure control systems with delay

*Cherkez Aghayeva*, Statistics, Yasar University, Selcuk Yasar Kampus Universite Caddesi, N 35-37, Bornova, 232, Izmir, Turkey, cher.agayeva@rambler.ru

Many problems in theories of the automatic control, in self-oscillating system and etc. are described by stochastic differential equations with delay. Earlier were considered problems of stochastic optimal control with variable structure and problems of stochastic optimal control with delay. The present work is devoted to the problem of stochastic optimal control for variable structure systems with delay on phase at restriction on right endpoint constrain. Our objective is to obtain a necessary condition for optimality, when diffusion coefficient does not contain the control variable.

#### ■ TD-37

Tuesday 12:55-14:15

GSI - S 12

#### Multi-Criteria Decision Aids - 2

Stream: Decision Analysis

*Contributed session*

Chair: *Mahmut Sonmez*, The Business School, Loughborough University, Ashby Road, LE11 3TU, Loughborough, Leicestershire, United Kingdom, m.sonmez@lboro.ac.uk

#### 1 - Building a binary outranking relation in uncertain, imprecise and multi-experts contexts: the application of evidence theory

*Boujelbene Mohamed Aymen*, GIAD, Faculté des sciences économiques et de gestion de Sfax, Route Ain km 5, Koucha Ben Amer, Chez Boujelbene Ridha (Quincaillerie), 3042, Sfax, Tunisie, Tunisia, ayman\_boujelben@yahoo.fr, *Yves De Smet*, *Frikha Ahmed*, *Habib Chabchoub*

We consider multicriteria decision problems where the actions are evaluated on a set of ordinal criteria. The evaluation of each alternative with respect to each criterion may be uncertain and/or imprecise and is provided by one or several experts. We model this evaluation as a basic belief assignment (BBA). In order to compare the different pairs of alternatives according to each criterion, the concept of first belief dominance is proposed. Additionally, criteria weights are also expressed by means of a BBA. A model inspired by ELECTRE I is developed and illustrated by a pedagogical example.

#### 2 - Purchasing professional services: which decision criteria?

*Mahmut Sonmez*, The Business School, Loughborough University, Ashby Road, LE11 3TU, Loughborough, Leicestershire, United Kingdom, m.sonmez@lboro.ac.uk

This paper reports the findings of a global survey on decision criteria used and the importance attached to these criteria when purchasing professional services for skills training in sales negotiations. This research was based on 24 face-to-face and telephone interviews with global learning and development managers plus 309 usable responses to an online survey. The respondents were asked to evaluate the importance of six 'high level' criteria and 37 sub-criteria when purchasing professional services. Descriptive statistics and exploratory factor analysis were used to analyse the survey data.

#### ■ TD-38

Tuesday 12:55-14:15

GSI - S 13

#### Optimization and Generalized Nash Equilibra

Stream: Variational Inequalities and Bi-Level Problems

*Invited session*

Chair: *Andreas Fischer*, Department of Mathematics, Technische Universität Dresden, Institute of Mathematics, 01062, Dresden, Germany, Andreas.Fischer@tu-dresden.de

#### 1 - Relaxation methods for generalized nash equilibrium problems

*Christian Kanzow*, University of Wuerzburg, Institute of Mathematics, Am Hubland, 97074, Wuerzburg, kanzow@mathematik.uni-wuerzburg.de, *Anna von Heusinger*

The generalized Nash equilibrium problem (GNEP) is an extension of the standard Nash game where also the strategy spaces depend on the rivals' strategies. A popular method for the solution of GNEPs is the relaxation method which is globally convergent under a set of rather strong or complicated assumptions. Here we present a modified relaxation method for the solution of GNEPs. The convergence analysis avoids some of the technical conditions for the original relaxation method. Numerical experiments indicate that the modified relaxation method performs quite well on a number of examples.

#### 2 - Newton's method for the computation of a normalized nash equilibrium through fixed point formulation

*Anna von Heusinger*, Institute of Mathematics, University of Würzburg, Am Hubland, 97074, Würzburg, Germany, heusinger@mathematik.uni-wuerzburg.de, *Christian Kanzow*, *Masao Fukushima*

We consider the generalized Nash equilibrium problem (GNEP), which differs from the standard Nash equilibrium problem in that not only the players' cost functions depend on the rivals' decision variables, but also their strategy spaces. The GNEP occurs, among others, in models for energy markets, emissions trading, and communication networks design. Here we present a fixed point formulation of the so-called normalized Nash equilibria, a subset of the generalized Nash equilibria. We apply Newton's method and prove local superlinear convergence under fairly mild conditions.

#### 3 - A new line search inexact restoration approach for nonlinear programming

*Andreas Fischer*, Department of Mathematics, Technische Universität Dresden, Institute of Mathematics, 01062, Dresden, Germany, Andreas.Fischer@tu-dresden.de, *Ana Friedlander*

A new inexact restoration approach is presented. It simplifies the restoration principle by Martinez and Pilotta. After the restoration step the new iterate is obtained by means of a single line search on an approximate tangent direction. All accumulation points generated by the algorithm are proved to satisfy a necessary optimality condition. In addition, the regularity condition that is usually needed in the restoration step is weakened. To some extent this also enables the application of the new approach to programs with complementarity constraints.

## ■ TD-39

Tuesday 12:55-14:15

GSI - S 14

### Computational methods for financial risk management

Stream: Operational Research and Quantitative Models in Banking

*Invited session*

Chair: *Michael Doumpos*, Dept. of Production Engineering and Management, Technical University of Crete, University Campus, 73100, Chania, Greece, mdoumpos@dpem.tuc.gr

Chair: *Constantin Zopounidis*, Dept. of Production Engineering and Management, Technical University of Crete, University Campus, 73100, Chania, Greece, kostas@dpem.tuc.gr

#### 1 - Using fuzzy multicriteria decision analysis and evolutionary intelligent techniques to construct portfolios that outperform benchmark indexes

*Nikolaos Thomaidis*, Financial Engineering & Management, University of the Aegean, 31 Fostini Str, 82 100, Chios, nthomaid@fme.aegean.gr

We analyse the construction of optimal portfolios in the context of active portfolio management. We consider synthetic objective functions which focus on the probability of outperforming the benchmark while setting a limit on the downside risk. These objectives can be effectively handled by fuzzy goals and constraints. To avoid inherent complexities of the optimisation problems we employ evolutionary intelligent techniques. The financial implications of our portfolio optimisation setting are analysed by benchmarking portfolios relatively to common stock market indexes.

#### 2 - Hybrid approach for foreign exchange rate forecasting

*Chokri Slim*, EMQ, ISCAE, Manouba, TUNISIA, 2010, Manouba, TUNISIA, chokri.slim@iscae.rnu.tn

Empirical studies have shown that Neural Networks outperform linear regression since stock markets are nonlinear, dynamic and chaotic. Neural Network makes very few assumptions as opposed to normality assumptions commonly found in statistical methods. Classical gradient is an extremely local pointer and does not point to global minimum. To overcome these deficiencies, the purpose of this paper is to use the soft computing methods in modelling and forecasting of Exchange rate time series. The platform of evaluation of the novel model involves comparisons with some models used in the literature.

#### 3 - Modelling banking sector stability with multicriteria approaches

*Constantin Zopounidis*, Dept. of Production Engineering and Management, Technical University of Crete, University Campus, 73100, Chania, Greece, kostas@dpem.tuc.gr, *Chrysovalantis Gaganis*, *Fotios Pasiouras*, *Michael Doumpos*

The assessment of the stability of the banking sectors is important for regulators, depositors and investors. In the present study, we use the risk ratings of the Economist Intelligent Unit, and we classify the banking sectors in three stability groups (low, medium, high). Classification models are developed using two MCDA techniques based on a sample of around 100 banking sectors. The set of criteria consists of indicators of the macroeconomic and institutional environment, as well as basic characteristics of the banking sector.

## ■ TD-40

Tuesday 12:55-14:15

GSI - S 27

### Nested Simulation in Decision Making

Stream: Simulation Based Decision Support

*Invited session*

Chair: *Ivan Krivy*, Dept. of Computer Science, University of Ostrava, 30. dubna 22, 70103, Ostrava, Czech Republic, ivan.krivy@osu.cz

#### 1 - Reflective simulation models and their use in decision making

*Ivan Krivy*, Dept. of Computer Science, University of Ostrava, 30. dubna 22, 70103, Ostrava, Czech Republic, ivan.krivy@osu.cz

This paper provides both the theory and applications of reflective simulation, i.e. simulation of systems containing an element that carries an internal simulation model of the system and, therefore, is possible to anticipate the system behavior in the future. The reason of the anticipation is to judge consequences of instantaneous decisions during the system development and make changes in the decisions. The reflective simulation carries some obstacles, but the obstacles can be effectively solved using the SIMULA language. Some applications of reflective simulation are also presented.

#### 2 - Nested models in information systems

*Cyril Klimes*, Informatics and Computers Science, Ostrava University in Ostrava, 30. dubna 22, 70301, Ostrava, Czech Republic, cyril.klimes@osu.cz, *Eugene Kindler*, *Jaroslav Prochazka*

Information systems exist as physical entities that operate in the space-time where the society exists that applies and has use of them. But they reflect another part of the reality, process knowledge on that part and send the results of the processing to the space-time in that they exist. Therefore two levels exist in them, the existence of which can be efficiently applied during their designs, namely during their simulation. The paper will demonstrate that in more details, applying programming methodology that is object-oriented, agent-oriented and block-oriented.

#### 3 - Programming languages as tools for description and simulation of systems

*Eugene Kindler*, Computers and Informatics, University of Ostrava, Simackova 10, 170 00, Prague 7, ekindler@centrum.cz

When designing and testing sophisticated decision rules for operation of a system, an exact description of that system is a desired objective, followed by simulation. For the complex systems, the optimal tools for that purpose are programming languages that are object-oriented, agent-oriented, block-oriented, implemented to produce in automatic way models able to run at computers but as languages independent of any computer hardware. The paper will emphasize certain non-trivial details and shown some applications in industry and transport.

**4 - Discrete models of social structures**

*Petr Bulava*, Dept. of Mathematics, University of Ostrava, 30.dubna street, 22, 70201, Ostrava, Czech Republic, [peta.bulava@email.cz](mailto:peta.bulava@email.cz)

My paper deals with models of social structures which are studied using the discrete simulation methodology. Such models are typically characterized by intelligent elements representing human entities which may constitute some groups and these groups or entities come into interaction. Living rules of entities are rather simple but they often make decisions in these models which depend on many miscellaneous factors. Behavior of such models is non-trivial. We will discuss several models, for example disease spread models which offer more possibilities than classical Kermack-Mckendrick approach.

**■ TD-41**

Tuesday 12:55-14:15

GSI - S 28

**Scheduling Algorithms I**

Stream: Scheduling

Contributed session

Chair: *Uttarayan Bagchi*, Information, Risk, & Operations Management, The University of Texas at Austin, McCombs School of Business, 1 University Station, B6500, 78712-0212, Austin, TX, [bagchiu@gmail.com](mailto:bagchiu@gmail.com)

**1 - Speeding up the optimal off-line algorithm for solving the k-server problem**

*Robert Manger*, Department of Mathematics, University of Zagreb, Bijenicka cesta 30, 10000, Zagreb, Croatia, [manger@math.hr](mailto:manger@math.hr), *Tomislav Rudec*, *Alfonzo Baumgartner*

This paper deals with the k-server problem, where one has to decide how a set of mobile servers should serve a sequence of requests. We are concerned with the optimal off-line algorithm for solving the k-server problem, which serves a given sequence of requests at minimum total cost. The optimal off-line algorithm is usually implemented by network flows. The aim of the paper is to propose certain modifications to each step of the original implementation. The aim is also to demonstrate by experiments that the proposed modifications dramatically improve the speed of the algorithm.

**2 - Scheduling and due-date assignment problems with job rejection**

*Assaf Sarig*, Statistics, The Hebrew University, Mount Scopus, 91905, Jerusalem, Israel, [assafsarig@mssc.huji.ac.il](mailto:assafsarig@mssc.huji.ac.il), *Gur Mosheiov*

Scheduling with rejection reflects a very common scenario, where the scheduler may decide not to process a job. We study the option of rejection in several popular and well-known scheduling and due-date assignment problems. A number of settings are considered: due-date and due-window assignment problems with job-independent costs, a due-date assignment problem with job-dependent weights and unit jobs, minimum total weighted earliness and tardiness cost with job-dependent and symmetric weights (known as TWET). All problems excluding TWET are shown to have a polynomial time solution.

**3 - Two linear programming formulations for scheduling multi-user periodic arrival tasks**

*Emmanuel Medernach*, CNRS, LIMOS, LIMOS - Complexe scientifique des Cézeaux, 63173, Aubiere,

France, [Emmanuel.Medernach@gmail.com](mailto:Emmanuel.Medernach@gmail.com), *Claire Hanen*, *Philippe Lacomme*, *Eric Sanlaville*

Grid scheduling handles periodic arrival of jobs by many users. A set of users share some homogeneous machines and each user has a set of independent generic periodic jobs. We tackle this problem with two linear programming models. The first one models the transitory part of a schedule until it reaches its periodic pattern. The second one models directly the schedule periodic pattern. Fairness is an important issue for grid management to avoid being congested by few users. We suggest many criteria to measure the load induced by user jobs. These criteria should favor the schedule fairness.

**4 - The two- and three-stage assembly flowshop problem**

*Uttarayan Bagchi*, Information, Risk, & Operations Management, The University of Texas at Austin, McCombs School of Business, 1 University Station, B6500, 78712-0212, Austin, TX, [bagchiu@gmail.com](mailto:bagchiu@gmail.com)

We consider the assembly flowshop problem with multiple parallel, non-identical machines in the first, say fabrication stage, one machine in the second, say assembly stage, and one machine in the third, say testing stage. For the two-stage (fabrication and assembly) problem, we extend the extant results concerning permutation schedules and heuristic performance. For the three-stage problem, we present new results similar to those for the two-stage problem. Finally, we consider the non-skipping version of the three-stage problem.

**■ TD-42**

Tuesday 12:55-14:15

GSI - S 3

**Software for OR/MS I**

Stream: Software for OR/MS

Invited session

Chair: *Bjarni Kristjansson*, Maximal Software, Ltd., Boundary House, Boston Road, W7 2QE, London, Iceland, [bjarni@maximalsoftware.com](mailto:bjarni@maximalsoftware.com)

**1 - Why is maximal software now giving away free development copies of mpl?**

*Bjarni Kristjansson*, Maximal Software, Ltd., Boundary House, Boston Road, W7 2QE, London, Iceland, [bjarni@maximalsoftware.com](mailto:bjarni@maximalsoftware.com)

In today's challenging economy, many companies are now looking for ways to save money, including on their IT budget for purchasing optimization software. We at Maximal have now decided to fundamentally change how we sell our software, by greatly reducing how much you pay for development copies of MPL, in many cases bringing the actual cost down to zero. In this presentation we will explain in detail several new pricing programs we are offering, including 'Pay Maintenance Only', 'Subscription-Based Pricing', 'Free Development Copies of MPL', and 'Free Software for Academics'.

**2 - Solving large-scale mixed-integer models with mops**

*Uwe Suhl*, DSOR Lab, Universität Paderborn, Warburger Strasse 100, 33098, Paderborn, Germany, [suhl@wiwiss.fu-berlin.de](mailto:suhl@wiwiss.fu-berlin.de), *Veronika Waue*

The Mathematical OPTimization System MOPS is a high speed optimizer to solve large scale mixed-integer optimization models. The system is used in academic and industrial applications since over 20 years. Recently the system can also be used as one of the solvers of MPL. The talk gives an overview about the system and some of its mathematical and algorithmic concepts. We discuss some numerical results on some very large LP and MIP models and give an outlook of further research and development aspects.

### 3 - Using an algebraic modeling language for access to advanced solver features

Robert Fourer, Industrial Engineering and Management Sciences, Northwestern University, 2145 Sheridan Road, 60208-3119, Evanston, IL, United States, 4er@iems.northwestern.edu, David M. Gay

Algebraic modeling languages can conveniently support such diverse solver features as infeasibility diagnosis, quadratic convexity detection, multiple solutions, parameter tuning, generalized variable domains, and logic operations in constraints. We present test results using the AMPL language to show how different features are applied and why they make a difference. AMPL's variable and constraint suffixes are notable for their role in making a number of these features readily accessible.

## ■ TD-43

Tuesday 12:55-14:15

GSI - S 10

### Health care and medical services for public, nursing, and school communities

Stream: Sustainable living: Cognitive, Social, Economical, Ecological and World View

*Invited session*

Chair: *Annette Hohenberger*, Middle East Technical University (METU), Informatics Institute, Cognitive Science Program, Inonu Bulvari, 06531, Ankara, Turkey, hohenberger@ii.metu.edu.tr

#### 1 - Headache diagnosis using artificial neural networks

Pedro Steiner neto, Business, Federal University at Paraná, R. Pe. Anchieta, 1231, 80730-000, Curitiba, Pr., Brazil, pedrosteiner@ufpr.br, Maria Teresinha Arns Steiner, Karina Borges Mendes

Headache is a very common and high cost disease, since studies show that it affects about 92% of the population. Through data collected on 2,177 patients with headache diagnosis, it is verified if Artificial Neural Networks (ANN) could be used as a recognizing tool of patterns for new patients diagnosis. The System is based on Perceptron ANN multilayers by using Neural Networks Toolbox for its implementation and training. On this paper, it is verified the use of ANN as a diagnosis supporting tool, as a way to help physicians' routines, as well as an educational tool on students training.

#### 2 - Solving multiple scenarios in the combinatorial auction of school meals in Chile

Mario Guajardo, University of Chile, 8370439, Santiago, Chile, maguajar@dii.uchile.cl, Jaime Catalan, Rafael Epstein, Daniel Yung, Cristian Martinez

The Chilean government provides 2 million meals daily to schoolchildren at an annual cost of USD 500 million. The catering is provided by firms chosen through a combinatorial auction. The bid evaluation process must solve multiple scenarios of a combinatorial optimization model. We describe the design of the auction and report that solution times can be significantly improved if the scenarios are solved in an appropriate order and the optimal solution to one scenario is used as the initial solution of another. Results reflecting these improvements are given for real instances of the auction.

#### 3 - Policy assessment in air quality management using an integrated bottom-up modeling approach and en-

### vironmental and public health externalities estimation

Alejandro Builes, Facultad de Minas, Universidad Nacional de Colombia, Crr 80 No 65 - 223, 57, Medellin, Antioquia, Colombia, elbuiles@gmail.com, Claudia Rave, Cristina Franco

An integrated analysis is proposed to urban and environmental policy assessment for Colombian cities by linking air quality management as an important variable in strategic land use planning, public health analysis, and mobility and industrial scenario modeling for decision making support. The analysis includes Markal model and EEE approach, externalities analysis methodology (morbidity, pollutants concentration, environmental noise and land use indicators information) and, scenario and prospective analysis. The results aim to support integrated project formulation for air quality improvement

## ■ TD-44

Tuesday 12:55-14:15

GSI - S 16

### Forecasting and Geospatial Modelling

Stream: Uncertainty and Environmental Decision Making

*Invited session*

Chair: *Belinda Chiera*, School of Mathematics & Statistics, University of South Australia, South Australia, Australia., 5001, Adelaide, SA, Australia, belinda.chiera@unisa.edu.au

Chair: *Daniel Zachary*, The Resource Centre for Environmental Technologies, Centre de Recherche Public Henri Tudor - Luxembourg, Technoport Schlassgoart, 66, rue de Luxembourg ,L-4421 Esch-sur-Alzette, L-4421, Esch-sur-Alzette, dan.zachary@tudor.lu

#### 1 - Problems and errors in up- and down-scaling in environmental modelling for policy decisions

Ulrich Leopold, Resource Centre for Environmental Technologies, Public Research Centre Henri Tudor, 66, rue de Luxembourg, 4010, Esch-sur-Alzette, Esch, Luxembourg, Ulrich.Leopold@Tudor.lu

Environmental models are typically developed to study processes at a certain scale. Many models were developed for research purposes rather than for policy support. Therefore, often several models are combined into meta-models in order to arrive at estimates for the policy scale. The change of scale in such coupled models involves up- and down-scaling of model inputs, model parameters as well as adaptations of model equations. This paper aims to raise awareness of the impacts that up and down-scaling can have on the quality of model results.

#### 2 - Sustainability screw: a mathematical perspective on some problems of environmental modelling

Jerzy Filar, Mathematics and Statistics, University of South Australia, Mawson Lakes Blvd, 5095, Mawson Lakes, SA, Australia, j.filar@unisa.edu.au

In this presentation, the author will discuss some concepts and results from the subjects of control theory and dynamical systems that appear to capture certain salient aspects of the challenges posed by the still poorly understood notion of "sustainable development". In particular, as a consequence of interpretation of the latter, it will be argued that problems of climate change and environmental degradation are really only symptoms of the more fundamental problem of the lack of synchronization between time scales of human development and natural processes of the biosphere.

### 3 - Comparative forecasting and a test for persistence in the el nino southern oscillation

*Belinda Chiera*, School of Mathematics & Statistics, University of South Australia, South Australia, Australia., 5001, Adelaide, SA, Australia, belinda.chiera@unisa.edu.au, *Jerzy Filar, Daniel Zachary, Adrian Gordon*

We present an analysis of two separate single-indicator forecasting methods for the El Nino Southern Oscillation based on oscillation persistence. We use the Southern Oscillation Index (SOI) to produce 5 month forecasts and a Bayesian approach to explore SOI persistence with results compared to a benchmarking Taylor Series expansion. We find signal persistence is important when forecasting more than a few months and the models presented may provide a relatively simple approach to environmental risk forecasting in situations where the underlying phenomenon exhibits substantial persistence.

### 4 - Uncertainty from model calibration — global models and regional data

*Bas van Ruijven*, Netherlands Environmental Assessment Agency (PBL), Antony van Leeuwenhoeklaan 9, 3712 MA, Bilthoven, bas.vanruijven@pbl.nl, *Jeroen P. van der Sluijs, Detlef van Vuuren, Peter Janssen, Peter Heuberger, Bert J.M. de Vries*

Uncertainties in energy demand modelling allow for the development of different models, but also leave room for different calibrations of a single model. We apply an automated procedure to analyse calibration uncertainty in energy use modelling of the TIMER 2.0 global energy model. The model simulates energy use on the basis of energy intensity changes, technology development and price responses. We found that different implementations of these factors yield behavioural model results. Model calibration uncertainty is identified as influential source for variation in future projections.

## ■ TD-45

Tuesday 12:55-14:15

GSI - S 33

### III: Societal Complexity and Healthcare

Stream: Methodology of Societal Complexity

*Invited session*

Chair: *Cor van Dijkum*, Methodology and Statistics, Utrecht University, Heidelberglaan 1, 3508TC, Utrecht, Utrecht, Netherlands, c.j.vandijkum@uu.nl

#### 1 - The complexity of the communication between gp and patient

*Cor van Dijkum*, Methodology and Statistics, Utrecht University, Heidelberglaan 1, 3508TC, Utrecht, Utrecht, Netherlands, c.j.vandijkum@uu.nl

The communication between a GP and a Patient is far more complicated than was thought in the medical profession. The social aspect of the communication, not well included in the medical education, is nowadays accepted as an element that can facilitate the medical diagnosis. Complex non linear models has to serve as a foundation for a model of the Patient-GP interaction. In earlier simulation studies the non chaotic dynamics of a model is reproduced with the aid of simulation software. In this paper the non linear chaotic dynamics of such models is further investigated by using Matlab.

### 2 - Economic impact of new malaria diagnostic devices on the malaria control program in brazil

*Breedge Quinn*, University Twente, Oberdorf, 53804, Much, NRW, Germany, b.p.quinn@student.utwente.nl, *Marjan Hummel*

This study focuses on the economic impact of a new malaria diagnostic device on the Malaria control processes in Brazil. Current diagnostic tools have disadvantages which prevent the total coverage of malaria risk regions. As a consequence, there is a high demand for a portable, fast, accurate device which can be used in remote settings. The objective of this research is to study the cost-effectiveness of new diagnostic devices. Process mapping and Markov modeling are used to gain insight in the expected cost reduction of overtreatment and improvement of health benefits for the patient.

### 3 - The complexity of healthcare handled by clients with the aid of Internet

*Cor van Dijkum*, Methodology and Statistics, Utrecht University, Heidelberglaan 1, 3508TC, Utrecht, Utrecht, Netherlands, c.j.vandijkum@uu.nl

E-health is improved by doing action-research. Decision support systems were developed to help(potential) clients with choosing professional help; to overcome their psychic problems and to participate in the modern society concerning work, housing and free time. By involving (ex)clients as associated researchers DSS knowledge was generated from inside experience. The decision support systems were also made interactive, to involve visitors of the website to add their own (ex) client's knowledge to the website, and made it available for other (potential)(ex)clients.

## Tuesday 14:30-15:50

### ■ TE-01

Tuesday 14:30-15:50

Beethoven

#### Excellence in Practice Award I

Stream: Excellence in Practice Award

*Semi-plenary session*

Chair: *Geir Hasle*, Applied Mathematics, SINTEF ICT, P.O. Box 124 Blindern, NO-0314, Oslo, Norway, Geir.Hasle@sintef.no

#### 1 - Operations research improves quality and

*Mikael Rönnqvist*, Department of Finance and Management Science, Norwegian School of Economics and Business Administration, NO-5045, Bergen, Norway, mikael.ronnqvist@nhh.no

Elderly care systems in the Western world are facing increased costs, primarily because the elderly constitute a growing percentage of the total population. It is a political aim to make it possible for elderly to keep living in their own homes. The result is increased quality of life as well as lower total cost for providing the care as compared to retirement homes. The care is performed through visits to the elderly, and a wide range of services are performed, including, cleaning, washing, medical assistance and social support. The elderly care sector is labour intensive, and therefore good staff planning is necessary.

The planning of home care services involves many components such as scheduling of visits, routing of staff, matching between visit requirements and staff competences, fairness among staff members and quality of services. In addition, the daily operative planning has to deal with many last minute changes and is therefore difficult and time-consuming.

The City of Stockholm employs 47,000 staff members, of which 60% work within social care. The budget for 2008 is EUR 3,9 billion, and social care to elderly citizens and disabled persons is the city's most expanding activity. The City of Stockholm has been using OR based decision support system, Laps Care, in a number of units since 2003. The system is used to create the daily operative plans, in which visits to elderly are allocated to staff members. The planning considers geographic information, calculates travel times for several transportation modes (car, bike and walking).

With the system, the planning time is reduced by 2/3. This means that staff members can spend more time on visits, rather than participating in daily morning meetings. The use of resources is also more efficient, for example there is less need to call in extra staff. This has resulted in increased efficiency of 10 — 15%. The qualitative aspects such as continuity and a fair work load level among staff members and security against missed or re-scheduled visits are considerably improved.

Currently there are 200 units with 4,000 staff members in 50 Swedish municipalities that are using Laps Care, and the annual savings reported are EUR 20 — 30 million. During 2008/2009 the City of Stockholm is rolling out another 1,000 units with 15,000 staff members, and estimates to save EUR 20 — 30 million for the city alone.

#### 2 - Scheduling the Chilean soccer league by integer programming

*Guillermo Duran*, Ingenieria Industrial, University of Chile, Republica 701, 1000, Santiago, Chile, gduran@dii.uchile.cl, *Mario Guajardo*, *Jaime Miranda*, *Denis Saure*, *Sebastián Souyris*, *Andrés Weintraub*, *Rodrigo Wolf*

Since 2005, Chile's professional soccer league has used a game-scheduling system that is based on an integer linear programming model. The Chilean league managers considered several operational, economic, and sporting criteria for the final tournaments' scheduling. Thus, they created a highly constrained problem that had been, in practice, unsolvable using their previous methodology. This led to the adoption of a model that used some techniques that were new in soccer-league sports scheduling. The schedules they generated provided the teams with benefits such as lower costs, higher incomes, and fairer seasons. In addition, the tournaments were more attractive to sports fans. The success of the new scheduling system has completely fulfilled the expectations of the Asociación Nacional de Fútbol Profesional (ANFP), the organization for Chilean professional soccer.

#### 3 - Sequencing and scheduling in coil coating with shuttles

*Marco Lübbecke*, Institut für Mathematik, MA 5-1, TU Berlin, Straße d. 17. Juni 136, 10623, Berlin, Germany, m.luebbecke@math.tu-berlin.de, *Wiebke Höhn*, *Felix G. König*, *Rolf Möhring*

We consider coating of metal coils in integrated steel production. Between coils time-consuming setup work may be necessary. Devising a production plan is sequencing the coils, assigning coils to color tanks, and scheduling scarce work resources for setup work, partly performed concurrently with production. The aim is to minimize the makespan. We present a precise mathematical formulation of the entire problem, give algorithms to solve it, and prove the good quality of solutions via an integer programming model. Our algorithms are being introduced at Salzgitter Flachstahl AG.

### ■ TE-02

Tuesday 14:30-15:50

Schumann

#### Planning Problems with Dynamic Travel Times

Stream: Transportation Planning

*Invited session*

Chair: *Karl Doerner*, Department of Business Studies, University of Vienna, Bruenner Strasse 72, 1210, Vienna, Vienna, Austria, karl.doerner@univie.ac.at

#### 1 - Performance evaluation of dijkstra's fastest path algorithm on realistic large street network with dynamic travel times

*Senthanaal Sirpi Manohar*, Jakob Haringer Strasse 5/3, 5020, Salzburg, Salzburg, Austria, senthanaal.manohar@salzburgresearch.at, *Günter Kiechle*

Computation of distance matrices is the basis for many applications in vehicle routing and tour optimization. Several shortest path algorithms were proposed in the literature to compute these matrices. The performance of shortest path algorithms is sensitive to properties of real-world street networks such as network size, representation of dynamic travel time, turn restrictions and penalties. The aim of this contribution is to evaluate the performance of Dijkstra's algorithm by considering the properties of real-world street networks with dynamic travel times computed from floating car data.

#### 2 - Coverage models with time dependent traveling times

*Verena Schmid*, Faculty of Business, Economics and Statistics, University of Vienna, Bruenner Strasse 72, 1210, Vienna, Austria, verena.schmid@univie.ac.at, *Karl Doerner*

For emergency service providers it is essential to locate and dispatch emergency vehicles while achieving adequate coverage. We extended the formulation of the double standard coverage model and emphasis locating more vehicles in densely populated areas. Furthermore we also take into account variations in travel times and reallocations. The goal of this approach is to ensure coverage all day long and keep reallocations at a decent level. The problem is solved using VNS.

### 3 - A dynamic programming approach to multi-objective time-dependent single capacitated vehicle routing problems with time windows

*Said Dabia*, Den Dolech 2, 5600 MB, Eindhoven, s.dabia@tue.nl, *Tom Van Woensel*, *Ton de Kok*

A single vehicle performs several tours to serve a set of geographically scattered customers. The vehicle has a finite capacity and is only available for a limited amount of time. Because of road congestion, travel times are time-dependent: depending on the departure time at a customer, a different travel time is incurred. Furthermore, all customers need to get delivered in their specific time windows. We aim to minimize the total time travelled including any waiting times, while the total quantity delivered by the vehicle is maximized. Efficient dynamic programming algorithms are developed.

## ■ TE-03

Tuesday 14:30-15:50

*Reger*

### Location

Stream: Network Optimization

*Invited session*

Chair: *Alessandro Tomazic*, Faculty of Business, Economics and Statistics, Universität Wien, Bruenner Str. 72, 1022, Vienna, alessandro.tomazic@univie.ac.at

#### 1 - The center facility location/network design problem with budget constraint

*Elena Fernandez*, Statistics and Operations Research, Technical University of Catalonia, Campus Nord, C5-208, Jordi Girona, 1-3, 08034, Barcelona, Spain, e.fernandez@upc.edu, *Ivan Contreras*, *Gerhard Reinelt*

We present the Center Facility Location/Network Design Problem with Budget Constraint that combines location decisions to find a set of nodes to locate facilities and an allocation of nodes to facilities, with network design decisions to find a set of arcs to use for connecting the nodes and their allocated facilities. The cost of the facilities plus the selected arcs cannot exceed a given budget. The objective is to minimize the maximum travel distance from a node to its allocated facility in the graph induced by the selected arcs. We present a MIP formulation and discuss some properties.

#### 2 - Ordered median hub location problems

*Justo Puerto*, Estadística e I.O., Universidad de Sevilla, Facultad de Matemáticas, 41012, Sevilla, Spain, puerto@us.es, *Antonio Manuel Rodríguez-Chía*, *Ana Bel Ramos-Gallego*

In this talk we present new formulations for the uncapacitated single assignment ordered median hub location problem. We compare them and test their availability for being used in general purpose IP solvers. We derive several families of cuts for the different formulations and present a new branch and cut algorithm for this problem that enlarge the resolution sizes of this class of problems.

### 3 - Preprocessing connected facility location problems

*Alessandro Tomazic*, Faculty of Business, Economics and Statistics, Universität Wien, Bruenner Str. 72, 1022, Vienna, alessandro.tomazic@univie.ac.at, *Ivana Ljubic*

We extend the definition of the Connected Facility Location Problem by allowing pre-opened and pre-fixed facilities. This new concept is advantageous for applying complex sequences of reduction tests. Besides transferring existing techniques designed for the Facility Location, Steiner Tree and Group Steiner Tree Problem, specific new reduction methods are introduced. We also propose an efficient self adaptive preprocessing strategy based on test dependencies and impacts. Computational studies show that the computational effort of our exact approach benefits and heuristical results are improved.

## ■ TE-04

Tuesday 14:30-15:50

*Liszt*

### Production Scheduling

Stream: Scheduling

*Invited session*

Chair: *Chih-Wei Chiu*, Graduate Institute of Management Sciences, Tamkang University, 151 Ying-chuan Road Tamsui, Taipei County Taiwan 25137, Republic of China, 25137, Taipei County, z35899@yahoo.com.tw

#### 1 - Minimizing sequence-dependent setup costs under due date restrictions

*Stefan Bock*, WINFOR (Business Computing and Operations Research) Schumpeter School of Business and Economics, University of Wuppertal, Gaußstraße 20, D-42097 Wuppertal, 42097, Wuppertal, NRW, Germany, sbock@winfor.de, *Kathrin Klamroth*

We address the minimization of sequence-dependent setup costs under due date restrictions. Analogously to the model of Gilmore and Gomory, total setup costs for changing between different jobs are assumed to be proportional to absolute state differences. We show that the integration of due dates still leads to a strongly polynomial problem if the number of setup states is a constant. In order to solve the problem, a best-first Branch&Bound algorithm is introduced. By making use of additional dominance rules, problem instances of larger size can be solved optimally.

#### 2 - Multi-product economic lot scheduling problem with manufacturing and remanufacturing: a new heuristic

*Simone Zanoni*, Dipartimento di Ingegneria Meccanica, Università di Brescia, via Branze 38, 25123, Brescia, Italy, zanoni@ing.unibs.it, *Anders Segerstedt*

We study the multi-item economic lot scheduling problem (ELSP) with two sources of production: manufacturing and remanufacturing. Tang and Teunter (2006) firstly studied this problem (named ELSPR) presenting an algorithm for this problem that determines the optimal solution within the class of policies with a common cycle time and a single (re)manufacturing lot for each item in each cycle. Relaxing these constraints we propose a simple heuristic easy implementable based on Segerstedt (1999): numerical study shows applicability of the heuristic and the savings that can be obtained.

#### 3 - Construct a model for scheduling problem of make-to-order production

*Mei-Hsiu Chen*, Graduate Institute of Management Sciences, Tamkang University, 151 Ying-chuan Road

Tamsui, Taipei County Taiwan 25137, Republic of China, 25137, Taipei County, msjessy47@yahoo.com.tw, *Chun-Hsiung Lan, Hai-Ming Chen, Chih-Wei Chiu*

This study mainly constructs a mathematical model focusing on production scheduling problem of make-to-order production where multiple orders, multiple types of products, manufacturing cost, resource cost, holding cost, and tardiness cost are considered for achieving the maximum profit. The syntax of Lingo 9.0 is applied to concrete and solve the proposed model. This study creates a highly repetitive characteristic because while facing different situations of the proposed problem, an enterprise can easily solve such a problem by changing the input parameters only.

#### 4 - Production scheduling of supply chain system

*Chih-Wei Chiu*, Graduate Institute of Management Sciences, Tamkang University, 151 Ying-chuan Road Tamsui, Taipei County Taiwan 25137, Republic of China, 25137, Taipei County, z35899@yahoo.com.tw, *Chun-Hsiung Lan, Hai-Ming Chen, Mei-Hsiu Chen*

This study aims to construct a supply chain system by using two models. The first model is the main frame of supply chain, and purchase, production, inventory, distribution, product shortage and demands are considered to solve the optimization. In addition, based on the optimal production quantity, the second model is applied to reveal the suggested layout of the production system. The syntax of Lingo9.0 and Visual Basic 6.0 is applied to achieve the optimum solutions of the proposed models respectively. This study provides a referenced tool to an enterprise for a supply chain system.

## TE-05

Tuesday 14:30-15:50

Haydn

### OR approaches to disease analysis and treatment

Stream: Computational Biology, Bioinformatics and Medicine

*Invited session*

Chair: *Erik Kropat*, Department of Mathematics, Friedrich-Alexander University Erlangen-Nuremberg, Martensstraße 3, 91058, Erlangen, Germany, kropat@am2.am.uni-erlangen.de

#### 1 - Application of pharmacokinetic models to post-contrastographic dce technique for the analysis of vascularization induced by crohn's disease

*Luisa Di Paola*, Faculty of Biomedical Engineering, University Campus Biomedico, via Alvaro del Portillo, 21, 00128, Rome, l.dipaola@unicampus.it, *Antonio Fasano, Valentina Russo*

Post-contrastographic Dynamic Contrast Enhancement (DCE) technique is an innovative tool for the analysis of ipervascularization due to inflammatory or neoplastic lesions. To perform DCE, proper mathematical models are needed, able to describe the evolution over time of the enhanced signal in the region of interest and estimate parameters useful for diagnosis and prognosis. We propose a pharmacokinetic model for the analysis of MRI related to the Crohn's disease, considering different regions of the lesion and nearby tissues, in order to derive the spatial distribution of vascularization.

#### 2 - A non-linear observer to forecast the outcome of chemotherapy for avascular solid tumors

*Alfredo Germani*, University of L'Aquila, 67040, L'Aquila, Italy, A.Germani@unicampus.it, *Filippo Cacace, Luisa Di Paola*

It is presented a method to forecast the chemotherapeutic outcome for solid tumors in the avascular phase. We use an existing mathematical model for tumor growth that relies on heterogeneous population balance (Preziosi et al., Cancer Modelling Simulation, 2003) accounting cell interactions with a chemotherapeutic drug. For the resulting dynamic system model we built a nonlinear observer providing the whole cell distribution over time starting from the clinically observable parameters (whole tumor and necrotic core). The observer is used to design a controller for the optimal drug assumption.

#### 3 - Towards prediction of hcv therapy efficiency

*Szymon Wasik*, Institute of Computing Science, Poznan University of Technology, ul. Piotrowo 2, 60-965, Poznan, Poland, szymon.wasik@cs.put.poznan.pl, *Piotr Formanowicz, Jacek Blazewicz*

We investigate a correlation between genetic diversity of HCV population defined using Hamming distance between RNA sequences and the level of viral RNA accumulation in patient blood. We have found that a low distance (i.e. low genetic diversity) correlates with a high RNA level and high diversity corresponds to a low RNA level. We contend that the obtained correlation strength justifies the use of the RNA level as a measure enabling prediction of efficiency of an established therapy. We also propose that patient qualification for therapy, based on viral RNA level, improves its efficiency.

## TE-06

Tuesday 14:30-15:50

Koch

### OR Applications in the Public Sector and Non Profit Organizations

Stream: OR and Real Implementations

*Invited session*

Chair: *Zilla Sinuany-Stern*, Industrial Engineering and Management, College of Judea and Samaria, College of Judea and Samaria, 44837, Ariel, Israel, zilla@bgu.ac.il

#### 1 - Quadratic model for budget allocation in non profit organization

*Zilla Sinuany-Stern*, Industrial Engineering and Management, College of Judea and Samaria, College of Judea and Samaria, 44837, Ariel, Israel, zilla@bgu.ac.il

We present a quadratic model for allocating operational budget in nonprofit organizations. The allocations for each organizational unit have lower and upper bounds. The model is applicable in the non-parametric case, when the functional relationship between outputs and inputs is fuzzy, and the outputs are vague. The objective function is to minimize the weighted sum of the quadratic deviations of each allocation from its bounds. The model with its variants was actually used for allocating budget in various university settings.

#### 2 - Modeling misclassification of populations in clinical national quality measures that are based on computerized patient records

*Gad Rabinowitz*, Department of Industrial Engineering and Management, Ben Gurion University of the Negev, P.O.B. 653, Beer Sheva 84105, 84105, Beer Sheva, Israel, rgadi@bgu.ac.il, *Ron Weitzman*

Background: The Israeli health quality indicators use proportion measures where the denominator and numerator populations are extracted from Computerized Patient Records for the entire population. Goals: Develop methods to estimate the magnitude and distribution of misclassification and identify its causes. Methods: We used Markov-Chain Monte-Carlo to model the distribution and on-site auditing to detect causes and obtain priors. Results: A framework to identify and evaluate misclassification was developed, leading to enhanced uniformity and accuracy of the health quality indicators.

### 3 - Fast multilevel solver for quadratic optimization under planar density constraints

*Dorit Ron*, Applied Mathematics and Computer Science, The Weizmann Institute of Science, POBox 26, 76100, Rehovot, Israel, dorit.ron@weizmann.ac.il, *Ilya Safro*, *Achi Brandt*

We address the problem of finding an optimal layout for a set of 2D connected objects (modeled by a graph) by minimizing the total length of the connections and the overlap between them while utilizing the given 2D space. This problem poses a computational bottleneck in many fields: in graph visualization, facility location problem, etc. We have developed a fast multilevel solver for the core part of those applications, i.e., the problem of minimizing a quadratic energy functional under planar constraints that bound the allowed amount of areas in various sub domains of the entire given domain.

### 4 - A research of mapmaking with planning techniques

*Omur Esen*, Geodesy and Photogrammetry, Selcuk University, Division of Cartography, 42031, Konya, Selcuklu, Turkey, omuresen@hotmail.com, *I.Bulent Gundogdu*

Digital map production in Turkey is realized by some governmental foundations. This paper elaborates current map production of 103 hectares area whose building number is approximately 33 per hectare, which tendered by General Directorate of Provincial Bank. At first, tables have been made, considering activities and their relations. Then according to this table planning has been realized with Gantt and Critical Path Method methods. Then by estimating shortest (a), potential (m) and the worst (b) time values, expected time (t) values were obtained and compared for PERT and TOC planning methods.

## ■ TE-07

Tuesday 14:30-15:50

GSI - S 29

### Robust vehicle and crew scheduling

Stream: Optimization in Public Transport

*Invited session*

Chair: *Natalia Kliewer*, Information Systems and Operations Research, University of Paderborn, Warburger Str. 100, 33100, Paderborn, Germany, kliewer@upb.de

#### 1 - A business perspective to robust airline planning

*Ivo Nowak*, NetLine Optimization Solutions, Lufthansa Systems, Salzufer 8, 10587, Berlin, Germany, ivo.nowak@lhsystems.com, *Ralf Borndörfer*, *Ivan Dovica*, *Thomas Schickinger*

Since airline schedules of today have often little slack and limited recovery opportunities, flights are frequently disrupted leading to significant additional recovery costs and lower passenger punctuality. Recent approaches in robust optimization make it possible to reduce the impact of flight disruptions. A main difficulty in applying these techniques to a real-world problem is to find an appropriate recovery model under uncertainty. In this talk we discuss opportunities and challenges in robust airline scheduling from a business process point of view.

#### 2 - Column generation approach to robust tail assignment

*Ivan Dovica*, Optimization, Konrad-Zuse-Zentrum für Informationstechnik Berlin, Takustrasse 7, 14195, Berlin, Germany, dovica@zib.de, *Ralf Borndörfer*, *Ivo Nowak*, *Thomas Schickinger*

This talk deals with a robust version of the tail assignment problem, which considers the routing of individual aircraft. We model this problem as optimization problem in which non-robustness costs are minimized. Our approach is based on a stochastic model of the operation of an airline. In our talk we propose possible measures of robustness such as expected propagated delay, and solve the robust tail assignment problem by column generation technique.

#### 3 - Stochastic column generation for crew pairing optimization

*Viktor Dück*, University of Paderborn, 33098, Paderborn, Germany, dueck@dsor.de, *Natalia Kliewer*, *Leena Suhl*

We propose a method for the stochastic crew pairing problem based on dynamic column generation. The dynamic column generation method is essential to solve crew pairing optimization problems of realistic size, but is very hard to apply to stochastic programs. The proposed method speeds up the stochastic evaluation of similar pairings and similar master solutions, by decomposing the second stage of the stochastic program following the Dantzig-Wolfe Decomposition of the original problem.

#### 4 - Robust optimization for delay-tolerant vehicle schedules

*Stefan Kramkowski*, Decision Support & OR Lab, University of Paderborn, Warburger Str. 100, 33098, Paderborn, Germany, kramkowski@dsor.de, *Natalia Kliewer*

In public bus transport delays occur frequently during the transportation process. Thus, schedules become infeasible and the operations control center has to undertake expensive actions. We present different offline approaches based on robust optimization to increase delay-tolerance of vehicle schedules. In doing so, the main focus is on introducing buffer times to cope with minor disruptions and to control delay propagation. Computational results for real-life timetables from German cities compare the approaches with regard to planned operational costs and delay-tolerance.

## ■ TE-08

Tuesday 14:30-15:50

GSI - S 30

### Supply Chain Planning Practice

Stream: Supply Chain Management

*Invited session*

Chair: *Moritz Fleischmann*, Rotterdam School of Management, PO Box 1738, 3000DR, Rotterdam, Netherlands, MFleischmann@rsm.nl

#### 1 - Modelling uncertainties in supply chains — challenges and algorithmic approaches

*Simone Gast*, Lehrstuhl für Angewandte Mathematik II, Universität Erlangen-Nürnberg, Martensstr. 3, 91058, Erlangen, Germany,

simone.gast@am.uni-erlangen.de, *Kathrin Klamroth, Mirko Eickhoff, Tobias Gerken, Jens Verstaen*

In designing and optimizing logistic supply chains several uncertainty factors need to be taken into account. Considering e.g. variable currency rates or raises in transport costs is substantial when planning logistic networks. Therefore, the goal of cost-effectiveness in traditional network optimization needs to be extended. Our goal is to develop optimization techniques that guarantee a certain level of robustness and flexibility. We survey different robustness concepts and present new ideas for dealing with the challenges described above. The approaches are illustrated at a case study.

## 2 - Strategy lifecycle for entering and operating emerging markets

*Florian Köhne*, Abteilung Supply Chain Management, Fraunhofer-Institut für Materialfluss und Logistik, Joseph-von-Fraunhofer-Strasse 2-4, 44227, Dortmund, Germany, *Florian.Koehne@iml.fraunhofer.de*

The different strategies to enter new car markets are well-known, but one important problem is the identification of the right strategy. Currently OEM try to answer this question with inaccurate approaches. This paper addresses a holistic approach to enter and operate emerging markets which heeds multiple requirements. Based on a criteria catalog a quantitative and qualitative method will be presented which allows fast decision support to identify the shifting point from one strategy to another during the product lifecycle.

## 3 - Bayaps®-ds - a software tool for generation of a long-term production plan at a bayer site

*Thomas Kampmeyer*, Process Management Technology, Bayer Technology Services GmbH, 51368, Leverkusen, Germany, *thomas.kampmeyer@bayertechnology.com*

In this presentation our production planning software tool for the next 9 months at a Bayer Crop Science AG site is presented. The production is a multi-stage batch process with several additional constraints regarding diversification of production, downsizing the setup works, length of the campaigns. In the talk the basic model and the underlying solution method is introduced. The aim is to avoid late deliveries and to produce campaigns as large as possible. The solution method has to take into account several thousand orders which have to be produced on around 30 machines.

## 4 - Optimizing closed loop supply chain network design with sustainability consideration

*Vildan Ozkir*, Barbaros Bulvarı Yıldız Teknik Üniversitesi Endüstri Mühendisliği Bölümü Beşiktaş, 34349, Istanbul, Turkey, *vildanozkir@gmail.com*, *Huseyin Basligil*

This paper reveals the main features of establishing a closed-loop supply chain (CLSC) including recovery processes and develops a mathematical model of a general CLSC network which includes plants, collection points, reverse centers, recovery facilities, distribution centers and consumers. The objective of this paper is to formulate a goal programming model including environmental, social and economical dimensions of sustainability for the most attractive profit value. Finally, we applied proposed model to an illustrative case. Finally, concluding remarks are made regarding the results.

## ■ TE-09

Tuesday 14:30-15:50

GSI - S 5

## Modelling Workforce Scheduling I

Stream: Timetabling and Rostering

Invited session

Chair: *Greet Vanden Berghe*, Information Technology, KaHo Sint-Lieven, Gebr. Desmetstraat 1, 9000, Gent, Belgium, *greet.vandenbergh@kahosl.be*

### 1 - A tractable column-generation based procedure for workforce management optimization

*Matthieu Chardy*, CORE/M2V, Orange Labs, 38-40 rue General Leclerc., 92794, Issy les Moulineaux, *matthieu.chardy@orange-ftgroup.com*, *Nancy Perrot*

Provision of service and network maintenance are part of core activities of telecommunication companies. For Orange, it involves thousands of technicians for dozen millions interventions a year. This work deals with technicians workforce management optimization, which has been modeled as a variant of the VRPTW. Branch&Price techniques are reputed most efficient to solve VRP-like problems but real-life features led us to renounce optimality. We propose a customized and tractable column generation based heuristic for the problem. The method is tested on real-life data from Operational Units.

### 2 - Formulating rostering problems as sat instances for complexity analysis

*Patrick De Causmaecker*, Informatica, Katholieke Universiteit Leuven, Campus Kortrijk, Etienne Sabbelaan 53, 8500, Kortrijk, Flanders, Belgium, *Patrick.DeCausmaecker@kuleuven-kortrijk.be*

Based on a structured and systematic description of constraints for nurse rostering we show how to derive a SAT representation of the same problem. Using complexity indicators for SAT instances, we can now construct similar indicators for nurse rostering problems. These indicators combine constraints in a non trivial manner and are different from any expert related guesses for domain dependent constraints. We investigate the power of these new indicators for the optimising nurse rostering problem.

### 3 - Embracing training and recruiting capabilities in (markov) manpower planning modelling

*Nikolas Tsantas*, Department of Mathematics, University of Patras, Department of Mathematics, University of Patras, 26500, Patras, *tsantas@upatras.gr*, *Vasileios Dimitriou*

The current work suggests a manpower planning model that takes into consideration the need of the employees to attend seminars, so as to improve their qualifications, as well as the organizations' intention to avoid circumstances concerning unavailability in skilled personnel when needed. In general, we study a time dependent hierarchical system where the workforce demand at each time period is satisfied through internal mobility and two streams of recruitment; the first originating from the outside environment and the second from a supplementary auxiliary system.

### 4 - Alternative mip formulations for an integrated shift scheduling and rostering problem

*Joao Telhada*, Departamento de Estatística e Investigação Operacional / Statistics and Operations Research Department, Centro de Investigação Operacional / Operational Research Centre - Faculdade de Ciências da Universidade de Lisboa / Faculty of Sciences - University of Lisbon, Bloco C6 - Campo

Grande, 1749-016, Lisboa, Portugal,  
joao.telhada@fc.ul.pt, Ana Godinho

Personnel scheduling is usually treated by decomposition into building blocks, some of which may be treated in an integrated approach. When there is a great proportion of flexible demand, in a multi-skilled workers environment, it becomes interesting to solve shift scheduling and rostering as one problem. Additionally, the integrated approach allows also to better model breaks scheduling and days-off scheduling. Alternative MIP formulations are presented which lead to optimal shift schedulings and task assignments. Computations results show the improvement obtained by extended formulations.

## ■ TE-10

Tuesday 14:30-15:50

GSI - S 6

### Multi-Criteria Decision Models Applications on Organizations Problems

Stream: Multiple Criteria Decision Analysis

*Invited session*

Chair: *Adiel Teixeira de Almeida*, Management Engineering, Federal University of Pernambuco - UFPE, Cx. Postal 7462, 50630-970, Recife, PE, Brazil, almeidaatd@gmail.com

#### 1 - Multicriteria group decision model for rehabilitation of water supply infrastructure

*Danielle Morais*, Dept. of Production Engineering, UFPE, R. Cons. Portela, 169/apt. 701, Espinheiro, 52020-030, Recife, Pernambuco, Brazil, dcmorais@ufpe.br, *Adiel Teixeira de Almeida*

The rehabilitation of water supply infrastructure is a complex activity and requires different actions from management, besides involving actors having sometimes divergent objectives and different interests. This paper presents a multicriteria group decision model based on the analysis of individual rankings with the aim of choosing an appropriate alternative, which is the best compromise according to the point of view of all the actors involved in the decision problem.

#### 2 - Model structure for monitoring critical activities in project management based on multiple criteria decision aid

*Caroline M Miranda Mota*, Federal University of Pernambuco, 50000000, Recife, PE, Brazil, carolmm@ufpe.br, *Adiel Teixeira de Almeida*

Project management is very growing area of study and therefore problems related to projects have become a global phenomenon. This study presents a model structure for supporting the selection of critical activities in project management based on a multiple criteria decision aid (MCDA) approach. MCDA approach takes into account several points of view. The proposed model improves the monitoring of activities in project management, particularly in a dynamic environment. A case study on the IT projects is used to demonstrate the model proposed.

#### 3 - Multi-criteria model to aid liquefied petroleum gas distributors in their classification of clients

*Ana Paula Costa*, Federal University of Pernambuco, 50.000-000, Recife, PE, Brazil, apcabral@ufpe.br, *Marcos Felipe Sobral*

Liquefied petroleum gas (LPG) is a fossil fuel of great prominence on the world market due to its versatility with regard to logistics, to its calorific power and to its low emission of pollutants. Given the importance of LPG, the process of how LPG distributors should best classify their clients is a strategic task. In this context, this paper puts forward a multi-criteria model to support LPG distributors in their problem of how best to classify clients. A model is proposed based on the ELECTRE TRI method which allocates the clients in a distributor's portfolio to a group of ranked classes.

#### 4 - Multicriteria models in outsourcing decision problems

*Adiel Teixeira de Almeida*, Management Engineering, Federal University of Pernambuco - UFPE, Cx. Postal 7462, 50630-970, Recife, PE, Brazil, almeidaatd@gmail.com, *Juliana Regueira Abath*

Multicriteria decision models for outsourcing contract problems are presented. These models are also related to outsourcing vendor selection. For each alternative of an outsourcing contract there is an evaluation of cost and performance criteria related to the quality of service, which may include probabilistic delivery time and confidence in quality commitment, for instance. Different methods have been used such as MAUT and ELECTRE according with the context and preferences structures. The paper discusses the formulation of the decision model and its application.

## ■ TE-11

Tuesday 14:30-15:50

GSI - S 17

### MCDA: Portfolio Decision Analysis: Cases and Applications II

Stream: Multiple Criteria Decision Analysis

*Invited session*

Chair: *Alec Morton*, Management/ Operational Research, London School of Economics, Houghton St, London, wc2a2ae, London, England, United Kingdom, a.morton@lse.ac.uk

Chair: *Jeff Keisler*, Boston College of Management, University of Massachusetts, 100 Morrissey Blvd., 02125-3393, Boston, MA, United States, jeff.keisler@umb.edu

Chair: *Ahti Salo*, Systems Analysis Laboratory, Helsinki University of Technology, P.O. Box 1100, Otakaari 1 M, 02015, TKK, Finland, ahti.salo@tkk.fi

#### 1 - Buying health care services on behalf of a local population: bridging the divide between theory and practice

*Mara Airoidi*, Management - OR group, London School of Economics and Political Science, Houghton Street, WC2A 2AE, London, United Kingdom, m.airoidi@lse.ac.uk, *Alec Morton*, *Nikolaos Argyris*, *Gwyn Bevan*

We present a number of cases in which we have used a multi-criteria portfolio approach with health planners in the UK and Canada. Our modelling draws on health economic concepts, but is a distinctively decision analytic approach in its emphasis on helping decision makers visualise the options space, integrate evidence and judgement, and decide how to use public funds to improve health and reduce health inequalities.

#### 2 - Portfolio analysis in the cost-efficiency evaluation of weapon systems

*Jussi Kangaspunta*, Systems Analysis Laboratory, Helsinki University of Technology, P.O. Box 1100,

02015, TKK, Finland, jussi.kangaspunta@tkk.fi, *Juuso Liesiö, Ahti Salo*

Cost-efficiency evaluation of weapon systems is challenging due to multiple mission objectives, interactions among weapon systems and variety of operating situations where these systems may be used. We develop a portfolio modeling framework to identify cost-efficient combinations of weapon systems at different budget levels in view of multiple mission objectives. The modeling framework — which builds on results from combat simulations — admits incomplete information about the importance of mission objectives and accounts for interactions that exist among dissimilar weapon systems.

### 3 - A portfolio model for the allocation of resources to standardization activities

*Antti Toppila*, Systems Analysis Laboratory, Helsinki University of Technology, P.O. Box 1100, Otakaari 1 M, 02015, TKK, Finland, antti.toppila@tkk.fi, *Ahti Salo, Juuso Liesiö*

High-technology companies seek to strengthen their technological competitiveness through standardization activities that contribute to enhanced interoperability and market growth. We present a standardization portfolio model that was developed for a major telecommunication manufacturer for the allocation of standardization resources. This model captures relationships between (i) standardization and development efforts and (ii) expected sales increases that can be achieved through widely adopted technologies. The resource allocation recommendations are robust to the model parameters.

### 4 - Interrelationships between the funding portfolios of research groups and their scientific outputs

*Matti Ollila*, Systems Analysis Laboratory, Helsinki University of Technology, 02015, Helsinki, Finland, Matti.Ollila@tkk.fi, *Ahti Salo, Antti Silvast*

In many countries, research groups at universities are increasingly dependent on several external sources of funding as the share of basic funding has tended to decline. We develop two frameworks for examining interrelationships between external funding and scientific outputs, based on aggregated data about the activities of research groups. The first framework is a phased model of the activities involved in attracting and using external funding. The second is an input-output model where the groups' scientific outputs (e.g. doctoral degrees) are attributed to corresponding funding sources.

## ■ TE-12

Tuesday 14:30-15:50

GSI - S 18

### Chance constraints

Stream: Stochastic Programming

*Invited session*

Chair: *Rene Henrion*, Weierstrass Institute for Applied Analysis and Stochastics, Mohrenstr. 39, 10117, Berlin, Germany, henrion@wias-berlin.de

### 1 - Combinatorial patterns for probabilistically constrained optimization problems

*Miguel Lejeune*, Decision Sciences, George Washington University, 2201 G Street, NW, 20052, Washington, DC, mlejeune@gwu.edu

We propose a new framework for the solution of probabilistic optimization problems by using combinatorial pattern theory. The method involves the binarization of the probability distribution  $F$  and the generation of a partially defined Boolean function (pdBf) representing the combination  $(F,p)$  of  $F$  and the probability level  $p$  and taking the form of a disjunctive normal form (DNF). We present several optimization-based methods for the construction of a DNF that defines necessary and sufficient conditions for the probabilistic constraint to hold. A numerical implementation will be discussed.

### 2 - Robust approach for aerospace optimal control problems

*Jean-Philippe Chancelier*, CERMICS, Ecole des Ponts, 6 et 8 Av Blaise Pascal, Cite Descartes I, Champs sur Marne, 77455, Marne La vallee cedex 02, France, jpc@cermics.enpc.fr, *Guy Cohen, Pierre Carpentier*

The purpose of this work is the planning of spatial rendez-vous which can be formulated as optimal control problems with terminal constraints and minimal terminal time and/or fuel consumption goals. The derived optimal control is not robust in that the possibility of satisfying the terminal constraints once a breakdown of the engine occurred may be very weak. We propose a formulation in which the final constraints are replaced by a constraint in probability. The goal is to plan a trajectory achieving the rendez-vous despite engine breakdowns, with a given probability.

### 3 - A model for dynamic chance constraints in water reservoir management

*Laetitia Andrieu*, OSIRIS, EDF R&D, 1 avenue du Général de Gaulle, 92140, Clamart, laetitia.andrieu@edf.fr, *Rene Henrion, Werner Römisch*

Chance constraints play an important role in many engineering problems affected by uncertain data. In this talk, we develop a model for joint dynamic chance constraints relying on discretization of the decision variables but not of the probability distribution; this builds a bridge to existing methods for (continuous) static chance-constrained problems. The model is then illustrated through numerical examples from the application in water reservoir management for a small number of stages.

## ■ TE-13

Tuesday 14:30-15:50

GSI - S 31

### Discrete location models

Stream: Location Analysis

*Invited session*

Chair: *Stefan Nickel*, Institut fuer Operations Research, Universitaet Karlsruhe, Geb 11.40, 76128, Karlsruhe, Baden-Wuerttemberg, Germany, Stefan.Nickel@kit.edu

### 1 - Lp-rounding and local search techniques to solve a multi-period facility relocation problem

*Teresa Melo*, Department of Business Administration, University of Applied Sciences, Waldhausweg 14, D-66123, Saarbrücken, Germany, teresa.melo@htw-saarland.de, *Francisco Saldanha-da-Gama, Stefan Nickel*

A new heuristic approach is proposed to solve a multi-echelon, multi-product facility relocation model. Capacity transfers from existing facilities to new sites are to be planned over a finite time horizon subject to budget constraints. The objective is to redesign the supply chain network so as to minimize the sum of variable costs associated with production, inventory and transportation activities, and fixed costs for facility operation. An initial feasible solution is obtained using an LP-rounding strategy. Post-optimization is applied combining variable neighbourhood and token ring search.

## 2 - Discrete facility location with nonlinear production costs

*Tue Christensen*, Business Studies, Coral,  
Helsingforsgade 13, 1, 4, 8200, Århus N, Denmark,  
tuechristensen@gmail.com

This presentation will include formulations, exact and heuristic solution methods for the discrete facility location problem with nonlinear production costs. Authors have in general simplified the non-linearity by working with piecewise linear approximations. The relatively few exact solutions methods generally works with different sorts of linearization of the cost term. The heuristic side is heavily dominated by Lagrangean heuristics where relaxing the demand constraint in a Lagrangean manner often gives good results. Here an overview on the existing literature will be given.

## 3 - Combining heuristic and exact approach for the vertex p-centre problem

*Abdullah Alharbi*, Centre for Heuristic Optimisation,  
University of Kent, 13 Scott Avenue, Kent Business  
School, CT2 7PE, Canterbury, United Kingdom,  
aa285@kent.ac.uk, *Said Salhi*, *Maria Paola Scaparra*

The vertex p-centre problem is investigated using an integrated approach that combines both heuristic and exact method. We first examine some exact and heuristic approaches whose information are then integrated into an approach by taking advantages of both methodologies. We aim to identify through the heuristic some promising facilities as usually done in Heuristic Concentration while building an iterative process to guide the search due to the large value of p. A large set of instances is used to assess the performance of this integrated approach when compared to the pure exact method.

## 4 - Hub location problems with capacity choices

*Isabel Correia*, New University of Lisbon, Lisbon,  
Portugal, isc@fct.unl.pt, *Stefan Nickel*, *Francisco  
Saldanha-da-Gama*

In strategic planning, determining the capacities of facilities is usually a part of the planning process and not given externally. We introduce this feature in the capacitated single assignment hub location problem. Existing formulations for the 'classical' hub location problem are extended to the new situation. A new set of formulations is also proposed. All formulations are compared in terms of the linear relaxation bounds. Computational tests performed to evaluate the models studied are presented.

## ■ TE-14

Tuesday 14:30-15:50

GSI - S 32

### Inventory

Stream: Inventory Management

Invited session

Chair: *Stefan Minner*, Business Administration, University of Vienna, Brünner Strasse 72, 1210, Vienna, Austria,  
stefan.minner@univie.ac.at

## 1 - How to deal with uncertain inventory control parameters

*Elleke Janssen*, Econometrics & OR, Tilburg  
University, P.O. Box 90153, 5000 LE, Tilburg,  
Netherlands, e.janssen\_1@uvt.nl, *Leo Strijbosch*, *Fred  
Janssen*

For some industries, like process industry, it is difficult to produce exactly the required replenishment quantity, due to, e.g., yield problems. Hence the optimal control parameter is more a target than an exact result. We provide a method to deal with this uncertainty in inventory control by considering the control parameters to be random, unlike classical inventory control. We apply our method to a periodic review, order-up-to policy, in which the length of the review period, the lead time and the order-up-to level may be random.

## 2 - Stochastic lead time models for inventory management

*Thomas Wensing*, Chair of Production Management,  
Catholic University of Eichstaett-Ingolstadt, Auf der  
Schanz 49, 84049, Ingolstadt, Germany,  
thomas.wensing@ku-eichstaett.de, *Heinrich Kuhn*

Analytical models of inventory systems commonly assume identically independent distributed lead times to reflect stochastic influences in the replenishment process. Furthermore, replenishment orders may not crossover, i.e. arrive in a different order than they were issued — a property that clearly challenges the assumption of independence. In this context, we examine three lead time models. The first meets both assumptions, the second rules out order-crossover at the price of dependent lead times and the third allows for orders to crossover.

## 3 - Pharmaceutical supply chain and inventory decisions for a hospital

*Peter Kelle*, ISDS, Louisiana State University, CEBA,  
70810, Baton Rouge, Louisiana, United States,  
qmkell@lsu.edu, *Helmut Schneider*, *John Woosley*,  
*Sonja Wiley-Patton*

We discuss the different often conflicting goals in pharmacy supply chains and provide quantitative tools for improvements in the pharmacy inventory management system of the hospital. We provide simple, close to optimal rules for the safety stock and cycle stock allocation under space constraint. We provide a decision support tool to analyze the tradeoffs among the three key performance indicators: the service level (emergency refill workload), the available space (depending on the variety of drugs — formulary), and the number of orders (refill workload).

## 4 - Warehouse space allocation problem in a carpet factory considering multiple criteria

*Muammer Ekinci*, Department of Industrial  
Engineering, Erciyes University, 38039 Kayseri,  
Turkey, 38039, Kayseri, Turkey,  
ekinci.muammer@gmail.com, *Banu Soyulu*

This study addresses a space allocation problem for different yarn bobbins in a carpet factory based on multiple criteria. The factory produces yarn for carpet production. Currently, the warehouse space is not used efficiently. The problem is to determine the space that should be reserved for each type of yarn. In this study, a warehouse space allocation policy is developed with respect to the yearly demand of yarn types and color tone inconsistency criteria. We apply an ABC analysis and DEA based approach. We discuss different scenarios and compare the results with the current situation.

## ■ TE-15

Tuesday 14:30-15:50

Einstein

### Management and Scheduling of R&D Projects

Stream: Project Management and Scheduling

*Invited session*

Chair: *Boaz Golany*, Industrial Engineering & Management, Technion - Israel Institute of Technology, Technion City, 32000, Haifa, Israel, [golany@ie.technion.ac.il](mailto:golany@ie.technion.ac.il)

#### 1 - A Markov decision process based approach for scheduling R&D projects in a stochastic dynamic environment

*Philipp Melchior*s, Lehrstuhl für technische Dienstleistungen und Operations Management, Technische Universität München: Fakultät für Wirtschaftswissenschaften, Arcisstr. 21, 80333, München, Bayern, Germany, [philipp.melchior@wi.tum.de](mailto:philipp.melchior@wi.tum.de), *Rainer Kolisch*

We consider the problem of scheduling multiple resource-constrained projects with stochastic arrivals and stochastic activity durations such that the expected weighted makespan is minimized. For the computation of scheduling policies we propose a new approach based on a Markov decision process in continuous time which allows solving the problem for small problem instances to optimality. We will present first computational results and report on ideas for the approximate solution of larger problem instances.

#### 2 - Resource allocation in development projects that yield temporary advantage

*Boaz Golany*, Industrial Engineering & Management, Technion - Israel Institute of Technology, Technion City, 32000, Haifa, Israel, [golany@ie.technion.ac.il](mailto:golany@ie.technion.ac.il), *Moshe Kress*, *Michal Penn*, *Uriel G. Rothblum*

We consider a competition between two opponents that develop competing products where each advantage that is achieved by one of the parties is limited in time and expires when the other party develops a new (and superior) product. We model such problems as (convex) nonlinear optimization problems. We also consider game-theoretic situations and develop Nash equilibrium solutions that set investment values that both parties have no incentive to change.

## ■ TE-16

Tuesday 14:30-15:50

Koenig

### Metaheuristics in Multi-Objective Optimization

Stream: Multi-Objective Optimization and Decision Theory 1

*Invited session*

Chair: *El-Ghazali Talbi*, Laboratoire d'Informatique Fondamentale de Lille, Bâtiment M3 - Cité Scientifique, 59655, Villeneuve d'Ascq, France, France, [talbi@lil.fr](mailto:talbi@lil.fr)

#### 1 - A genetic algorithm with local search for reactive power compensation in electrical networks

*Carlos Henggeler Antunes*, DEEC, University of Coimbra and INESC Coimbra, Rua Antero de Quental 199, 3000-033, Coimbra, Portugal, [ch@deec.uc.pt](mailto:ch@deec.uc.pt)

Reactive power compensation (VAR planning) is an important issue in electric power systems, being directly related with efficient delivery of active power to loads. The problem consists in selecting the network nodes to install capacitors as well as their dimension. The mathematical model includes two objective functions concerning costs and system losses, while the bus voltage profile and power flow equations are considered as sets of constraints. The results of an elitist Non-dominated Sorting Genetic Algorithm enhanced with local search for computing non-dominated solutions are presented.

#### 2 - Morphological system design and multicriteria decision making

*Mark Sh. Levin*, Inst. for Inform. Transmission Problems, 19 Bolshoj Karetny Lane, 127994, Moscow, Russian Federation, [mslevin@acm.org](mailto:mslevin@acm.org)

Design of system configurations is examined. Modifications of morphological analysis (MA) are considered as multicriteria decision making procedures based on combinatorial optimization. The following methods are studied: (i) MA, (ii) MA based on proximity to ideal point(s), (iii) MA based on linear programming, (iv) multicriteria multiple choice problem, (v) QAP, (vi) Pareto-based MA, (vii) Hierarchical Morphological Multicriteria Design (HMMD) approach, and (viii) HMMD approach based on probabilistic/fuzzy estimates. The methods are illustrated by examples, and applications.

#### 3 - A new data mining based approach for multi-objective optimisation

*Jingpeng Li*, School of Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, Nottinghamshire, [JPL@cs.nott.ac.uk](mailto:JPL@cs.nott.ac.uk), *Edmund Burke*, *Rong Qu*

In this approach, we first generate an initial solution and then use any local search method to identify a new solution. Compromise programming is investigated to evaluate the quality of the new solution under multiple objectives. Later, we use a falling tide search to determine the acceptance of this solution, and update an obtained Pareto set. The above steps are iterated, until a stopping condition is met. In the meantime, we employ data mining methodologies to aid or speed up the search. We can use this to predict the quality of resulting solutions without calculating the objective values.

## ■ TE-17

Tuesday 14:30-15:50

Rheinaue

### Cutting and Packing 7

Stream: Cutting and Packing

*Invited session*

Chair: *A. Miguel Gomes*, Faculty of Engineering / INESC Porto, University of Porto, Rua Dr. Roberto Frias s/n, 4200-465, Porto, Portugal, [agomes@fe.up.pt](mailto:agomes@fe.up.pt)

#### 1 - Dynamic multi-period scheduling of cutting and sequence-dependent setup operations

*Harald Reinertsen*, Leeds School of Business, University of Colorado at Boulder, 419 UCB, 80309-0419, Boulder, CO, United States, [Harald.Reinertsen@Colorado.edu](mailto:Harald.Reinertsen@Colorado.edu), *Thomas Vossen*

Cutting and sequence dependent setup operations commonly appear in a stochastic and dynamic setting on an infinite horizon where orders arrive and are filled within due dates. These problems have a common structure where the cost of production depends on the other orders in the system. Because of this special problem structure, approximating future orders and taking advantage of order selection and postponement strategies in planning the next period leads to significant improvements in scrap and setup time as well as on-time delivery of orders.

## 2 - Pallet design and distribution planning for an integrated beverage manufacturer—chain market system

Rifat Gürçan Özdemir, Industrial Engineering Department, Istanbul Kültür University, Atakoy Campus, Atakoy-Bakirkoy, 34156, Istanbul, Turkey, rg.ozdemir@iku.edu.tr, Tülin Aktin, Filiz Avcı

This paper proposes the joint pallet design and distribution planning problem for a system involving a single manufacturer and multiple chain markets. Given demands of customers, the first level generates mixed pallet design alternatives to minimize total unused pallet spaces. The resulting alternative pallet designs including multiple products are input to the second level. This level determines a distribution plan for a global objective function in which the overall costs of the integrated system are minimized. The approach is implemented using GAMS software in a real industrial problem.

## 3 - Lp-based branching schemes in the orthogonal packing feasibility problem

Gleb Belov, Numerical Mathematics, TU Dresden, 01062, Dresden, Germany, bg37@gmx.net

The Orthogonal Packing Feasibility Problem (OPP) asks whether a given set of cuboid items can be orthogonally packed in a given cuboid container. The natural model of OPP operates with item coordinates. The interval graph model of OPP considers overlapping relations of item projections on the coordinate axes. Today's state-of-the-art exact approaches operate with these models and apply combinatorial heuristics for branching decisions. We propose new branching schemes for OPP based on 1D LP relaxations and both on natural and interval graph models.

## 4 - A hybrid approach to the rectangle packing area minimization problem

A. Miguel Gomes, Faculty of Engineering / INESC Porto, University of Porto, Rua Dr. Roberto Frias s/n, 4200-465, Porto, Portugal, agomes@fe.up.pt, Marisa Oliveira, M<sup>a</sup> Eduarda Pinto Ferreira

In the Rectangle Packing Area Minimization Problem (RPAMP) one wishes to pack a set of non-overlapping rectangles while minimizing the enclosing rectangular area. This problem is applicable to a wide range of activities, such as Very Large Scale Integration (VLSI) module placement and facility layout (FL). In this work we propose to tackle the RPAMP with a hybrid approach of iterated local search (ILS) with linear programming models (LP).

## ■ TE-18

Tuesday 14:30-15:50

Lenné

### Various New Achievements in Mathematical Programming I

Stream: Mathematical Programming

Invited session

Chair: Basak Akteke-Ozturk, Institute of Applied Mathematics, Middle East Technical University, Scientific Computing, 06531, Ankara, Turkey, bozturk@metu.edu.tr

Chair: Gerhard-Wilhelm Weber, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

## 1 - Development of a new method for arriving at initial basic feasible solution for optimization problems in engineering

Chandrasekhar Putcha, Civil and Environmental Engineering, California State University, Fullerton,

800 North State College Blvd., 92834, Fullerton, CA, cputcha@fullerton.edu

Northwest corner rule and Russell method are widely used for obtaining Initial Basic Feasible Solution (IBF) in Optimization problems and both have drawbacks. The IBF obtained is either far from optimal solution or does not have adequate number of entries to initiate transportation simplex algorithm. The Northwest Corner rule gives an initial feasible solution that is far from optimal while the IBF solution obtained using Russell method doesn't give enough number of entries to start the transportation simplex algorithm. Hence, need of new basis feasible solution, the basis of this paper.

## 2 - Pivoting in linear complementarity: two polynomial-time cases

Jan Foniok, Institute for Operations Research, ETH Zurich, HG G 22.2, Rämistrasse 101, 8092, Zurich, Switzerland, foniok@math.ethz.ch, Komei Fukuda, Bernd Gärtner, Hans-Jakob Lüthi

We demonstrate that unique-sink orientations of cubes are a useful combinatorial tool for studying the behaviour of simple principal pivoting methods for the P-matrix linear complementarity problem (P-LCP). We solve an open problem of Walter D. Morris by showing that Murty's least-index pivot rule (under any fixed index order) leads to a quadratic number of iterations on Morris's highly cyclic P-LCP examples. We then show that on K-matrix LCP instances, all pivot rules require only a linear number of iterations.

## 3 - Parameter estimation in stochastic differential equations by modern continuous optimization

Gerhard-Wilhelm Weber, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr, Pakize Taylan, Ayşe Özmen, Nuket Erbil, Cem Ali Gökçen

Stochastic differential equations play an increasing role in financial mathematics, in sciences and technology. We identify their parameters by various kinds of estimation, e.g., nonlinear regression, additive models with splines, MARS and the recently introduced C-MARS. We present and discuss the use techniques such as Levenberg-Marquardt method and conic quadratic programming with interior point methods. Our optimization problems also include regularization terms to prevent from overfitting. We discuss structural frontiers and present research challenges.

## ■ TE-19

Tuesday 14:30-15:50

Haber

### Neighbourhood search for logistics

Stream: Metaheuristics

Invited session

Chair: Celso Ribeiro, Department of Computer Science, Universidade Federal Fluminense, Rua Bogari 70, 22471-340, Rio de Janeiro, RJ, Brazil, celso@inf.puc-rio.br

## 1 - A variable neighborhood search for a practical food distribution problem

Min Wen, Department of Management Engineering, Technical University of Denmark, DTU - Bygning 426, room 043, 2800, Lyngby, Denmark, mw@imm.dtu.dk, Emil Krapper, Jesper Larsen, Thomas Stidsen

We study a practical distribution problem encountered in a food company in Denmark. The problem is to determine routes for a fleet of heterogeneous vehicles and assign the routes to a number of drivers over a week such that the customers are supplied within their time windows. Furthermore, the drivers can not work for more than 37 hours per week. Special driving rules must be respected, e.g., a 45-minute break must be ensured after 4.5 hours driving. The objective is to minimize the total traveling distance. A variable neighborhood search is developed. Preliminary results will be presented.

## 2 - On the use of run time distributions to characterize stochastic local search algorithms

*Celso Ribeiro*, Department of Computer Science, Universidade Federal Fluminense, Rua Bogari 70, 22471-340, Rio de Janeiro, RJ, Brazil, celso@inf.puc-rio.br, *Isabel Rosseti*, *Reinaldo Vallejos*

We explore run time distributions and describe a new tool to compare two algorithms based on stochastic local search. For the case where the running times of both algorithms fit exponential distributions, we derive a closed form index that gives the probability that one of them finds a solution at least as good as a given target value in a smaller computation time than the other. This result is extended to the case of general run time distributions and a numerical iterative procedure is described for the computation of the above probability value.

## ■ TE-20

Tuesday 14:30-15:50

Mann

### DEA Applications I

Stream: DEA and Performance Measurement

*Invited session*

Chair: *Ali Emrouznejad*, Aston Business School, Aston University, B4 7ET, Birmingham, United Kingdom, a.emrouznejad@aston.ac.uk

#### 1 - Dea in evaluating managerial practices

*Juha Eskelinen*, Helsinki School of Economics, Uimarannantie 23 C, 00780, Helsinki, Finland, juha.eskelinen@student.hse.fi

A DEA model was employed to rank branches of a retail bank by their efficiency. A significant positive relationship was found between the efficiency rankings and team leader evaluations made by the branch staff.

The findings are aligned with the theory of High Performing Work Systems according to which a bundle of good managerial practices is a driver of workplace performance.

The study provides a bridge between techniques of Operations Research and contemporary HR Management. DEA can shape the HRM research and practices on the workplace level.

#### 2 - Performance comparison between retailing stores using a malmquist-type index

*Clara Vaz*, Escola Superior de Tecnologia e de Gestão, Instituto Politécnico de Bragança, Campus de Santa Apolónia, Apartado 134, 5301 - 857, Bragança, Portugal, clvaz@ipb.pt, *Ana Camanho*

This study develops a framework that combines different methods to provide insights regarding the performance of retailing stores. Firstly, the framework enables to specify appropriate targets for stores using DEA. This involves comparing stores within homogeneous groups. Secondly, the framework compares the overall performance of these groups. This requires the combined use of Malmquist type index and statistical tests. This index is decomposed into components for comparing the efficiency spread between groups and the productivity differences between the best-practice frontiers of the groups.

#### 3 - Performance evaluation of universities from the students' perspective

*Regina Schindwein*, Institut für BWL (510A), University of Hohenheim, Schloss Osthof Nord, 70599, Stuttgart, Germany, r.schindwein@uni-hohenheim.de

One of the most popular evaluations of universities in Germany is the CHE-Ranking conducted annually since 1998 by the Centrum für Hochschulentwicklung. This ranking builds three ranking groups for different criteria. Based on the CHE data, especially the surveys among students, we evaluate teaching performance from the students' perspective through a data envelopment analysis (DEA). We use a DEA bootstrap approach to consider stochastic influences in the data. Moreover we are able to identify stochastic dominance relations between university departments.

#### 4 - Efficiency analysis of islamic banks: a case of gulf cooperation council (gcc)

*Abdel Latef Anouze*, Aston Business School, Aston University, 5 Colchester Street, CV1 5NY, Coventry, United Kingdom, aamajed2001@hotmail.com, *Ali Emrouznejad*

This paper aims to analyze the efficiency and productivity change of 70 commercial banks: Gulf Cooperation Council (GCC) cases over period 2000-2007. To deal with negative data, the semi-oriented radial model, the modified slack based model and the range directional model were employed. Statistical tests are used for cross country comparison and for comparison between Islamic and Conventional banks. Our findings are that Islamic Banks are more efficient than Conventional Banks in GCC. Cross-countries analysis shows that the countries with less concentration banks are more efficient.

## ■ TE-21

Tuesday 14:30-15:50

Hauptmann

### AHP I

Stream: Analytic Hierarchy Processes, Analytic Network Processes

*Invited session*

Chair: *İlker Topcu*, Istanbul Technical University, Turkey, ilker.topcu@itu.edu.tr

#### 1 - A multi-criteria decision model framework for military force comparison

*Ahmet Kandakoglu*, Department of Industrial Engineering, Istanbul Technical University, Macka, 34367, Istanbul, Turkey, kandakoglu@itu.edu.tr, *Y. İlker Topcu*

This paper proposes a multi-criteria decision model framework based on the integrated utilization of SWOT analysis and Analytic Hierarchy Process (AHP) to compare the military forces. In this framework, while SWOT analysis structures the decision hierarchy for the evaluation, AHP measures the relative importance of evaluation criteria in this decision hierarchy. Then, the comparison of opponent forces is determined to increase the situation awareness in the battlefield. An illustrative case study is presented to demonstrate the applicability of the proposed framework.

## 2 - Multi-attribute decision support for project portfolio of railway infrastructure

*Majda Bastiè*, Faculty of Economics and Business, University of Maribor, Razlagova 14, 2000, Maribor, majda.bastic@uni-mb.si

In Slovenia, the construction of railway infrastructure within TEN will be carried out on the traffic corridors V and X within ten projects. Considering strategic objectives, TEN requirements and financial possibilities of investors the model was developed to find project portfolio which meets those requirements as much as possible. First, multi-criteria decision analysis was applied to rank projects with respect to macroeconomic and infrastructural criteria. In order to determine the start of the project they are grouped in stages with respect to the available financial funds of investors.

## 3 - The analytic hierarchy process for the social complex problems analysis

*Rina Manuela Contini*, Scienze Sociali, Università Chieti-Pescara, Via di Vestini, 31, 66013, Chieti, Italy, rm.contini@unich.it, *Antonio Maturo*

The aim of this study is to show how the Analytic hierarchy process can be an adequate tool to analyze the social complex problems. Specifically, the AHP is applied to analyze the complex and multidimensional phenomenon of foreign students' school integration. For this purpose a case study is presented in which, according to inquiries conducted with teacher's interviews an order of priorities is presented in which n satisfactory alternatives are placed, in different measures, having prescribed choice criteria.

## 4 - Making better decisions by integrating GIS with AHP

*Turan Erden*, Geodesy and Photogrammetry Engineering, Istanbul Technical University, Istanbul Teknik Universitesi, Insaat Fakultesi, Jeodezi ve Fotogrametri Muhendisligi Bolumu, 34469, Istanbul, Turkey, erdentur@itu.edu.tr, *Ozay Ozaydin*, *Y. Ilker Topcu*

As systems become more complex, decision support systems require an evolution. The integration of analytical hierarchy process (AHP) with the geographical information systems (GIS) combines decision support methodology with powerful visualization, mapping and analyzing capabilities which should considerably facilitate i.e. creation of the suitability maps, location selection problems and critical areas for specific resource management and control practices. In this study, the effects of integrating GIS with analytical hierarchy process are investigated with respect to before-mentioned aspects.

## ■ TE-22

Tuesday 14:30-15:50

Arndt

### Emissions Trading

Stream: OR and Environmental Management

*Invited session*

Chair: *Peter Letmathe*, FB 5: Wirtschaftswissenschaften, University of Siegen, Chair of Value Chain Management, Hoelderlinstr. 3, 57068, Siegen, Germany, peter.letmathe@uni-siegen.de

## 1 - Incentives and burden sharing in post-kyoto climate regimes — a cge analysis with the dart model

*Sonja Peterson*, Kiel Institute for the World Economy, Duesternbrooker Weg 120, 24105, Kiel, sonja.peterson@ifw-kiel.de, *Gernot Klepper*

Because of large economic and environmental asymmetries among world regions and the incentive to free ride, a Post-Kyoto international climate regime with broad participation is hard to reach. Using the CGE model DART we compare different stylized regimes with respect to the distribution of economic costs and in particular the incentives for the developing countries to participate. The regimes include a harmonized international carbon tax and cap and trade systems with different popular allocation rules for the emission caps. Also we calculate the carbon content of trade.

## 2 - Relevance of industrial sectors for emission trading in an optimizing energy system model

*Lutz Hillemaier*, Institut für Industriebetriebslehre und Industrielle Produktion (IIP), Universität Karlsruhe (TH), Hertzstraße 16, 76187, Karlsruhe, Germany, Lutz.Hillemaier@kit.edu, *Christoph Nolden*, *Dominik Möst*, *Wolf Fichtner*

The energy and material flow model PERSEUS has been developed to give decision support for strategic planning of energy utilities in liberalised energy markets and to provide a tool for deriving electricity and CO<sub>2</sub>-certificate prices. The model determines the "optimal" structure of the future energy system of an electric utility for a typical time horizon of about 30 years considering environmental constraints like emission restrictions. In our contribution, relevant industrial sectors are included and their influences on emission trading and CO<sub>2</sub>-certificate prices are analysed.

## 3 - The decision value of a future fusion power plant in an emissions trading system

*Heinz Eckart Klingelhöfer*, Knopfstraße 1, 17489, Greifswald, Germany, hekling@web.de, *Peter Kurz*

This paper outlines an approach to valuating a future fusion power plant in imperfect markets. We use simultaneous calculation of optimal production, trading and investment programs under characteristic constraints. Duality theory allows to interpret the determinants of the price ceiling as (corrected) Net Present Values. Although fusion power itself will be CO<sub>2</sub>-emissions free, emissions trading will affect the profitability of a fusion power plant via its alternatives. Hierarchical planning combines the advantages of the accurate simultaneous approach with reduced complexity.

## ■ TE-23

Tuesday 14:30-15:50

Planck

### Networks and Alliances

Stream: Demand, Pricing and Revenue Management

*Invited session*

Chair: *Michaela Graf*, Mercator School of Management, Chair of Logistics, University Duisburg-Essen, Lotharstr. 65, 47057, Duisburg, Germany, michaela.graf@uni-duisburg-essen.de

## 1 - An option-based revenue management procedure for strategic alliances

*Michaela Graf*, Mercator School of Management, Chair of Logistics, University Duisburg-Essen, Lotharstr. 65, 47057, Duisburg, Germany, michaela.graf@uni-duisburg-essen.de, *Alf Kimms*

We propose a capacity control process for strategic alliances, which determines the booking limits as control variables in the capacity control with the aid of real options. The booking limits are calculated in an iterative process with simulation-based optimization. In a computational study the results of the simulations-based optimization will be compared with the results of a FCFS-approach and the ex post optimal solution.

## 2 - Nucleolus based revenue allocation in airline alliances

*Demet Cetiner*, Mercator School of Management,  
University of Duisburg-Essen, Lotharstrasse 65 LB  
212, 47057, Duisburg, Germany,  
demet.cetiner@uni-due.de, *Alf Kimms*

Airline alliances offer many multi-leg itineraries where flight legs are operated by different airlines. Due to the increased number of flight combinations, they can serve more destinations and achieve better revenues. In this paper, we study the problem of allocating the alliance revenue to the partners in a fair way to ensure the stability of the alliance. We define the problem as a cooperative game and propose the Nucleolus solution as a fair revenue allocation mechanism. We carry out a computational study on randomly generated networks to test the performance of our allocation mechanism.

## 3 - Performance measurement in airline network revenue management

*Christian Temath*, Decision Support & Operations  
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Techniques for Performance Measurement are an integral part of a Revenue Management System. For leg-based controls the Revenue Opportunity Model (ROM) is a widely known method for measuring Revenue Management performance. However, this traditional ROM does not show valid results for network-based Revenue Management especially with dependent demand structures. We will discuss a network-based ROM for both independent and dependent demand. In this context, we will introduce a method for measuring the robustness of the ROM against influencing factors and present computational results.

## ■ TE-24

Tuesday 14:30-15:50

GSI - S 20

## Nonlinear and Semidefinite Programming

Stream: Nonlinear Programming

*Invited session*

Chair: *Olga Kostyukova*, Institute of Mathematics,  
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### 1 - Error bounds property and other types of constraint qualification in perturbed nonlinear programming

*Leonid Minchenko*, Informatics, Belarus State  
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L.Minchenko, S. Stakhovski

Error Bounds Property in Perturbed Nonlinear Programming  
The error bounds property is a constraint qualification closely related to the concept of calmness. The well-known Mangasarian-Fromovitz constraint qualification implies the error bounds property. The aim of our paper is to show that under some conditions for the perturbed nonlinear program the error bounds property is also implied with the constant rank constraint qualification.

### 2 - Option pricing under mass and shape constraints via semidefinite programming

*Geert Wouters*, University of Antwerp, Prinsstraat 13,  
2900, Antwerp, geert.wouters2@ua.ac.be

Consider the problem of computing optimal bounds on a functional expected value of a partially known random variable. In contrast to traditional models which impose moment constraints, we show that superior bounds can be achieved by restricting the corresponding density by mass and shape constraints. Our main result provides an important generalization to the case of shape constraints imposed on different parts of the domain. We propose a programming framework based on conic duality theory which enables us, under mild conditions, to reduce the optimization problem to a semidefinite program.

### 3 - Robust parameter estimation based on Huber estimator in systems of differential equations

*Ekaterina Kostina*, Department of Mathematics and  
Computer Science, University of Marburg,  
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The problem of parameter identification in dynamic models is among the most important tasks in mathematical modeling of dynamic processes. One of the problems in real-life applications is that data contains outliers. Thus, a reliable parameter estimation procedure is necessary that deliver estimates less sensitive to measurement errors. One of the robust parameter estimation is based on the so-called Huber estimator. The talk focuses on the method for robust parameter estimation for dynamic systems. The method is successfully applied to several real-life problems.

### 4 - Immobile indices in study of convex SIP and SDP problems

*Tatiana Tchemisova*, Mathematical Department,  
Aveiro University, Campus Universitário de Santiago,  
3810-193, Aveiro, Portugal, tatiana@mat.ua.pt, *Olga Kostyukova*

We introduce notions of immobile indices and immobility orders for Semi-Infinite and Semi Definite Programming. The set of immobile indices is an important characteristic of feasible sets and can be successfully used in optimality conditions without constraint qualifications.

For a convex SIP problem with compact index set in  $\mathbb{R}_s$ , we prove the Implicit Optimality Criterion that permits to substitute the optimality conditions for initial SIP problem by such conditions for an auxiliary linear SDP problem. When immobile indices are of small orders, these conditions are explicit.

## ■ TE-25

Tuesday 14:30-15:50

GSI - S 25

## Dynamics and Applications

Stream: Dynamical Systems and Game Theory

*Invited session*

Chair: *Rui Gonçalves*, Engenharia Civil, Faculdade de  
Engenharia da U. Porto, R. Dr. Roberto Frias, 4200-465,  
Porto, rjasg@fe.up.pt

### 1 - Difference equations and strongly regular graphs

*Luís Vieira*, Engenharia Civil, Faculdade de  
Engenharia do Porto, R. Dr. Roberto Frias, 4200-465,  
Porto, lvieira@fe.up.pt

Let  $n$  be a natural number. We deduce that the spectra of the family  $F$  of strongly regular graphs obtained in Cardoso et al.(2004) is determined by homogeneous linear difference equations of second order.

Cardoso, D. M. and Vieira, L.A. Euclidean Jordan algebras with strongly regular graphs. *Journal of Mathematical Sciences*, 120 (2004):881-894.

## 2 - Universality in the stock exchange

Rui Gonçalves, Engenharia Civil, Faculdade de Engenharia da U. Porto, R. Dr. Roberto Frias, 4200-465, Porto, rjsg@fe.up.pt, Alberto A. Pinto

We analyze the constituents stocks of the Dow Jones Industrial Average and the Standard & Poor's 100 index of the NYSE stock exchange market. Surprisingly, we discovered that the distribution of the fluctuations of the cubic root of the squared daily return are close to the universal non-parametric Bramwell-Holdsworth-Pinton (BHP) distribution. Since the BHP probability density function appears in several other dissimilar phenomena, our result reveals an universal feature of the stock exchange market.

## 3 - Extending the hotelling model: incomplete information and networks

Alberto A. Pinto, Departamento de Matematica, University of Minho, Escola de Ciências, Universidade do Minho, 4710-057, Braga, Portugal, aapinto1@gmail.com, Rosa Esteves, Telmo Parreira

We develop a theoretical framework to study spatial price competition in a Hotelling-type network game. We investigate price competition à la Hotelling with complete and incomplete information about the network structure. The goal is to investigate the effects of the network structure on firms' prices and profits. We first analyse the benchmark case where each firm knows its own degree as well as the rivals' degree. Then, we also analyse the incomplete information case where each firm knows its type but not the competitors' type.

## 4 - Walrasian price in an edgeworthian economy

Bruno M.P. M. Oliveira, FCNAUP, R. Dr. Roberto Frias, 4200-465, Porto, Portugal, bmpmo@fcna.up.pt, Barbel Finkenstadt, Alberto A. Pinto, Athanassios Yannacopoulos

A key problem of economic theory is the convergence of the prices in a market to their equilibrium values. Several models have been proposed to answer this problem. Two of the most important are Walras' model of general equilibrium and the model of Edgeworth. We show that under some fairly general and easy to check symmetry conditions, depending on the initial distribution of endowments and the agents preferences, the sequence of Edgeworthian prices in a random matching economy converges to the Walrasian prices for this economy.

## ■ TE-26

Tuesday 14:30-15:50

GSI - S 35

### Graph Theory

Stream: Discrete Optimization

Contributed session

Chair: Dolgor Zambalaeva, Discrete Analysis and Operations Research, Sobolev Institute of Mathematics, Prospekt Koptyuga, 4, 630090 Novosibirsk, 630090, Novosibirsk, Russian Federation, dolgor@ngs.ru

## 1 - K\_bipartite distance hereditary graphs

Slimani Souad, operation research, Mathematics, USTHB, Faculté de Mathématiques Département de Recherche Opérationnelle, 16 111, Algiers, Algeria, slimanisouad8@gmail.com, Méziane Aïder

The distance between two vertices represents the length of the shortest path connecting them. This notion has been used in graphs to construct the class of distance hereditary graphs which the distance between any two non adjacent vertices of any connected subgraph of a connected graph is the same as the distance between these two vertices in the original graph. Adapting this concept to the bipartite graphs, Aïder introduced the class  $B(k, +)$  where the length of the shortest  $u, v$ -path of  $G$  is at most equal to  $d(u, v) + 2k$ . In this paper, we study the general case by giving some forbidden subgraphs.

## 2 - Planar graphs without short cycles OR close triangles are three-colourable.

Aleksey Glebov, Discrete Analysis and Operations Research, Sobolev Institute of Mathematics, Prospekt Koptyuga, 4, 630090, Novosibirsk, Russian Federation, angle@math.nsc.ru

We present new sufficient conditions for a planar graph to be three-colourable: any planar graph without cycles of length five and with minimum distance between triangles at least two is three-colourable; a planar graph where five-cycles have no common edges with triangles and any two triangles are at distance at least four is three-colourable; a planar graph where triangles have no common edges with cycles of length between four and seven is three-colourable.

## 3 - Decomposing planar graphs into degenerate subgraphs

Dolgor Zambalaeva, Discrete Analysis and Operations Research, Sobolev Institute of Mathematics, Prospekt Koptyuga, 4, 630090 Novosibirsk, 630090, Novosibirsk, Russian Federation, dolgor@ngs.ru, Aleksey Glebov

The problem of decomposing planar graphs into degenerate subgraphs have been actively investigated lately. We present some recent results about decompositions of planar graphs into forests, star forests and subgraphs with restricted path lengths. For example, we prove that the vertex set of a planar graph of girth seven can be partitioned into two subsets each of which induces a star forest. Another important result is that any planar graph of girth five is tau-partitionable which partially confirms the well-known conjecture by Frick, Mihok et al.

## ■ TE-27

Tuesday 14:30-15:50

GSI - S 21

### Integer Programming

Stream: Discrete Optimization

Contributed session

Chair: Sonja Friedrich, Fachbereich Mathematik, TU Darmstadt, AG Optimierung, Schlossgartenstraße 7, 64289, Darmstadt, Hessen, Germany, friedrich@mathematik.tu-darmstadt.de

## 1 - Mathematical modelling of transition from open pit to underground mining using integer programming

K. Oraee, Stirling University, FK9 4LA, Scotland, United Kingdom, sk01@stir.ac.uk, Arsalan Rahmani, Ezzeddin Bakhtavar, Kouros Shahriar

Conventionally, there are established surface and Underground (Ug) methods to mine deposits. Somewhen, it is more suitable to mine a deposit by combined method of Open Pit (OP) as a common surface method and Ug. Now, the most important question emerges: where is the Optimum Transition Depth (OTD) from OP to Ug? Recently, this problem (OTD) is introduced as a major challenge in mining. In this study, to optimize the problem and modelling, the 0-1 Integer Programming (IP) was employed. Its objective function was founded upon maximization of total profit of OP and Ug with related limitations.

## 2 - Developing and using further higher-order cover cuts from pairs of 0-1 inequalities

*John Wilson*, The Business School, Loughborough University, Loughborough, United Kingdom, [j.m.wilson@lboro.ac.uk](mailto:j.m.wilson@lboro.ac.uk)

The use of cover inequalities in 0-1 integer programming problems is well-established and has proved beneficial computationally. More recently a class of second-order cover inequalities has been proposed and shows promise computationally. In this paper the development of second-order covers will be extended further and it will be shown how they may still prove useful in situations where only relatively weak constraints are available. It will also be shown how three further types of 0-1 relationships can be used to generate second-order covers.

### 3 - Partial reverse search

*Sonja Friedrich*, Fachbereich Mathematik, TU Darmstadt, AG Optimierung, Schlossgartenstraße 7, 64289, Darmstadt, Hessen, Germany, [friedrich@mathematik.tu-darmstadt.de](mailto:friedrich@mathematik.tu-darmstadt.de), *Lars Schewe*

Knowing the structure of vertices of polytopes around optimal solutions is of particular interest. Partial reverse search (prs) is an algorithm which looks for integer vertices in MIPs in a clever way. The implementation uses the lp-solver Clp and is based on the algorithm partial reverse search by David Avis and Komei Fukuda. Whereas reverse search is looking for all vertices, prs is interested in the integer ones. Therefore it can be used to solve 0-1-problems and promises to be useful as heuristic for MIPs. We present some preliminary results of computational examples.

## ■ TE-28

Tuesday 14:30-15:50

GSI - S 1

### SCM in Retailing

Stream: Demand and Supply in Consumer Goods and Retailing

*Invited session*

Chair: *Waldemar Toporowski*, Faculty of Economic Sciences, Georg-August-Universität Goettingen, Platz der Goettinger Sieben 3, 37073, Goettingen, Germany, [wtoporo@uni-goettingen.de](mailto:wtoporo@uni-goettingen.de)

#### 1 - Analyzing channel structures for the procurement of store brands with a game-theoretic approach

*Stephan Zielke*, Chair of Retailing, Georg-August-Universität Göttingen, Platz der Göttinger Sieben 3, 37073, Göttingen, Germany, [szielke@uni-goettingen.de](mailto:szielke@uni-goettingen.de), *Waldemar Toporowski*

This paper analyzes different channel structures for the procurement of store brands. In structure 1, one of the national brand manufacturers produces the store brand, while in structure 2, the store brand is produced by a small (regional) supplier. A game-theoretic model analyzes the economic consequences of these channel structures from a retailer's perspective. The results underline that the retailer's decision in introducing the store brand and selecting a supplier for the product depends on the competition between the national brands in the category.

#### 2 - Integrative retail logistics

*Michael Sternbeck*, Logistics, Catholic University of Eichstaett Ingolstadt, Auf der Schanz 49, 85049, Ingolstadt, [michael.sternbeck@ku-eichstaett.de](mailto:michael.sternbeck@ku-eichstaett.de), *Heinrich Kuhn*

A grocery retail chain generally consists of the three subsystems warehousing, transportation and instore-logistics. In traditional planning approaches the shop itself usually played a minor role. In fact the operating expense in the outlets often is higher than in the upstream activities. In the speech the problems of integrating instore activities are addressed and an integrative approach is discussed.

### 3 - Relational supply contracts

*Arnd Huchzermeier*, Production Management, WHU Otto Beisheim School of Management, Burgplatz 2, 56179, Vallendar, Germany, [ah@whu.edu](mailto:ah@whu.edu), *Michaela Hoehn*, *Martin A. Lariviere*

Motivated by recent developments in the consumer goods and automotive industry, this paper studies a two-firm supply chain, where repeated transactions via supply contracts and continued quality-improvement efforts are governed by a relational contract. With the help of dynamic programming, we are able to characterize an optimal relational contract for this setting. We examine both quantity-based (quantity flexibility contracts) and price-based returns (buy backs) mechanisms.

### 4 - Quality, pricing, and inspection decisions in supply chains

*Murat Erkoc*, Industrial Engineering, University of Miami, P.O. Box 248294, 33124, Coral Gables, FL, United States, [merkoc@miami.edu](mailto:merkoc@miami.edu), *Haresh Gurnani*

We study quality-price-demand relationship in a supply chain where the product may be inspected prior to sale. We consider a decentralized supply chain where market demand depends on the resale price and the consumer's perception on quality. We show that when the cost-reducing impact outweighs the demand-enhancing effect, higher quality may result in lower prices. In price-sensitive markets, the buyer is more likely to conduct inspection. Finally, we show that inspection can in fact lead to lower in-built product quality, as the supplier is able to free ride on the buyer's inspection effort.

## ■ TE-29

Tuesday 14:30-15:50

GSI - S 2

### Commodity Risk Management 2

Stream: Financial Modelling

*Invited session*

Chair: *Rita D'Ecclesia*, Teoria Economica e Metodi Quantitativi per le Scelte politiche, Università di Roma, Piazza Aldo Moro 5, 00185, Roma, Italy, [rita.decclesia@uniroma1.it](mailto:rita.decclesia@uniroma1.it)

#### 1 - Electricity price modelling with a regime-switching volatility

*Silvana Musti*, Dipartimento di Scienze Economiche, Matematiche e Statistiche, University of Foggia, Largo Papa Giovanni Paolo II, 1, 71100, Foggia, Italy, Italy, [s.musti@unifg.it](mailto:s.musti@unifg.it), *Viviana Fanelli*

In this paper we focus on the analysis of the energy prices using a regime switching approach to describe the volatility evolution. The regime switching approach allows to capture the conditional volatility persistency and the jump behaviour of energy prices. We model directly the forward price adopting the Heath-Jarrow-Morton approach from interest rate theory. This approach suggests to directly assume the dynamics of the forward price evolution either in terms of market dynamics or under the risk-neutral measure.

## 2 - An efficient parametric pricing rule for single commodity exchange

Piotr Palka, Institute of Control & Computation Engineering, Warsaw University of Technology, ul. Nowowiejska 15/19, 00-665, Warsaw, Poland, P.Palka@ia.pw.edu.pl, *Eugeniusz Toczyłowski*

In the paper we propose pricing rule for the stock market in situation of oligopoly. It is developed basing on the Modified Vickrey Double Auction pricing rule (Yoon, 2001) which provides incentives for participants to provide truthful offers. It cannot be applied to stock market, because of differences between the auctions and stock markets. The new pricing rule is based on a parametric analysis of mathematical model (PAM) of the stock market. For every offer, the iterative sensitivity analysis is performed, which gives us individual prices. We analyze properties of the PAM pricing rule.

## 3 - Stochastically resonating spiking in power markets and its estimation

Carlo Lucheroni, Dept. of Mathematics and Informatics, University of Camerino, via M. delle Carceri 9, 62032, Camerino (MC), Italy, carlo.lucheroni@unicam.it

Recently, a new way to model the irregularly peaking price dynamics of power markets was introduced [1], which uses a system of nonlinear stochastic differential equations and is able to display both sudden narrow spikes of variable height and small day/night oscillations. This system can be calibrated on discrete-time sets of prices using both least squares and maximum likelihood, despite the delicate issue of possible non-stationarity in price series data. [1] C. Lucheroni, Resonating models for the electric power market, Phys. Rev. B, 62, 9831, 2007.

## ■ TE-30

Tuesday 14:30-15:50

GSI - S 26

### Energy, Oil and Gas 2

Stream: Engineering Optimization

*Invited session*

Chair: *Jose Herskovits*, COPPE, Federal University of Rio de Janeiro, Caixa Postal 68503, 21945970, Rio de Janeiro, RJ, Brazil, jose@optimize.ufrj.br

Chair: *Bastian Felix*, Lehrstuhl für Energiewirtschaft, Universität Essen, Universitätsstr. 12, 45117, Essen, Germany, bastian.felix@uni-duisburg-essen.de

#### 1 - Evaluation of joint balancing of electric energy, options for energy and transmission rights

Przemysław Kacprzak, Institute of Control & Computation Engineering, Warsaw University of Technology, Swiatowida 63/16, 03-144, Warsaw, Poland, P.Kacprzak@elka.pw.edu.pl, *Eugeniusz Toczyłowski*

In this paper we compare hybrid auction based on multicommodity turnover model with other market-based allocation methods: implicit and explicit auctions. The hybrid models is extension of models proposed for Open Market Coupling. This hybrid model combines positive feature of implicit auction: effectiveness and ease of use for standard commodities and explicit auction: possibility to create customized deals between offerers. In addition this model offers more effective balancing of options for energy than other models.

#### 2 - Optimization applications in natural gas industry

Steffen Rebennack, Industrial and Systems Engineering, University of Florida, 303 Weil Hall, P.O.

Box 116595, 32611, Gainesville, Florida, United States, steffen@ufl.edu, *Qipeng Phil Zheng, Niko Iliadis, Panos Pardalos*

With the surge of the global energy demand, natural gas plays an increasingly important role in global energy market. To meet the demand, optimization techniques have been widely used in the natural gas industry, and yielded a lot of good results. In this chapter, we give a detailed discussion of optimization applications in natural gas industry in three aspects: production, transportation, and market.

## ■ TE-31

Tuesday 14:30-15:50

GSI - S 34

### Data Mining for Life Sciences

Stream: Optimization and Data Mining

*Invited session*

Chair: *Carlotta Orsenigo*, p.zza leonardo da vinci 32, 20133, milan, italy, carlotta.orsenigo@polimi.it

#### 1 - Optimal selection of protein structure models

Fabio Stella, Department of Information, Systems and Communication, Università degli Studi di Milano Bicocca, Viale sarca 336, U14 Building, 20126, Milan, Italy, stella@disco.unimib.it, *Enrico Fagioli, Elena Gatti, Gianluca Negri, Giacomo Tuana, Giacomo Tuana*

Protein structure prediction, which aims to predict the 3D structure of proteins, starting from their amino acid sequences, is one of the most complex tasks in bioinformatics. Protein structure prediction is very relevant in medicine (drug design) and biotechnology (design of novel enzymes). This contribution describes a methodology to efficiently explore the class of data mining models known as feedforward networks. The proposed methodology, based on experimental design, allows to select the optimal architecture of feedforward networks to forecast the quality of protein structure models.

#### 2 - New challenges for feature selection in the life sciences

Karsten Borgwardt, Interdepartmental Bioinformatics Group, MPIs Tübingen, Spemannstr. 38, 72076, Tübingen, Germany, karsten.borgwardt@tuebingen.mpg.de

The life sciences create new challenges for feature selection in data mining: First, there is a need for feature selection on structured data such as strings and graphs. Second, a deeper theoretical understanding of the connections between existing feature selection approaches would be beneficial, to explain the discrepancies in their results on the same datasets. Third, the large number of features poses a computational and algorithmic challenge and requires the development of new, efficient selection techniques. In this talk, we will present our work on these three topics.

#### 3 - Kernel methods for imbalanced data

Theodore Trafalis, Industrial Engineering, University of Oklahoma, 202 West Boyd, Rm 124, 73019, Norman, OK, United States, ttrafal@ou.edu

We address the problem of learning from imbalanced data sets. Specifically we assume that the number of instances in one class is much larger than the number of instances in the other class. Common approaches for dealing with the class imbalance problem is modifying the data distribution or using a biased classifier. Here we investigate the use of kernel methods for imbalanced data and propose a kernel logistic regression method with an intelligent sampling scheme. Computational results for several data sets from the life sciences are presented.

#### 4 - Cancer microarray data classification by discrete svm with nonlinear kernels

Carlo Vercellis, Ingegneria Gestionale, Politecnico di Milano, P.za Leonardo da Vinci 32, 20133, Milano, Italy, carlo.vercellis@polimi.it, Carlotta Orsenigo

In this paper we consider discrete support vector machines (SVM) based on nonlinear kernels for microarray data classification. The approach consists of a two stage procedure; in the first phase, a small subset of highly discriminant genes is selected by solving a mixed-integer optimization problem. In the second phase, discrete SVM with nonlinear kernels are used in order to label gene expression data. Computational experiments indicate the effectiveness of the proposed method which achieves a high classification accuracy on benchmark microarray datasets for cancer diagnosis.

#### TE-32

Tuesday 14:30-15:50

GSI - S 4

#### DMKD frameworks and systems

Stream: Data Mining and Knowledge Discovery

Invited session

Chair: Ioannis Kopanakis, Technological Educational Institute of Crete, 72200, Ierapetra, Greece, i.kopanakis@emark.teicrete.gr

#### 1 - Learning of adaptation strategies in particle swarm optimization

Tjorben Bogon, Institute of Computer Science, Goethe University Frankfurt, P.O. Box 111932, 60054, Frankfurt, Germany, tbogon@informatik.uni-frankfurt.de, Andreas Lattner, Yann Lorion, Ingo J. Timm

We present an approach to learning adaptation strategies for Particle Swarm Optimization (PSO). The optimization process very much depends on the parameters how to compute the new velocity of the particles. Different settings can lead to a high variety in the duration and quality of the optimization process depending on the fitness function. We apply machine learning techniques to learn successful adaptation strategies by taking into account properties of different situations (e.g., swarm density and average velocity). For evaluation we apply the approach to typical benchmark functions.

#### 2 - Rules-based data warehouse quality framework for data mining

Bradji Louardi, MI, UNIVERSITY OF TEBESSA, Algeria, bradjilouardi@yahoo.fr, Boufaïda Mahmoud

This work uses the data cleaning mechanisms during the DW to improve the quality of OLTP system. The main contributions are : 1-Rule warehousing: a software infrastructure which collect, Transform and clean rules by using the first order logic properties in the rule staging area, loading it in a repository. 2-Rules based data cleaning for DW inspired from DM in order to speed the DM process and improvement of DM results. 3-Cleaned feedback: before loading data in DW, the cleaned data will be propagating to the OLTP system in order to ensure the coherency between DW and OLTP system.

#### 3 - Knowledge acquisition for multi-attribute classification problem solving on the basis of the verbal decision analysis

Eugenia Furems, Decision Making, Institute for System Analysis, 9, Prospect of 60 let Octyabrya, 117312, Moscow, furems-em@mtu-net.ru

Strengths and weaknesses of some VDA-based knowledge acquisition techniques for ordinal and/or nominal multi-attribute classification problems are analyzed. A combined approach to knowledge acquisition is proposed using inheritance of the attributes' values in classes, admissibility of the attributes' values and simulating the dialogue with an expert close to his/her professional activity. Such approach allows both to obtain the complete (up to the expert knowledge) and consistent set of his/her classification rules and to avoid the exhaustive search of the objects to be classified.

#### TE-33

Tuesday 14:30-15:50

GSI - S 7

#### Linear Programming

Stream: Linear Optimization

Contributed session

Chair: Apostolos Panagiotopoulos, Business School, Nottingham University, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, lixap14@nottingham.ac.uk

#### 1 - Least norm solution to large-scale linear programming problems

Parvin Khosravi, Mathematics, Shahed University, Department of Mathematics, Shahed University, Tehran, Iran, 1417953836, Tehran, Iran, Islamic Republic Of, parvin\_khosraviii@yahoo.com, Hamid Reza Navidi, Alaeddin Malek

The aim of this paper is to find an exact least 2-norm solution to a primal problem and generate an exact solution to the dual problem. The algorithm can solve linear problems with 1000,000 of variables and 100 of constraints. We use generalized Newton method and strong Wolf conditions. The algorithm converges to the optimal solution independent of the starting point. There are some problems that without using strong Wolf conditions can not be solved. We give encouraging comparative test results with MATLAB on a class of generated large-scale linear problem.

#### 2 - Systematic construction of examples for cycling in the simplex method

Peter Zörnig, Statistics, University of Brasilia, Asa Norte, 70910-900, Brasilia, DF, peter@unb.br

In Linear Programming the problem of cycling of Dantzig's simplex method has been captivating the spirits of mathematicians. Almost all "simplex type" algorithms involve the possibility of cycling (or stalling). However, until recently only a "handful" of cycling examples could be found in the literature. We develop systematic procedures to construct such examples for diverse variants of pivot selection strategies. Constructed cycling examples may serve as test problems to evaluate the practical performance of anticycling procedures or new variants of simplex type methods.

#### 3 - Optimising autoregressive based forecasts through linear programming

Apostolos Panagiotopoulos, Business School, Nottingham University, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, lixap14@nottingham.ac.uk, Luc Muyldermans

We explore the use of Linear Programming (LP) as an alternative tool to develop and optimise autoregressive based forecasting models. We estimate the coefficients of several models by minimising the Mean Absolute Deviation or the Mean Absolute Percentage Error. The models are tested on 60 randomly selected time series from the M3 Competition. We compare the forecast accuracy of the LP-based approaches, the Ordinary Least Squares method (minimising the Mean Squared Error) and six other traditional forecasting techniques.

## ■ TE-34

Tuesday 14:30-15:50

GSI - S 8

### BI applications

Stream: Applications in Business Intelligence and Knowledge Discovery

*Invited session*

Chair: *Matthias Steinbrecher*, Department of Knowledge and Language Engineering, Otto-von-Guericke University Magdeburg, Universitätsplatz 2, 39106, Magdeburg, Germany, msteinbr@ovgu.de

#### 1 - An empirical comparison of recent fuzzy rule generators based on kernel machines

*Christian Moewes*, School of Computer Science, Otto-von-Guericke University of Magdeburg, Universitätsplatz 2, 39114, Magdeburg, Saxony-Anhalt, Germany, cmowes@ovgu.de

Different approaches exist to learn fuzzy rules from observed data. Several researchers proposed to induce fuzzy rules from support vector machines. Unfortunately, these approaches have not been evaluated enough.

So, we categorize those that are known to us. Then, we empirically evaluate them on several benchmark data sets. Moreover, we sketch some real-world problems that demand interpretable models. We define requirements that such a machine must fulfill to solve these problems efficiently. Finally we summarize our work and give possible directions for future research.

#### 2 - Intelligent data analysis for business performance management

*Martin Spott*, BT Innovate, British Telecom, Adastral Park, Orion MLBG 10, IP5 3RE, Ipswich, martin.spott@bt.com, *Detlef Nauck*, *Detlef Nauck*

Business Performance Management (BPM) is about knowing how an organisation is performing at all times and in any part of the business. This paper describes how data mining approaches can promote current BPM systems from reporting tools to analytical tools for decision support. Data Mining techniques can be used to automatically detect interesting patterns, to learn relationships between business control parameters, external influences and performance indicators. Control parameters can be optimised to achieve business goals and what-if analysis performed for business analysis.

#### 3 - Malicious activities classification using adversarial data mining and games of incomplete information

*Gastón L'Huillier*, Camino de las ermitas 3833, 7690841, Santiago, Región Metropolitana, Chile, glhuilli@dcc.uchile.cl

In adversarial systems, the performance of a classifier decreases after it is deployed, as the adversary learns to defeat it. Recently, adversarial data mining was introduced as a solution to this, where the classification problem is viewed as an adversary versus classifier game. In this domain, using games of incomplete information, a game theoretic data mining framework is proposed in order to build an adversary aware classifier. Experiments in a phishing fraud detection domain show that the proposed framework outperforms incremental classification algorithms in this adversarial environment.

#### 4 - An application of econometric and fuzzy clustering methods to the it coalescence between selected industries

*Georg Peters*, Department of Computer Science and Mathematics, University of Applied Sciences - München, Lothstrasse 34, 80335, Munich, georg.peters@cs.hm.edu, *Simon Poon*

The impacts of the evolving IT on organizations and industries have been researched intensively. With the increasing availability of panel data it is now possible to study its longer term effects and its role in industry coalescence and the reshaping of industry boundaries. This study develops a concept of industry coalescence by examining the effects of IT on industry profiles and the shifting industry boundaries over more than two decades. In our research we utilize both the fixed effects model and fuzzy clustering and show the suitability of these methods for our economic analysis.

## ■ TE-35

Tuesday 14:30-15:50

GSI - S 9

### Risk Measures and Risk Management

Stream: Value and Risk in Incomplete Markets

*Invited session*

Chair: *Martin Rainer*, ENAMEC, Glockengasse 15, D-97070 Würzburg, 97070, Würzburg, Germany, martin.rainer@enamec.de

Chair: *Susanne Lind-Braucher*, Institute for Finance, University, Universitätsstraße 15/G2, 8010, Graz, Austria, susanne.lind-braucher@uni-graz.at

#### 1 - Efficient asset allocation for global portfolio management

*Susanne Lind-Braucher*, Institute for Finance, University, Universitätsstraße 15/G2, 8010, Graz, Austria, susanne.lind-braucher@uni-graz.at, *Edwin O. Fischer*

This paper empirically investigates the diversification effects to a traditional portfolio of stocks and bonds by introducing alternative investments (hedge funds, managed futures, real estate, private equities and commodities). This paper is the first attempt to incorporate a variety of risk measures (Volatility, VaR, CVaR, mVaR and mCVaR) as a goal function for the portfolio optimization and different estimates for the expected return (historical estimates, CAPM estimates, robust Bayes/Stein estimates and the Black/Litterman Model).

#### 2 - Portfolio selection under a set of risk measures: the case of var and cva

*Eva Alfaro-Cid*, Instituto Tecnológico de Informática, Camino de Vera, S/N, 46022, Valencia, evalfaro@iti.upv.es, *J. Samuel Baixauli*, *Matilde O. Fernández-Blanco*

This paper is concerned with asset allocation under real constraints, using a set of two widely used risk measures, which are the Value at Risk and the Conditional Value at Risk. Our main contributions are that we consider two risk measures which lead to non-convex problem and we introduce real constraints. The approach we propose is based on multi-objective genetic algorithms. Our results show the adequacy of the multi-objective approach for the portfolio optimization problem and emphasize the importance of dealing with real constraints during the optimization process.

### 3 - Risk measures respecting comparative risk aversion

*Klaas Schulze*, Department of Economics, University of Bonn, Thielstr. 2, 53113, Bonn, Germany, [klaas.schulze@uni-bonn.de](mailto:klaas.schulze@uni-bonn.de)

Decisions involving uncertainty depend on two distinct aspects: the risk of the position and the attitude towards risk of the investor. The literature captures the first aspect by risk measures and the second by risk aversion. We connect both concepts by introducing the class of risk measures which respect comparative risk aversion. The connection is achieved by an axiom, which asserts that less risk averse agents accept riskier gambles. We characterize this class by a simple equivalent condition. This equivalence provides a representation theorem and a construction method for this class.

## ■ TE-36

Tuesday 14:30-15:50

GSI - S 11

### Stochastic modelling 1

Stream: Stochastic Modelling

*Contributed session*

Chair: *Thomas Lee*, Information and Decision Sciences (M/C 294), University of Illinois, 601 S. Morgan Street, 60607-7124, Chicago, ILLINOIS, United States, [yslee@uic.edu](mailto:yslee@uic.edu)

### 1 - Dynamic reliability under preventive maintenance: application to mv/lv power transformers.

*Medjoudj Rabah*, Electrical engineering, University of Bejaia, University of Bejaia, 06000, Bejaia, Algeria, [medjoudj@yahoo.fr](mailto:medjoudj@yahoo.fr), *Djamil Aïssani*

The purpose of this paper is to investigate the expected performances of MV/LV power transformers of an electrical distribution system. Depending, on threshold reliability and maximum benefit, maintenance actions are developed and applied for performances improvement. Performances are described in terms of failure rates, outage times and availability. The modelling is based on the Weibull-Markov approach. In practical operation, the results analysis allows to the decision maker to reach better information for practicing suitable maintenance actions.

### 2 - Recursive estimation of the parameters of a parch model

*Abida Kerdali*, INPS, Institut National de la Planification et de la Statistique,, 11 rue Doudou Mokhtar,, Ben Aknoun, 16000, Algiers, [akerdali@yahoo.fr](mailto:akerdali@yahoo.fr)

We consider on-line estimation methods for PARCH models where data are gradually available in time. These methods help to compute recursively an estimator of the parameters of the model. First, we present a new off-line and not recursive method that requires the inversion of a big size matrix. In the second step, we improve this method for the on-line estimation that does not require the inversion of the cited matrix; however, some precautions should be taken because recursive methods are very sensitive to the initial values. All methods are presented with numerical experimentations

### 3 - Maximum number of blocked terminals and number of collisions in p-persistent csma/cd protocols

*Antonio Gomez-Corral*, Department of Statistics and OR, Complutense University of Madrid, Faculty of Mathematics, Plaza de Ciencias, 3, 28040, Madrid, [antonio\\_gomez@mat.ucm.es](mailto:antonio_gomez@mat.ucm.es)

We present the number of collisions as a performance descriptor of practical relevance in CSMA/CD (carrier sense multiple access with collision detection) protocols. We introduce a suitable Markovian framework defined from a discrete-time batch Markovian arrival process and phase-type distributional assumptions for packet transmission and collision resolution times. The embedded Markov chain at slot boundaries can be seen as a level-dependent Markov chain of M/G/1-type. Based on the time to reach the maximum number of blocked terminals, we derive the distribution of the number of collisions.

## ■ TE-37

Tuesday 14:30-15:50

GSI - S 12

### Multi-Criteria Decision Aids - 3

Stream: Decision Analysis

*Contributed session*

Chair: *Boris Yatsalo*, Information Systems, Obninsk State University (IATE), IATE, Studgorodok 1, 249040, Obninsk, Russian Federation, [yatsalo@obninsk.ru](mailto:yatsalo@obninsk.ru)

### 1 - A multiple criteria sorting methodology with multiple classification criteria and an application to country risk evaluation

*Aydin Ulucan*, Dept. of Business Administration, Hacettepe University, Beytepe Campus, 06532, Ankara, [aulucan@hacettepe.edu.tr](mailto:aulucan@hacettepe.edu.tr), *Kazim Baris Atici*

UTADIS (Utilities Additives Discriminates) methodology requires a predefined classification for a set of alternatives obtained through a classification criterion. However, some real world decisions may require consideration of more than one classification criteria. We propose an extension of UTADIS such that it can handle more than one classification criteria simultaneously which possibly involves different predefined classes for alternatives in an application to country risk evaluation. Moreover, we test the classification ability of UTADIS using the out-of-classification criterion approach.

### 2 - The use of design research in the validation qualitative in operational research

*William Vianna*, Production Engineering, Federal University of Santa Catarina, Rua Cônego Bernardo, 100, Ap. 202, 88036570, Florianopolis, Santa Catarina, Brazil, [wpwilliam@hotmail.com](mailto:wpwilliam@hotmail.com), *Leonardo Ensslin*, *Edilson Giffhorn*

The objective is to propose the use of Design Research to encourage the process of scientific validation of qual-quantitative models in Operations Research. The result is the identification of the need for evidencing and discussion around the Design Research on internal and external criteria for validation, alignment between the methodologies and techniques qualitative and quantitative, surveillance on the compliance issue and usability of the models. Finally, it is concluded on the importance of training as a researcher's primary strategic and the process of production of knowledge.

### 3 - Decision support for detection of unauthorized genetically modified organisms in food and feed products

*Marko Bohanec*, Department of Knowledge Technologies, Jozef Stefan Institute, Jamova 39,

SI-1000, Ljubljana, marko.bohanec@ijs.si, *Esther Kok, Martin Znidarsic, Smelt Anita*

We present a decision-support approach to the problem of potential presence of unauthorized genetically modified organisms (GMOs) in food/feed products. The issue is to assess the likelihood of admixture with unauthorized GMO varieties using the product's traceability data: origin, transportation, logistics. We approached the problem by developing two decision models, a decision tree and a hierarchical multi-criteria model, implemented as a web application and within the system DEXi. We compare them with respect to their properties, implementation and suitability for the problem.

#### 4 - Decerns sdss: multi-criteria decision support system for analysis of spatial alternatives

*Boris Yatsalo*, Information Systems, Obninsk State University (IATE), IATE, Studgorodok 1, 249040, Obninsk, Russian Federation, yatsalo@obninsk.ru, *Sergey Gritsyuk*

DECERNS is a web-based Spatial Decision Support System (Web-SDSS) for multicriteria analysis of a wide range of (spatial and non-spatial) alternatives. DECERNS integrates several MADM methods (MAVT, AHP, TOPSIS, PROMETHEE, MAUT, ProMAA/SMMA and some their fuzzy modifications) and all basic and some advanced GIS functions. DECERNS can also be integrated with a model server containing site specific models for analysis of risks and other decision criteria. Applications of the DECERNS for analysis of some case studies on multicriteria landuse management have been implemented.

## TE-38

Tuesday 14:30-15:50

GSI - S 13

### Nonlinear Optimization

Stream: Variational Problems - Theory, Methods and Applications

*Invited session*

Chair: *Kaiwen Meng*, Department of Applied Mathematics, PolyU, Kowloon, Hong Kong, Hong Kong, China, mkwfly@126.com

#### 1 - On characterizations of local error bounds by derivative-like conditions

*Kaiwen Meng*, Department of Applied Mathematics, PolyU, Kowloon, Hong Kong, Hong Kong, China, mkwfly@126.com

In Theorem 2.5 of [Marcin Studniarski and Doug E. Ward, SIAM J. Control Optim. 38 (1999), no. 1, 219–236], a sufficient condition was derived in terms of a contingent-type directional derivative for weak sharp minima or equivalently local error boundness. The purpose of this talk is to extend Studniarski and Ward's condition in a unified and natural way, and to look into some conditions related to variational geometry of the given set, under which the proposed sufficient conditions are also necessary for local error boundness. Moreover, some interesting examples are demonstrated.

#### 2 - On the equivalence of global quadratic growth condition and second-order sufficient condition

*Zhangyou Chen*, Department of Applied Mathematics, The Hong Kong Polytechnic University, Hungghom, Kowloon, Hong Kong, Hong Kong, China, 07901401r@polyu.edu.hk

In this talk, we will concentrate on the relations between the global quadratic growth condition and the global second-order sufficient condition for mathematical programming problems. In case of minimizing of the maximum of finite quadratic functions, we have obtained that the global second-order sufficient condition implies the global quadratic growth condition. Then we apply this result to the quadratic constrained quadratic programs. However, the converse is not true except for the unconstrained problems.

#### 3 - Penalty versus filter methods

*Aldina Correia*, Mathematics, Escola Superior de Tecnologia e Gestão de Felgueiras - Instituto Politécnico do Porto and Centro de Matemática da UTAD (CM-UTAD), Rua do Curral, Casa do Curral, Margaride, 4610-156, Felgueiras, Portugal, aldinaisabel@gmail.com, *João Matias, Pedro Mestre, Carlos Serôdio*

Black box problems occur frequently in science and engineering. In those cases it becomes essential to use optimization methods where the calculation of the derivatives, or the verification of their existence, is not necessary the Direct Search Methods. But, when the problem has constraints, they are not enough, because they only solve Unconstrained Nonlinear Problems. This kind of problems is usually solved using Penalty or Filter Methods. In this work we compare the behavior of some of the existing Penalty and Filter Methods.

#### 4 - Weak sharp minima for set-valued vector variational inequalities with an application

*Xiaoqi Yang*, Department of Applied Mathematics, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, mayangxq@polyu.edu.hk

Gap functions for vector variational inequalities are studied. Relations between set-valued strong/weak vector variational inequality problems is established. Moreover, it is shown that weak sharp minima properties for the solution sets of set-valued strong/weak vector variational inequality problems hold in terms of gap functions. As an application, the weak efficient solution set of vector optimization problems is proved to be weak sharp minimum. This is a joint work with J. Li and N.J. Huang and was supported by RGC (PolyU 5317/07E).

## TE-39

Tuesday 14:30-15:50

GSI - S 14

### Financial instability

Stream: Operational Research and Quantitative Models in Banking

*Invited session*

Chair: *Giorgio Consigli*, Mathematics, Statistics and Computer Sciences, University of Bergamo, Via dei Caniana 2, 24127, Bergamo, Italy, giorgio.consigli@unibg.it

#### 1 - Endogenous risk factors for discontinuous financial markets

*Giorgio Consigli*, Mathematics, Statistics and Computer Sciences, University of Bergamo, Via dei Caniana 2, 24127, Bergamo, Italy, giorgio.consigli@unibg.it

The distribution of securities prices in financial markets is known to exhibit heavy tails, and furthermore the time trajectory has occasional extreme swings or reversals in direction. The modelling of heavy tails has been achieved with the addition of a homogeneous point process to a diffusive process. In this paper a non-homogeneous point process is introduced, so that the intensity and size of jumps are state dependent. The study is conducted over the 1990-2007 period in the US market.

## 2 - Scenario models for dynamic optimization during crises periods

*Gaetano Iaquinta*, University of Bergamo, 24127, Bergamo, Italy, gaetano.iaquinta@unibg.it, *Giorgio Consigli*

A scenario generation procedure to be interfaced with a dynamic stochastic program developed for a credit risk problem is presented and applied to the recent credit crisis. The statistical models considered in the approximation procedure are a Garch(1,1) process and a jump-to-default model for credit risk factors. Evidence of the ability to approximate a fat-tailed market probability distribution is presented.

## 3 - The role of options in hedging portfolios in regimes of high volatility

*Francesco Sandrini*, Institutional investments, Pioneer Investments, 16 Appianstrasse, Unterforhing, bei Munchen, 81675, Munchen, Germany, francesco.sandrini@pioneerinvestments.com

We investigate the role of derivatives in hedging total return portfolios in times of high volatility. The sensitivity of the hedging solution with respect to volatility regime changes is investigated by comparing hedging results under constant volatility assumptions with Heteroschedastic models such as Garch DCC employing stochastic programming techniques to achieve a realistic pay-off under stressed market conditions.

## ■ TE-40

Tuesday 14:30-15:50

GSI - S 27

### Simulation decision support in enterprises

Stream: Simulation Based Decision Support

*Invited session*

Chair: *Davorin Kofjač*, Laboratory of Cybernetics and DSS, University of Maribor, Faculty of Organizational Sciences, Kidričeva cesta 55a, 4000, Kranj, Slovenia, davorin.kofjac@fov.uni-mb.si

Chair: *Miroљub Kljajic*, Faculty for organizational sciences, University of Maribor, Kidriceva cesta 55, 4000, Kranj, Slovenia, miroљub.kljajic@fov.uni-mb.si

## 1 - Simulation based inventory control for products with stochastic lead time and demand

*Miroљub Kljajic*, Faculty for organizational sciences, University of Maribor, Kidriceva cesta 55, 4000, Kranj, Slovenia, miroљub.kljajic@fov.uni-mb.si, *Davorin Kofjač*, *Tadej Vidic*, *Valter Rejec*

This article describes inventory optimization for products with stochastic lead time and demand. For simulation purpose mathematical tool Matlab and C# were compared. The basic system dynamics model for inventory control was built and validated according to system dynamics methodology. Several optimization algorithms were analyzed in order to reduce total inventory control costs. Two restrictions were considered: no stockouts should occur and the inventory capacity should not be exceeded. Web based solution has been introduced for predictive validation of algorithms in the real environment.

## 2 - Job shop scheduling production with makespan criterion - a real case simulation study

*Davorin Kofjač*, Laboratory of Cybernetics and DSS, University of Maribor, Faculty of Organizational Sciences, Kidričeva cesta 55a, 4000, Kranj, Slovenia, davorin.kofjac@fov.uni-mb.si, *Miroљub Kljajic*, *Andrej Knaflc*

This paper presents a real case customized flexible furniture production optimization. Frequent review of the production process is needed to ensure near-optimal production schedule to meet the minimal makespan constraint. In such a case we are confronted with a tradeoff between makespan and optimization runtime to ensure efficient realtime scheduling. The genetic algorithm for job shop scheduling optimization is presented. The visual model of the furniture production was developed. Such a model is closer to end-user perception and is used to clarify the results of numerical optimization.

## 3 - Applying system dynamics to design scenarios and the strategy of a region using quantitative and qualitative information

*Carlos Legna*, Institutional Economics, La Laguna University, Universidad de La Laguna, Facultad de Derecho., 38071, La Laguna, Canary Islands, Spain, clegna@ull.es

The design of strategies for social systems requires the use of qualitative information; in addition, the information that the specialists and the decision makers often obtain is incomplete and unsure. Nevertheless, the leaders have to make strategic decisions despite these deficiencies. The author has been working —with decision makers— in the design of tools to help them to improve their decisions in these conditions. An example is the methodology elaborated to design the strategy for the city of Santa Cruz, which is presented in this paper.

## ■ TE-41

Tuesday 14:30-15:50

GSI - S 28

### Project Scheduling

Stream: Scheduling

*Contributed session*

Chair: *S.Hossein Hashemi Doulabi*, Industrial Engineering, Amirkabir University of technology, Shariati st, North west, side of sadr, no 1, 19148, Tehran, Tehran, Iran, Islamic Republic Of, hosein.hashemi@yahoo.com

## 1 - A new lower bound for the resource-constrained project scheduling problem (rcpsp)

*Luis Moreno*, Systems, Universidad Nacional de Colombia, Facultad de Minas cra. 80 65-223, Bloque M8 oficina 207, 1, Medellin, Antioquia, Colombia, lfmorono@unalmed.edu.co, *Javier Diaz*

This paper considers a new lower bound for the RCPSP with resource constraints and objective the minimization of the makespan. The bound is an extension of Stinson's lower bound, where instead of using a non critical activity together with the critical path, a second full path consisting of noncritical activities is executed simultaneously with the critical path. By using some powerful dominance rules a very efficient algorithm is developed where the number of schedules reviewed from the huge potential combinatorial set is minimized getting a lower bound much better than that of Stinson.

## 2 - Evaluation and comparison of the relative performance of projects using Weibull analysis on earned value metrics

*Ching Chih Tseng*, Business Administration, Dayeh University, 168 University Rd., Dacun, Taiwan, R.O.C., 51591, Changhua, Taiwan, cctseng@mail.dyu.edu.tw

Many literatures have proposed assessment the performance of a project; however few of them consider the issue of comparison of relative performance of projects. A major concern for a multi-project organization is how to assess and compare them. Therefore, this paper introduces a statistical analysis for evaluating and comparing the reliability of relative overall performance of projects using Weibull analysis on earned value metrics. Finally, the various steps in the analysis are discussed along with an example in which three projects are analyzed and compared.

## 3 - A Lagrangean heuristic to the capacitated planned maintenance problem

*Torben Kuschel*, WINFOR - Wirtschaftsinformatik und Operations Research, Bergische Universität Wuppertal, Schumpeter School of Business and Economics, Gaußstraße 20, 42119, Wuppertal, Germany, tkuschel@winfor.de, *Stefan Bock*

The Capacitated Planned Maintenance Problem seeks a maintenance plan guaranteeing the machine does not break down and the maintenance time is not exceeded. The Lagrangean relaxation of the capacity constraint is NP-hard and the complementary slackness is applied to the dual of the Lagrangean LP-relaxation to construct an upper bound. It yields valid subgradients to the Lagrangean dual and the lower bound is used for the step size estimation. This differs from many approaches in literature. A feasible solution to the CPMP is obtained. Valuable insights to the problem structure are provided.

## 4 - Resource leveling with activity splitting

*S.Hossein Hashemi Doulabi*, Industrial Engineering, Amirkabir University of technology, Shariati st, North west, side of sadr, no 1, 19148, Tehran, Tehran, Iran, Islamic Republic Of, hosein.hashemi@yahoo.com, *Abbas Seifi*

The resource leveling problem is common and has been studied numerous times. A basic assumption in these studies is that activities cannot be split. However, in real projects very often we can find some non-continuous activities. In this paper, a novel genetic algorithm is proposed to tackle the resource leveling problem with activity splitting. To evaluate the algorithm, we establish an experimental benchmark including instances up to 250 activities. The algorithm's results are compared with lower bounds in the literature. All the analyses demonstrate that the proposed algorithm is effective.

## ■ TE-42

Tuesday 14:30-15:50

GSI - S 3

### Software for OR/MS II

Stream: Software for OR/MS

*Invited session*

Chair: *Bjarni Kristjansson*, Maximal Software, Ltd., Boundary House, Boston Road, W7 2QE, London, Iceland, bjarni@maximalsoftware.com

#### 1 - New coinmp release 1.4: a simple c-api windows dll and unix solver library (lp/mip) based on coin

*Bjarni Kristjansson*, Maximal Software, Ltd., Boundary House, Boston Road, W7 2QE, London, Iceland, bjarni@maximalsoftware.com, *Sandip Pindoria*

The COIN Open Source Initiative has become very popular in the recent years. To make life easier for users that simply want to solve models and not compile C++ applications, we have developed a standard C-API Windows DLL CoinMP.DLL that implements most of the functionality of CLP, CBC, and CGL. A Linux/Unix version using AutoMake is also available. We will also demonstrate how scenario-based and independent variables stochastic models can be formulated in MPL and solved with COIN, CPLEX, and GUROBI solvers.

#### 2 - Optimization modeling with AIMMS in academia and industry

*Frans de Rooij*, AIMMS, Paragon Decision Technology B.V., Schipholweg 1, 2034 LS, Haarlem, Netherlands, frans.de.rooij@aimms.com

AIMMS is an advanced modeling system for building optimization-based decision support applications.

AIMMS is used in academia for teaching and research in OR. We will demonstrate how students can quickly formulate optimization models and add a graphical user interface; and how researchers can benefit from AIMMS' advanced algorithmic capabilities.

AIMMS is used in industry to solve complex business problems. We will show with real-life cases how AIMMS models can be turned into fully-operational optimization applications, enabling business users to experience the power of OR.

#### 3 - Rapid application prototyping with GAMS

*Lutz Westermann*, GAMS Software GmbH, Eupener Str. 135-137, 50933, Koeln, Germany, lutz@gams.com

GAMS Development will demonstrate how an application can be built using GAMS. We'll use both fundamental modeling practices, our state of the art solvers, and the latest in data access and application integration tools to quickly produce a working application.

## ■ TE-43

Tuesday 14:30-15:50

GSI - S 10

### Development Dynamics

Stream: System Dynamics Modelling

*Invited session*

Chair: *Stefan Groesser*, Institute of Management, University of St. Gallen, Dufourstrasse 40a, 9000, St. Gallen, Switzerland, stefan.groesser@web.de

### 1 - Laws as models: demobilization and congestion in colombia's justice and peace process

Laura Pardo, Cra 1 # 110-12, 0000, Bogota,  
l.pardo139@uniandes.edu.co, *Camilo Olaya*

Colombian government began a negotiation process with the "paramilitaries"; a special Law was created to proceed with demobilization. A growing population of 31.000 men has entered this process but none of them have been sentenced; the system is stuck with unresolved cases. We built a SD model that shows the inertia of accumulation of these cases, the elusive character of Stock-and-Flow structures, and the impact of information delays. We highlight the significance of simulation for supporting Law making processes. We are testing the model for presenting our results to involved agencies.

### 2 - A system dynamics model to aid planning and allocation of health resources: a case of prevention and treatment of malaria in uganda

Stephen Tumutegyeize, Institute of Statistics and Applied Economics, Makerere University, P.O.Box 7062, Kampala, 256, Kampala, Uganda,  
tumutegyeizes@yahoo.com, *Theodor Stewart, Juwa Nyirenda, Leanne Scott*

In this paper we show that a System Dynamics model for malaria helps to allocate available budget for prevention, treatment, human resource and infrastructure development to alternatives leading to highest number of averted infections and deaths. The model suits developing countries characterized with hard decisions for choosing interventions, priorities, and allocating resources due to health sector under funding, shortage of health workers, high disease burden, and lack of reliable data to guide planning.

### 3 - Economic growth accounting: model-based policy analysis

John Ansah, system dynamics, university of bergen,  
fantoft studentboliger, 5075, bergen,  
pastorkobina@yahoo.com, *Stefan Groesser*

The GDP growth pater of Ghana from 1960 to 2000 shows a roller-coaster behavior. This phenomenon has been studied by several researchers. We want to offer a richer explanation. Our model accounts for human and physical capital and the productivity of labor as well as their dynamic interactions. We are (1) able to replicate the historical GDP growth, (2) use the model to estimate the contribution of factors of production and labor productivity to economic growth, (3) offer a consistent causal explanation about the growth pattern, and (4) conduct a counterfactual policy analysis.

### 4 - The chaotic behavior of prices in the modified kaldor model

Jan Kodera, Center for Basic Research in Dynamic Economics and Econometrics, University of Economics Prague, nam. Winstona Churchilla 4, 130 67, Praha 3, Czech Republic, kodera@vse.cz, *Quang Van Tran, Miloslav Vosvrda*

The model of price dynamics is analyzed. The approach presented in this contribution is based on the works of Goodwin, Kaldor and Kalecki which were developed by Flaschel, Semmler and Medio. The aims of this paper are to design an example, solve it and test if the variables dynamics is chaotic. While the flow variables in the model are intensities, in the real economics they are measured as interval quantities. Therefore, we try to find the answer to the question if the observed economic variables recorded in these regular intervals capture the actual dynamics produced by the model.

## TE-44

Tuesday 14:30-15:50

GSI - S 16

### Migration, Education and Sustainable Development 1

Stream: Migration, Education and Sustainable Development

*Invited session*

Chair: *Hanife Akar*, Department of Educational Sciences, Middle East Technical University, Orta Dogu Teknik Universitesi, Egitim Fakultesi EF 316, 06531, Ankara, Turkey, hanif@metu.edu.tr

#### 1 - An implementation of data envelopment analysis (dea) in Turkish medical schools

*Abdullah Korkut Üstün*, Industrial Engineering, Eskisehir Osmangazi University, Eskisehir Osmangazi Universitesi Endüstri Mühendisliği Bölümü, 26030, Eskisehir, Turkey, korkut.ustun@gmail.com, *Sermet Anagun*

In this study, we investigate the educational and hospital performances of medical schools in Turkey. Since both performance measures of schools affect students' selection in University Entrance Exam, inefficiencies in educational and hospital quality of these schools must be evaluated. A data envelopment analysis (DEA) technique is used to determine for performance measurement. Efficient and inefficient units are examined and possible improvements are discussed.

#### 2 - Adaptation of balanced scorecard for Brazilian educational organization third sector - simulation experiment

*William Vianna*, Production Engineering, Federal University of Santa Catarina, Rua Cônego Bernardo, 100, Ap. 202, 88036570, Florianopolis, Santa Catarina, Brazil, wwilliam@hotmail.com, *Leonardo Ensslin, Edilson Giffhorn*

This article is a simulation which purpose was the adapted construction of Kaplan and Norton's Balanced Scorecard (BSC, 1997) to the Third Sector. For that purpose the choice was for a case study at the Salesian Inspectorate São Pio X, of the Salesian Network for Social Action. In this specific case, the adaptation of Balanced Scorecard allowed to clarify the strategic objectives and to identify the critical processes. The benefits were identification of the learning's perspective as more adequate to initiate the process and promote a sequential effect involving the actors.

#### 3 - Equality of opportunity in education, and sustainable development of the urban and rural poor

*Hanife Akar*, Department of Educational Sciences, Middle East Technical University, Orta Dogu Teknik Universitesi, Egitim Fakultesi EF 316, 06531, Ankara, Turkey, hanif@metu.edu.tr

Equality of opportunity is an important principle in the Turkish Educational Policy it limits the educational needs of urban and rural poor. This paper is based on survey findings with 1504 students. It discusses how the poor children struggle with unequal education opportunities from multiple perspectives such as school quality; income disparities; achievement gaps, and basic physiological needs. Implications for equity and educational policy will be discussed.

## ■ TE-45

Tuesday 14:30-15:50

GSI - S 33

### Ethics and OR I

Stream: OR and Ethics

*Invited session*

Chair: *Mikael Laaksoharju*, Department of IT-HCI, Uppsala University, Box 337, 75105, Uppsala, Sweden, Mikael.Laaksoharju@it.uu.se

Chair: *Iordanis Kavathatzopoulos*, IT-HCI, Uppsala University, Box 337, 751 05, Uppsala, Sweden, iordanis@it.uu.se

#### 1 - Computer supported ethical decision making

*Iordanis Kavathatzopoulos*, IT-HCI, Uppsala University, Box 337, 751 05, Uppsala, Sweden, iordanis@it.uu.se, *Mikael Laaksoharju*

In this paper we will present in detail the structure and work process of EthXpert - a computer system for supporting ethical decision-making. Through examples, we will show how the tool can be used to reach a better-structured and more holistic overview of moral problems. Based on case studies with students, we will also discuss the level of experience in handling ethical problems that is required to make proper use of the system in real-life decision-making. Finally we will suggest how the resulting documentation of ethical implications can serve as justification for decision-making.

#### 2 - How OR can better contribute to ethics in sustainable development

*Jean-Pierre Brans*, MOSI (CSOO), V.U.B., Pleinlaan,2, 1050, Brussels, Belgium, jpbrans@vub.ac.be, *Pierre Kunsch*

Operations Research (OR) has an important potential for addressing crucial challenges of Sustainable Development (SD). But OR remains mainly involved with optimisation problems, often not compatible with Ethics. This paper provides some propositions on new OR instruments for addressing Mankind's sustainability problems complying with ethical principles. A technique mix is proposed of systems thinking, multi-criteria decision-making and dynamic control within the ASMC framework (Adaptive, Systemic, Multi-criteria, Control Procedure). SD applications of the framework are presented.

## Tuesday 16:05-17:25

### ■ TF-01

Tuesday 16:05-17:25

Beethoven

### Excellence in Practice Award II

Stream: Excellence in Practice Award

*Invited session*

Chair: *Geir Hasle*, Applied Mathematics, SINTEF ICT, P.O. Box 124 Blindern, NO-0314, Oslo, Norway, Geir.Hasle@sintef.no

#### 1 - Blood platelet optimization at blood banks

*Nico van Dijk*, Quantitative Economics, University of Amsterdam, Roetersstraat 11, 1018 WB, Amsterdam, Netherlands, N.M.vanDijk@uva.nl, *René Haijema*, *Wim De Kort*, *Nikky Kortbeek*, *Cees Th. Smit Sibinga*, *Jan Van Der Wal*

For blood platelets, which have a limited shelf life (e.g. 5 days), both shortages and outdating are to be minimized. Recent European studies (2005, 2006) report an average outdating of 15%. So far, an OR implementation seemed hampered by: i) The computational complexity ii) The structure of the optimal policy iii) Blood Medicine being unfamiliar with OR. To deal with i) and ii), a 5-step integration of Stochastic Dynamic Programming (SDP) and Simulation has been developed. Case-studies for two Dutch Blood Banks showed a reduction of shortages and outdating to less than 1%. Also the issuing age was reduced. As for iii), a user-friendly DSS-tool TIMO (Thrombocytes Inventory Management Optimizer) has been implemented.

#### 2 - Fair payments for efficient allocations in public sector combinatorial auctions

*S. Raghavan*, The Robert H. Smith School of Business, University of Maryland, 4345 Van Munching Hall, 20742-1815, College Park, MD, United States, raghavan@umd.edu, *Robert Day*

Motivated by the increasing use of auctions by government agencies, we consider the problem of fairly pricing public goods in a combinatorial auction. A well-known problem with the incentive-compatible Vickrey-Clarke-Groves (VCG) auction mechanism is that the resulting prices may not be in the core. Loosely speaking, this means the payments of the winners could be so low, that there are bidders who would have been willing to pay more than the payments of the winning bidders. Clearly, this "unfair" outcome is unacceptable for a public sector auction. Recent advances in auction theory suggest that combinatorial auctions resulting in efficient outcomes and bidder-Pareto-optimal core payments offer a viable practical alternative to address this problem. This paper confronts two critical issues facing the bidder-Pareto-optimal core payment. First, motivated to minimize a bidder's ability to benefit through strategic manipulation (through collusive agreement or unilateral action), we demonstrate the strength of a mechanism that minimizes total payments among all such auction outcomes, narrowing the previously broad solution concept. Second, we address the computational difficulties of achieving these outcomes with a constraint-generation approach, promising to broaden the range of applications for which bidder-Pareto-optimal core pricing achieves a comfortably rapid solution.

#### 3 - Optimal real-time traffic control in metro stations

*Carlo Mannino*, Informatica e Sistemistica, Università La Sapienza, Via Buonarroti 12, 00185, Rome, Italy, mannino@dis.uniroma1.it, *Alessandro Mascis*

Train movements across railway stations are in general still operated by human dispatchers. In order to increase traffic performances and save on operating costs, Azienda Trasporti Milanese, the largest Italian Municipal transport company, decided to implement a fully automated traffic control system. The task was assigned to Bombardier Transportation, a major multinational company who established a cooperation with the university of Rome. The task posed severe modelling and algorithmic difficulties, and indeed former attempts substantially failed. The model needed to be very accurate to represent real-time decisions; the algorithm had to find good, possibly optimal solutions in less than 1 second. Optimality was nearly a strict requirement as, by contractual clause, the system had to perform better than dispatchers, and heuristic approaches tend sometimes to neglect solutions that are easily achievable by human operators.

We model the problem as a sequence of routing and job-shop scheduling sub-problems and solve it by branch-and-bound. To tackle the job-shop scheduling problem we exploited the properties of a generalized disjunctive graph and developed a fast and tight lower bound procedure by solving a circulation problem on a suitable, small network.

The system was put into operation in June 2007 and to our opinion it must be regarded as a remarkable success of OR application to real-life problems.

## ■ TF-02

Tuesday 16:05-17:25

Schumann

### Collaborative Transportation Planning I

Stream: Transportation Planning

Invited session

Chair: *Giselher Pankratz*, Dept. of Information Systems, FernUniversität - University of Hagen, Profilstrasse 8, 58084, Hagen, Germany, giselher.pankratz@fernuni-hagen.de

#### 1 - Transport operations planning within a cooperation of complementary producers

*Andrea Nagel*, Dept. of Information Systems, FernUniversität - University of Hagen, 58084, Hagen, Germany, andrea.nagel@fernuni-hagen.de, *Giselher Pankratz*, *Hermann Gehring*

In this contribution, we examine a cooperation of four producers in the food and beverages industry. The companies decided to coordinate their distribution activities by inter-organisational transportation planning. The setting is characterized by a dynamic inflow of orders, capacity bounds, a heterogeneous vehicle fleet and back-hauls. We present a meta-heuristic approach for the simultaneous planning of own-name transport and subcontracting that deals with this specific situation by combining a Large Neighbourhood Search with a Threshold Accepting Procedure. Test results will be presented.

#### 2 - Market-based request re-allocation in collaborative transportation networks

*Melanie Bloos*, Chair of Logistics, Bremen University - Department of Business and Economics, Wilhelm Herbst Str.5, 28359, Bremen, Germany, bloos@uni-bremen.de, *Herbert Kopfer*

Operational transport collaborations are formed by independent hauliers in order to increase the vehicle utilization of each participant. Transport orders are interchanged among the participants in order to enable each participant to compile profitable routes from compatible requests. We discuss a model for the operational transport order re-allocation in a collaboration using market mechanisms. In this market, bundles of available orders are created from individually acquired orders and the bundles are traded. No central institution for hosting the order interchange mechanism is required.

#### 3 - Ant colony algorithms to solve multi depot vehicle routing problems with interim storages

*Ralf Sprenger*, Chair of Enterprise-wide Software Systems, University of Hagen, 58097, Hagen, Germany, Ralf.Sprenger@fernuni-hagen.de, *Lars Moench*

We discuss multi depot vehicle routing problems with interim storages that appear in cooperative transportation planning scenarios where different companies share their distribution network. Each company has one or more distribution centers that work for the other companies as interim storages. We present a method that applies ant colony optimization (ACO) to solve this type of problem. We demonstrate the benefit of using ACO in a rolling horizon setting. Discrete-event simulation is used to assess the performance of the suggested scheme. We present results of computational experiments.

## ■ TF-03

Tuesday 16:05-17:25

Reger

### Network design 1

Stream: Network Optimization

Invited session

Chair: *Bernard Fortz*, Département d'Informatique, Université Libre de Bruxelles, CP 210/01, Bld du Triomphe, 1050, Bruxelles, Belgium, bfortz@euro-online.org

#### 1 - Properties of a layered extended graph formulation for designing k-edge(arc) disjoint l-paths

*Quentin Botton*, Louvain School of Management - CORE, Université catholique de Louvain, place des doyens, 1, 1348, Louvain-la-Neuve, Belgium, quentin.botton@uclouvain.be, *Bernard Fortz*, *Luis Gouveia*

In this paper, we propose an extended formulation for the K-Arc(Edge)-Disjoint Hop-Constrained Network Design Problem in the single commodity case. We formulate some interesting properties and we prove that our formulation provides a complete description of the polyhedron when  $L \leq 3$  and for any value of  $K$  for the Arc-Disjoint case. We propose some new valid inequalities for the Edge-Disjoint case and we illustrate the quality of the lower bound when  $L > 3$  through some numerical results.

#### 2 - Networks with unicyclic connected components

*Walid Ben-ameur*, Institut Telecom, 9 rue Charles Fourier, 91011, Evry, France, walid.benameur@it-sudparis.eu, *Adam Ouorou*, *Makhlouf Hadji*

This paper focuses on the design of networks with unicyclic connected components. The size of each cycle should not be less than a given number. A polyhedral study is proposed. Many facets and valid inequalities are derived. Some of them can be exactly separated in polynomial time. Then the network design problem is solved by a cutting plane algorithm based on these inequalities and using a compact formulation issued from the transversality of the bicircular matroid.

#### 3 - The cost constrained minimum label spanning tree and label constrained minimum spanning tree problems

*Zahra Naji Azimi*, Viale Risorgimento 2, 40136, Bologna, Italy, zahra.najiazimi2@unibo.it, *Majid Salari*, *Bruce Golden*, *S. Raghavan*, *Paolo Toth*

Given an undirected graph whose edges are labeled or colored and have weights, and a budget  $B$ , the goal of the Cost Constrained Minimum Label Spanning Tree Problem (CCMLST) is to find a spanning tree that uses the minimum number of labels while ensuring its cost does not exceed  $B$ . In the Label Constrained Minimum Spanning Tree Problem (LCMST), we are given a threshold  $K$  on the number of labels. The goal is to find a minimum weight spanning tree that uses at most  $K$  distinct labels. In this paper, we present a Variable Neighborhood Search algorithm for the CCMLST and LCMST problems.

## ■ TF-04

Tuesday 16:05-17:25

Liszt

### Scheduling and Lotsizing

Stream: Scheduling

Invited session

Chair: *Waldemar Kaczmarczyk*, Department of Operations Research & Information Technology, AGH University of Science & Technology, ul. Gramatyka 10, 30-067, Krakow, Poland, waldek@agh.edu.pl

#### 1 - A new algorithm with shifting representation for hybrid flowline problems

*Thijs Urlings*, Instituto Tecnológico de Informática, Universidad Politécnica de Valencia, Camino de Vera s/n, 46022, Valencia, Spain, thijs@iti.es, *Ruben Ruiz*

This work considers the hybrid flowline problem with a set of restrictions and generalisations that are common in practice. We introduce a novel algorithm that starts with an iterated greedy algorithm applied to a job permutation and at a given time switches to an iterated local search on the full search space. To the best of our knowledge, this shift of the solution representation is new in scheduling literature. Experimental results prove the superiority of the algorithm compared to the state-of-the-art, which indicates a breakthrough for scheduling problems with more than one problem aspect

#### 2 - A dynamic lot size model with two shipping modes

*Hiroiyuki Wakinaga*, Graduate School of Mathematical Science and Information Engineering, Nanzan University, 27 Seirei-cho, Seto-shi, Aichi, Japan, 489-0863, Seto, Japan, hwakkin@nifty.com, *Katsushige Sawaki*

In this study we extend a dynamic lot size model to the case of incorporating shipping schedule into the model. The shipping consists of two modes. The shipping options are a full container load with fixed cost, a less than container load with a constant cost per unit, or using a combination of both modes simultaneously. The purpose of this study is to present an optimal production scheduling with two shipping modes so as to minimize the total cost over the finite planning horizon when the demands are deterministic.

#### 3 - Scheduling of common setup resources in dynamic multi-machine lotsizing models

*Christian M. Steffens*, Seminar für SCM und Produktion, Universität zu Köln, Albertus-Magnus-Platz, 50923, Köln, NRW, Germany, christian.steffens@uni-koeln.de

In this presentation, we extend PLSP-based lotsizing and scheduling models which explicitly include the simultaneous consideration of common setup operators. Especially, parallel machines and sequence-dependent setup operations will be introduced. The performance of heuristic solution approaches will be compared to optimal solutions generated using CPLEX. We show that our heuristic is able to generate near-optimal solutions very fast, even for real-world-sized cases.

#### 4 - Proportional lot sizing and scheduling problem with identical parallel machines

*Waldemar Kaczmarczyk*, Department of Operations Research & Information Technology, AGH University of Science & Technology, ul. Gramatyka 10, 30-067, Krakow, Poland, waldek@agh.edu.pl

Proposed paper addresses mixed integer programming models of the lot-sizing and scheduling problems for several products on identical parallel machines with limited capacity. Proposed new model extends so called proportional model (PLSP) which allows processing of two products in single period on the same machine. In proposed model, thanks to explicit modeling of processing times before and after changeovers, binary variables has been replaced by integer variables. Such aggregation of decision variables makes the model much easier to solve with standard MIP methods.

## ■ TF-05

Tuesday 16:05-17:25

Haydn

### Bioinformatics VI

Stream: Computational Biology, Bioinformatics and Medicine

Invited session

Chair: *Jacek Blazewicz*, Instytut Informatyki, Politechnika Poznańska, ul. Piotrowo 2, 60-965, Poznan, Poland, jblazewicz@cs.put.poznan.pl

Chair: *Marta Szachniuk*, Institute of Bioorganic Chemistry, PAS, Noskowskiego 12/14, 61-704, Poznan, Poland, Marta.Szachniuk@cs.put.poznan.pl

#### 1 - Multiple sequence alignment for a small number of sequences: general method for improving the quality.

*Pawel Wojciechowski*, Poznan University of Technology, 60-965, Poznan, Poland, pwojciechowski@cs.put.poznan.pl, *Piotr Formanowicz*, *Jacek Blazewicz*

Analysis of the quality of multiple sequence alignment shows that it depends on the number of sequences. The relatively worst results are obtained where the number of sequences in the input set is small. We proposed a general method for improving the quality of alignment for those cases. Our method relies on adding some sequences to the input set before creation of alignment and removing them after. Such an approach is independent of method solving an alignment problem. We have checked what kind of sequences should be added. The method have been evaluated for several alignment database.

#### 2 - Doman2 — approach for predicting domains boundaries in proteins

*Maciej Antczak*, Institute of Computing Science, Faculty of Computer Science and Management, Poznan University of Technology, ul. Piotrowo 2, 60-965, Poznan, Wielkopolska, Poland, mantczak@cs.put.poznan.pl, *Maciej Milostan*, *Piotr Lukasiak*

The new method of domains boundaries prediction called DomAn2 has been proposed. Techniques of OR were introduced in the protein analysis area to support biologists. The definition of a domain is not always straightforward. The DomAn2 approach predicts protein domains based on domain boundaries sequence patterns and tries to follow designed decision tree to give a final decision about localization of domain boundary in protein chain. Based on the data from CASP8 accuracy of prediction is on the level higher than 70%. Proposed approach can be successfully applied for the considered problem.

### 3 - Algorithmic aspects of the rna degradation process

*Agnieszka Rybarczyk*, Poznan University of Technology, 60-965, Poznan, Poland,  
arybarczyk@cs.put.poznan.pl, *Jacek Blazewicz*

Chemical instability of individual phosphodiester bonds is important in the processing of RNA particles and reflects the autocatalytic properties of this class of nucleic acids. It can possibly play a noticeable role in regulation of RNA stability in vivo. The mechanism of selective hydrolysis was deeply investigated and it was found, that it is sequence and structure dependent. In this study we present a formulation of a new problem of nonenzymatic RNA degradation and an algorithm for finding the solution of the problem. We also show laboratory results.

### 4 - Parallel computing in dna assembly

*Piotr Gawron*, Institute of Computing Science, Poznan University of Technology, ul. Piotrowo 2,, 60-965, Poznan, piotr.gawron@cs.put.poznan.pl

New approaches to DNA sequencing provide much more data in shorter time. Thus there is need to find solutions, which can handle with the input data quicker. There are two possible solutions: propose new algorithm or speed up existing algorithms, by using multi-processor computers, GPU or grid to make faster computation. Presented solution is a parallel version of the assembly algorithm based on a graph model. Parallelism was introduced in a few procedures: calculation of the overlap of each pair of input sequences, searching for longest paths in the graph, creating of consensus sequences.

## ■ TF-06

Tuesday 16:05-17:25

Koch

### Innovative Applications of OR in Supply Chains

Stream: OR and Real Implementations

*Invited session*

Chair: *Ioannis Minis*, Financial and Management Engineering, University of the Aegean, University of the Aegean, DFME, 82100, Cios, Greece,  
i.minis@fme.aegean.gr

Chair: *Vasileios Zeimpekis*, Department of Financial and Management Engineering, University of the Aegean, Fostini 31, 82100, Chios, Greece, vzeimp@fme.aegean.gr

#### 1 - Cross-docking, a managerial innovation in the logistics field and an application to a major greek retailer

*Vassilios Vrisagotis*, Department of Logistics Management, Technological Educational Institute of Chalkis, 32200, Thiva, Greece, brisxri@otenet.gr,  
*George Kaimakamis*, *Christina Beneki*, *Konstantinos Siassiakos*

Cross docking is a technique that eliminates storing and order picking functions of a warehouse while still allowing it to serve its receiving and shipping functions. Main issues are the calculation of the number of the building's gates and size of the facility through the calculation of facility's width. We correspond in these two issues by modeling a cross-docking distribution center as a network of queues by using Markov stochastic processes. Then we refer to an application in a leader retailer in Greece.

#### 2 - An intelligent fleet management system for real-time courier services

*Vasileios Zeimpekis*, Department of Financial and Management Engineering, University of the Aegean, Fostini 31, 82100, Chios, Greece,  
vzeimp@fme.aegean.gr, *George Ninikas*, *Theodore Athanasopoulos*, *Ioannis Minis*

The need for higher customer service and minimization of operational costs led many courier companies to seek innovative systems for managing customer requests that occur during the planning and/or the execution of daily deliveries. This paper presents the design and implementation of an innovative fleet management system that handles in a dynamic manner the requests that arise during delivery execution and at the same time routes effectively deliveries that are planned in a multi-day framework. The proposed system is tested in real-life scenarios in a Greek courier operator.

#### 3 - A stochastic model for evaluating the vulnerability of a supply network

*Claudia Colicchia*, Logistics Research Center, Carlo Cattaneo University LIUC, Corso Matteotti 22, 21053, Castellanza, Italy, ccolicchia@liuc.it, *Fernanda Strozzi*, *Carlo Noe*, *Ljupco Kocarev*

Supply chain vulnerability has gained considerable attention, since the more complex the relationships, the more prone modern global supply chains are to disruptions. As vulnerability increases, there needs to develop effective mathematical tools for its evaluation. The purpose of this paper is to assess the vulnerability of a network in a global logistics environment using the Influence Model, a stochastic model composed of interactive Markov Chains. The aim is to foster a more explicit understanding of the relationships between network characteristics and vulnerability of supply chains.

## ■ TF-07

Tuesday 16:05-17:25

GSI - S 29

### Passenger congestion in urban transit

Stream: Optimization in Public Transport

*Invited session*

Chair: *Fabien Leurent*, DPER, SETRA, 46 avenue A. Briand, 92 225, Bagneux, FRANCE, France,  
fabien.leurent@equipement.gouv.fr

#### 1 - A systemic analysis of congestion in a transit network

*Fabien Leurent*, Laboratoire Ville, Mobilité, Transport, Université Paris-Est, Enpc, 6-8 avenue Blaise Pascal, Cité Descartes, Champs sur Marne, 77455, Marne la Vallée, Cedex 2, France, fabien.leurent@enpc.fr

An analysis framework is provided for congestion phenomena in public transit networks, in order to identify the relevant limited resources and the congestion mechanisms on passengers and/or vehicles. Four basic subsystems are considered, namely: (i) line; (ii) vehicle; (iii) station; (iv) passenger. By subsystem, the specific congestion phenomena are identified and described qualitatively, with indication of how to model them in a relevant way. The associated optimization problems of route choice and network traffic equilibrium are outlined.

## 2 - On congestion phenomena in static models of traffic assignment to transit networks

*Fabien Leurent*, Laboratoire Ville, Mobilité, Transport, Université Paris-Est, Enpc, 6-8 avenue Blaise Pascal, Cité Descartes, Champs sur Marne, 77455, Marne la Vallée, Cedex 2, France, fabien.leurent@enpc.fr

The paper is purported to model congestion phenomena in a public transit network in a straightforward way applicable to many kinds of limited resources, and to adapt correspondingly the optimal strategy model of Spiess and Florian (1989). A richer framework is developed, in which the congestion state induces the rider to choose her queuing area prior to choosing a service from among a subset which is conditional on the queuing area and state. This is stated as a primal-dual program, solved using an augmented Lagrangean scheme. Numerical application to the metropolitan Paris area is provided.

## 3 - Schedule-based dynamic assignment models for congested urban transit networks

*Umberto Crisalli*, Department of Civil Engineering, University of Rome, via del politecnico 1, 00133, Rome, Italy, crisalli@ing.uniroma2.it, *Agostino Nuzzolo*, *Luca Rosati*

This paper presents a schedule-based dynamic assignment model, which explicitly takes into account vehicle capacity by representing each run of transit services through a diachronic network. The core of the assignment model is the use of a joint departure time, stop and run choice model based on a mixed pre-trip/en-route choice behaviour, in which some attributes and congestion (fail-to-board experiences), that are defined at single vehicle (run) level, are estimated by day-to-day learning processes. Finally, an application example to a realistically-sized test network will be presented.

## ■ TF-08

Tuesday 16:05-17:25

GSI - S 30

### System Dynamics

Stream: Supply Chain Management

*Invited session*

Chair: *Stephan Wagner*, Department of Management, Technology, and Economics, Swiss Federal Institute of Technology Zurich (ETH Zurich), Chair of Logistics Management, Scheuchzerstrasse 7, 8092, Zurich, Switzerland, stwagner@ethz.ch

#### 1 - Dns-curves in a production/inventory model

*Alois Steindl*, Institute for Mechanics and Mechatronics, Vienna University of Technology, Wiedner Hauptstr. 8-10, 1040, Wien, Austria, Alois.Steindl@tuwien.ac.at, *Gustav Feichtinger*

We investigate the bifurcation behaviour of an inventory/production model close to a Hamilton-Hopf bifurcation. For a subcritical bifurcation scenario two competing long term strategies exist, the steady state solution and a hyperbolic limit cycle. The DNS-curve, separating the domain of attraction of these solutions, may contain self-intersections, which lead to a threefold DNS-point in state space, where three different optimal trajectories yielding the same cost emerge.

#### 2 - Drum buffer rope versus anchoring and adjustment approaches in flow shop operations

*Alexandra Politou*, Mechanical Engineering, Aristotle University of Thessaloniki, P.O. Box 461, 541 24, Thessaloniki, apolitou@auth.gr, *Patroklos Georgiadis*

This paper aims to compare the efficiency of Drum Buffer Rope (DBR) approach of Theory of Constraints (TOC) in production planning with the well known anchoring and adjustment approach. This comparison is based on a System Dynamics (SD) model representing a three-stage flow shop system that produces a single product. The simulation results of the SD model are specific performance measures of the production and the raw material procurement processes of the model. The impact of specific control parameters on the performance measures is investigated by means of Analysis of Variance (ANOVA).

#### 3 - A framework to model reduction and stability analysis for supply chains

*Thomas Makuschewitz*, IPS - Intelligent Production and Logistics Systems, BIBA - Bremer Institut für Produktion und Logistik GmbH at the University of Bremen, Hochschulring 20, 28359, Bremen, Bremen, Germany, mak@biba.uni-bremen.de, *Bernd Scholz-Reiter*, *Michael Kosmykov*, *Michael Schönlein*

Supply Chains often consist of a large number of geographically distributed production facilities. The material flow within these networks is subject to the complex structure as well as to external and internal dynamics. In this paper we present a framework for stability analysis of a supply chain based on a representative fluid model. Excluding less important locations of the network leads to a fluid model of lower size that performs in the same manner. Important locations are determined by an adaptation of the PageRank algorithm, which takes network structure and material flow into account.

#### 4 - Modeling defaults of companies in multi-stage supply chain networks

*Stephan Wagner*, Department of Management, Technology, and Economics, Swiss Federal Institute of Technology Zurich (ETH Zurich), Chair of Logistics Management, Scheuchzerstrasse 7, 8092, Zurich, Switzerland, stwagner@ethz.ch, *Kamil Mizgier*, *Janusz Holyst*

Our approach to study supply chain networks as complex systems draws on the concept of heterogeneous interacting agents in a repeated process of orders and production. Due to random failures the dynamics of production in the network is nonlinear. We focus on the influence of local processes on the global economic behavior of the system. We introduce a supply chain network model with the following features which better reflect the real economic environment: evolution of a supply chain network with the reconfiguration of links, price dispersion and the dynamics of prices and costs of production.

## ■ TF-09

Tuesday 16:05-17:25

GSI - S 5

### Modelling Workforce Scheduling II

Stream: Timetabling and Rostering

*Invited session*

Chair: *Celia Glass*, Cass Business School, City University, 106 Bunhill Row, EC1Y 8TZ, London, United Kingdom, c.a.glass@city.ac.uk

#### 1 - Temple — a language for staff scheduling problems

*Werner Schafhauser*, Institute of Information Systems, Vienna University of Technology, Favoritenstrasse 9-11, 1040 Vienna, 1040, Vienna, Austria,

schafha@dbai.tuwien.ac.at, *Andreas Beer, Johannes Gaertner, Nysret Musliu, Wolfgang Slany*

In this paper we present TEMPLE, a language designed for modelling and solving staff scheduling problems. In TEMPLE a particular staff scheduling task is described with intervals, relationships between intervals, user-defined properties, curves and constraints. Once a problem has been defined in TEMPLE it can be solved automatically by using a generic local-search-based solver. We demonstrate how real-life staff scheduling problems can be modelled with TEMPLE and show that the solutions obtained with our approach are of satisfying quality.

## 2 - Testing while modelling staff scheduling problems

*Andreas Beer*, Graz University of Technology, 8010, Graz, Austria, abeer@ist.tugraz.at, *Johannes Gaertner, Nysret Musliu, Werner Schafhauser, Wolfgang Slany*

To ease the user's modelling effort and reduce errors when using TEMPLE, a language designed for modelling and solving staff scheduling problems, we propose two testing approaches. The first one utilizes small, self-contained tests that verify the user's logic. The second one consists of larger tests using a model's objects themselves, which check the system's correct processing of the user input. These tests aim at verifying the code and the entire model itself. Due to this approach errors in a problem model are identified at an early stage.

## 3 - Rosters versus rotas for nhs nurses and doctors (in the uk)

*Celia Glass*, Cass Business School, City University, 106 Bunhill Row, EC1Y 8TZ, London, United Kingdom, c.a.glass@city.ac.uk

We explore the combinatorial aspects of different approaches to personnel rostering. We focus on practices in the UK NHS, and other cases in the Nurse Rostering literature. Rotas are a set of weekly shift patterns through which staff rotate. We formulate the rota problem as an Integer Programme. A Roster, by contrast, matches staff supply to demand, and patterns of work over the week are more freely defined. Contrasting results are presented from two, or more, NHS wards, and their impact highlighted. Manual and optimised schedules are presented and discussed for both rotas and rosters.

## TF-10

Tuesday 16:05-17:25

GSI - S 6

## Portfolio Decision Analysis: Theory and Methods

Stream: Multiple Criteria Decision Analysis

*Invited session*

Chair: *Alec Morton*, Management/ Operational Research, London School of Economics, Houghton St, London, wc2a2ae, London, England, United Kingdom, a.morton@lse.ac.uk

Chair: *Jeff Keisler*, Boston College of Management, University of Massachusetts, 100 Morrissey Blvd., 02125-3393, Boston, MA, United States, jeff.keisler@umb.edu

Chair: *Ahti Salo*, Systems Analysis Laboratory, Helsinki University of Technology, P.O. Box 1100, Otakaari 1 M, 02015, TKK, Finland, ahti.salo@tkk.fi

### 1 - Era: a framework and interactive scheme for elicitation in resource allocation decisions

*Alec Morton*, Management/ Operational Research, London School of Economics, Houghton St, London,

wc2a2ae, London, England, United Kingdom, a.morton@lse.ac.uk, *José Rui Figueira*

Portfolio Decision Analysis (PDA) has seen increasingly widespread application in recent years. A difficulty in applying PDA, however, is the significant elicitation burden involved, particularly in the case of multicriteria models where decision makers have to assess both weights and values. We present a framework for thinking about Elicitation in Resource Allocation decisions, based on a constructive view of preference formation. We show how this framework can be the basis of a computationally practical interactive scheme and demonstrate this scheme with examples drawn from practice.

## 2 - Portfolio decision quality

*Jeff Keisler*, Boston College of Management, University of Massachusetts, 100 Morrissey Blvd., 02125-3393, Boston, MA, United States, jeff.keisler@umb.edu

The decision quality framework has been useful in guiding decision processes and analyses. Translating the framework to the context of portfolio decisions requires that we address their specific analytical and organizational characteristics. In some ways, the translation is direct, e.g., valuing outcomes. In some ways, elements have different meanings for portfolios, e.g., creative alternatives. In some ways, portfolio decisions have unique quality demands, e.g., identifying synergies between projects. We define elements of portfolio decision quality and a four level quality scale for each.

## 3 - A new interactive approach for the multicriteria portfolio selection problem

*Nikolaos Argyris*, Operational Research, London School of Economics, Houghton Street, WC2A 2AE, London, United Kingdom, n.argyris@lse.ac.uk, *José Rui Figueira, Alec Morton*

We present a novel interactive approach for the Multi-Criteria Portfolio Selection Problem (MCPSP). This is based on new results for identifying preferred solutions to Multi-Objective Binary Optimisation problems. We present new formulations for the MCPSP which integrate the decision space with the criterion space. These allow for incorporating preference information directly and identifying preferred efficient portfolios accordingly.

## 4 - Optimizer's curse in project portfolio selection

*Juuso Liesiö*, Systems Analysis Laboratory, Helsinki University of Technology, P.O.Box 1100, 02015 HUT, Espoo, Finland, juuso.liesio@tkk.fi, *Ahti Salo, Bert De Reyck*

Project portfolios are often built by selecting the projects which have the best prior estimates about their future performance. Because these estimates are uncertain, the selected projects are likely to have estimates that are higher than the projects' actual realized performance. This gives rise to the optimizer's curse phenomenon which is here analyzed in view of key decision parameters (e.g., quality of estimates, number of proposals and funded projects) at the portfolio and project levels. We also consider implications for project funding and information acquisition strategies.

## ■ TF-11

Tuesday 16:05-17:25

GSI - S 17

### Multicriteria evaluation, information systems and agents

Stream: Multiple Criteria Decision Analysis

*Invited session*

Chair: *Pascal Oberti*, Université de Corse, UFR Droit Economie., Av. Jean-NICOLI, BP 52, 20250 CORTE, 20250, Corte, France, pascal.oberti@univ-corse.fr

#### 1 - Introduce an outranking method as a substitute to a synthetic index in monitoring and evaluation of public policies and programs

*Maud Hualme*, Economic, CREM-CNRS, 7, Place Hoche, 35065, Rennes Cedex, France, maud.hualme@univ-rennes1.fr, *Maurice Baslé*

On going evaluations focus on the chain outputs-outcomes-effects or impact of current public policies. Targets are supposed to be produced by policymakers. Do we want quantitative or qualitative materials, intermediate or more synthetic indexes? Maurice Baslé has proposed an original process of monitoring and evaluation. Then, it is easier to define a performance indicators holding indicators of results. We deal with the methodologies of multicriteria decision aid to aggregate these indicators of results and to build in this way a composite indicator.

#### 2 - Actors roles and software interface users rights in a multicriteria evaluation process : state of the art and proposals

*Christophe Paoli*, Université de Corse, 20250, CORTE, France, christophe.paoli@univ-corse.fr, *Pascal Oberti*

The participation of actors in multicriteria evaluation processes of alternatives is a challenge for the analyst. Various contributions exist [Roy, 1996][Froger, Oberti, 2002][Oberti, 2004][Munda, 2004][Jabeur, Martel, 2005]. First we will present how is studied the structure of evaluation process. In a second time, we will propose an implementation through MECADEPPE software [Oberti et al., 2008], translating the actor roles into user rights in order to represent a real process. Finally we will present an illustration of a participatory evaluation for energy projects.

#### 3 - Multicriteria outranking evaluation of energy options in insular contexts: application of electre models in greece and corsica

*Matteaccioli Paul-François*, Université de Corse, 20250, CORTE, France, pf.matteaccioli@sartene.fr, *Pascal Oberti*

Energy planning in insular context is a complex exercise, because of varied factors: particular status, overcost of basic production, strong seasonal variations with tourist consumption, frequent power cuts, multilevel public decision, strong local demand of participation and NIMBY syndrome, important potential of renewable energies to be exploited, etc. This research aims at studying how the ELECTRE multicriteria methods [Figueira and al., 2005], can help with the evaluation of energy options [Georgopoulou and al., 2003, 1997] [Oberti, Matteaccioli, 2008] [Papadopoulos, Karagiannidis, 2008].

## ■ TF-12

Tuesday 16:05-17:25

GSI - S 18

### Tools for stochastic optimization

Stream: Stochastic Programming

*Invited session*

Chair: *Tamas Szantai*, Institute of Mathematics, Budapest University of Technology and Economics, Muegyetem rkp. 3., 1111, Budapest, Hungary, szantai@math.bme.hu

#### 1 - Successive regression approximations in stochastic programming

*Istvan Deak*, Computer Science, Corvinus University of Budapest, Fovam ter 8., 1093, Budapest, Hungary, istvan.deak@uni-corvinus.hu

Recently a new iterative method has been developed for solving problems with noisy function values, which uses iteratively updated regression functions. First we give details of the method for solving an equation with noisy function evaluation, highlighting the main ideas and the computational problems. Then we summarize stochastic programming problems, where this technique was applied successfully, according to extensive numerical experiments (probabilistic constrained and two stage problems, a combined model and random linear problems are dealt with).

#### 2 - Bounding the reliability of a stochastic transportation network with random demands and arc capacities

*Andras Prekopa*, RUTCOR, Rutgers University, 640 Barholomew Road, 08854-8003, Piscataway, New Jersey, United States, prekopa@rutcor.rutgers.edu, *Merve Unuvar*

Bounding the reliability of a transportation network was proposed by Pr kopa and Boros (Op.Res.39, 119-129), where the demand values are random and binomial moment bounds are used. In many practical applications (flood control, evacuation), however, the arc capacities are also random. This makes the number of feasibility constraints very large. We propose efficient elimination procedures of the redundant constraints and use up to date bounding technique to approximate the probability of the existence of a feasible flow.

#### 3 - Models for the determination of the irrigation water supply in streamflows

*Tamas Szantai*, Institute of Mathematics, Budapest University of Technology and Economics, Muegyetem rkp. 3., 1111, Budapest, Hungary, szantai@math.bme.hu, *Andras Prekopa*

Three stochastic programming models will be presented. The first one serves to determine the amount of water that can be used, by a large probability, where there is no storage possibility. In the second model we assume that the water can be stored in reservoir and the problem is to determine its optimal capacity. In the third model we allow that for a few number of days there is not enough water for irrigation. The tools for numerical solution of the mathematical models are Matlab codes and AMPL modeling language.

## ■ TF-13

Tuesday 16:05-17:25

GSI - S 31

### Network location models

Stream: Location Analysis

*Invited session*

Chair: *Anita Schoebel*, Fakultät für Mathematik, Georg-August Universität Göttingen, Lotzestr. 16-18, 37083, Göttingen, Germany, [schoebel@math.uni-goettingen.de](mailto:schoebel@math.uni-goettingen.de)

#### 1 - The uniform capacitated flp on path network

*Alexander Kurochkin*, mechanic-mathematical, Novosibirsk State University, Pirogova, 2, 630090, Novosibirsk, Russian Federation, [alkurochkin@ngs.ru](mailto:alkurochkin@ngs.ru),  
*Edward Gimadi*, *Alexander Ageev*

It is known that Capacitated Facility Location Problem (CFLP) on path network is NP-hard for arbitrary capacities of facilities. We consider the CFLP on path network when capacities of facilities are equal. Earlier for this problem  $O(m5n2 + m3n3)$ -time complexity algorithm was constructed by A.Ageev. In this report a modification of the algorithm is presented. The running time of the algorithm is equal to  $O(m4n2)$ . So it has smaller complexity respective the number of clients as well as the number of facilities. This work is supported by RFBR (projects 08-01-00516, 08-01-00370).

#### 2 - Locating facilities in a dense grid network where travel times follow gravitational patterns

*Francisco A. Ortega*, University of Seville, 41012, Seville, Spain, [riejos@us.es](mailto:riejos@us.es)

(Francisco A. Ortega, Juan A. Mesa & Rosario Arriola) For urban settings, a common objective to decide the location of facilities is the minimization of the maximum travel time between demand points and such sites. Excluding other external factors, travel time depends mainly on the distance along the feasible street network and the transit speed on this network. The location problems dealt with in the paper combine rectilinear trajectories with a distribution of levels of velocity in a dense grid of streets which follows an inverse gravitational model, according to a given orientation.

#### 3 - Locating speed-up networks

*Marie Schmidt*, Institut für Numerische und Angewandte Mathematik, Georg-August-Universität Göttingen, Lotzestraße 16-18, 37073, Göttingen, Germany, [marie\\_schmidt@gmx.net](mailto:marie_schmidt@gmx.net), *Anita Schoebel*

Let a network together with a set of origin-destination pairs (OD-pairs) be given. We consider the problem of locating a subnetwork of given length along which travel times are reduced by a given speed-up factor. The OD-pairs can choose to use the new subnetwork if this is the faster option for them. Our goal is to locate the subnetwork so that the largest traveling time of all OD-pairs is minimized. An application is the location of a rapid transport network within a city. We present various NP-completeness results and efficient algorithms depending on the types of the networks involved.

## ■ TF-14

Tuesday 16:05-17:25

GSI - S 32

### Service parts management

Stream: Inventory Management

*Invited session*

Chair: *Matthieu van der Heijden*, Operational Methods for Production and Logistics, University of Twente, P.O. Box 217, 7500 AE, Enschede, [m.c.vanderheijden@utwente.nl](mailto:m.c.vanderheijden@utwente.nl)

#### 1 - Integrated planning of spare parts and service tools

*Ingrid Vliegen*, Industrial Engineering and Innovation Sciences, Technische Universiteit Eindhoven, P.O. Box 513, 5600 MB, Eindhoven, [i.m.h.vliegen@tue.nl](mailto:i.m.h.vliegen@tue.nl),  
*Geert-Jan van Houtum*

To perform a maintenance action, spare parts, service tools and service engineers need to be available. In this talk, we focus on the planning problem for a combination of tools and parts, and base ourselves on an actual planning problem of an Original Equipment Manufacturer in the semiconductor supplier industry. We consider a multi-location, multi-item inventory model, in which demands occur for sets of parts and tools. Our objective is to minimize the investment in service tools and spare parts, subject to meeting the service level agreed upon with customers.

#### 2 - End of life inventory decisions for consumer electronics spare parts

*Morteza Pourakbar*, Erasmus School of Economics, Econometric Institute, Erasmus University Rotterdam, BurgOudlaan 50, 3000 DR, Rotterdam, [pourakbar@ese.eur.nl](mailto:pourakbar@ese.eur.nl), *J.b.g. Frenk*, *Rommert Dekker*

we consider a consumer electronics(CE) manufacturer problem of controlling the inventory of spare parts in the final phase. Final phase starts upon termination of production and lasts till last service contract expires. Previous works consider repair of the parts as the only way to serve customers. For CE products since they are subjected to remarkable price erosion over time other policies such as swapping might be profitable. We accommodate alternative policy into final phase inventory policies and develop models to optimize both final order quantity and time to switch to alternative policy

#### 3 - An integrated approach for level of repair analysis and spare parts stocking using marginal analysis

*Matthieu van der Heijden*, Operational Methods for Production and Logistics, University of Twente, P.O. Box 217, 7500 AE, Enschede, [m.c.vanderheijden@utwente.nl](mailto:m.c.vanderheijden@utwente.nl), *Rob Basten*, *Erhan Kutanoglu*, *Marco Schutten*

When developing a capital good, we should decide how to maintain it once it is in the field. The level of repair analysis is used to decide: 1) Which components should be repaired upon failure and which should be discarded, 2) where components should be repaired 3) where resources (e.g. testers) should be deployed. Next, we should decide how many spare parts for each component are needed where in the network to guarantee a certain product availability. We develop an integrated optimization method to support these decisions and illustrate it using a case study in industry.

## ■ TF-15

Tuesday 16:05-17:25

Einstein

### Project Scheduling - Extensions and Applications

Stream: Project Management and Scheduling

Invited session

Chair: *Jürgen Zimmermann*, Operations Research, TU Clausthal, Julius-Albert Str. 2, 38678, Clausthal-Zellerfeld, Germany, [juergen.zimmermann@tu-clausthal.de](mailto:juergen.zimmermann@tu-clausthal.de)

#### 1 - Real time planning system for a multi-channel support centre

*M.Pilar Lino*, Mathematics for Economy, University of Valencia, Avda Naranjos s/n, 46021, Valencia, Spain, [pilar.lino@uv.es](mailto:pilar.lino@uv.es), *M. Angeles Pérez, Sacramento Quintanilla, Vicente Valls*

The objective is to aid in the automatic planning of the daily activities of service centres using ITC, developing a user interface which includes the scheduling of tasks and the management of human resources by means of project scheduling techniques. We present software which analyses, numerically and graphically, the proposed plans. The interface allows the managers to modify, in the Gantt charts, the schedule of a set of tasks. The system updates all the information related to the fulfilment of the service quality agreements and the worker loads, both individually and by areas of knowledge.

#### 2 - A voting-based heuristic for decentralized multi-project scheduling

*Jörg Homberger*, Alpenrosenstr. 26, 70563, Stuttgart, [joerg.homberger@hft-stuttgart.de](mailto:joerg.homberger@hft-stuttgart.de)

A voting-based heuristic for the Decentralized Resource Constrained Multi-Project Scheduling Problem is described. The heuristic combines several priority rules and schedule generation schemes, applied decentrally by project planning agents, with several synchronization rules for the access of the agents to shared resources. The combination of rules leads to a set of solutions from which one is chosen by the agents through voting. The approach, which takes asymmetric information into account, is evaluated on 140 benchmark instances taken from the literature.

#### 3 - Introduction of learning effects in resource-constrained projects

*Vincent Van Peteghem*, Faculty of Economics and Business Administration, Ghent University, Tweekerkenstraat 2, 9000, Gent, Belgium, [vincent.vanpeteghem@ugent.be](mailto:vincent.vanpeteghem@ugent.be), *Mario Vanhoucke*

Learning effects assume that a resources' efficiency increases with the duration of a task. Although these effects are commonly used in machine scheduling environments, they are rarely used in a project scheduling setting. We study learning effects for the discrete time-resource tradeoff scheduling problem, where for each activity a work content is specified and different execution modes (duration/resource requirement pairs) are defined. Computational results emphasize the significance of the effect and reveal promising results for specific project networks.

#### 4 - Exact methods for the resource levelling problem

*Thorsten Gather*, Operations Research Group, Clausthal Institute of Technology, Julius-Albert-Str. 2, 38678, Clausthal, Niedersachsens, Germany, [gather@tibasc.de](mailto:gather@tibasc.de), *Jürgen Zimmermann*

Project management in present time is characterized by hardly calculable risks and very tight deadlines. Project Managers must consider carefully the resources required to complete a project on time and within the budget. As a consequence, the levelling of resources gets more and more attention. We consider a new tree-based enumeration method exploiting fundamental properties of spanning trees and order polytopes to minimize the variation of resource utilization in the course of projects. To solve larger problem instances we embedded the enumeration in a branch and bound procedure.

## ■ TF-16

Tuesday 16:05-17:25

Koenig

### Multiple Objective Combinatorial Optimization

Stream: Multi-Objective Optimization and Decision Theory 1

Invited session

Chair: *Jochen Gorski*, Department of Mathematics and Informatics, University of Wuppertal, Gaußstraße 20, 42119, Wuppertal, Germany, [gorski@math.uni-wuppertal.de](mailto:gorski@math.uni-wuppertal.de)

#### 1 - Combinatorial optimization with generalized bottleneck objective(s)

*Jochen Gorski*, Department of Mathematics and Informatics, University of Wuppertal, Gaußstraße 20, 42119, Wuppertal, Germany, [gorski@math.uni-wuppertal.de](mailto:gorski@math.uni-wuppertal.de), *Kathrin Klamroth, Stefan Ruzika*

In Combinatorial optimization (CO) both the sum objective as well as the bottleneck objective are of great interest. While using sum objectives often leads to NP-hard problems, problems with bottleneck objectives can often be solved more efficiently. We introduce a class of generalized bottleneck objectives where instead of the largest cost coefficient of a solution, its k-largest cost coefficient has to be minimized. We discuss theoretical properties and present algorithms for solving CO problems with one and more k-max objectives in the single and multiple criteria case, respectively.

#### 2 - A linear-time algorithm for the binary bicriteria spanning tree problem

*Stefan Ruzika*, Department of Mathematics, University of Kaiserslautern, P.O. Box 3049, 67653, Kaiserslautern, Germany, [ruzika@mathematik.uni-kl.de](mailto:ruzika@mathematik.uni-kl.de), *Jochen Gorski, Kathrin Klamroth*

Consider an extension of the minimum spanning tree problem for undirected graphs  $G=(V,E)$ : Let two cost functions  $c: E \rightarrow 0,1$  and  $d: E \rightarrow 0,1$  be given. The resulting problem is called the binary bicriteria spanning tree problem. Our goal is to compute all nondominated points and for each nondominated point one efficient solution. First, we modify graph  $G$ , thus taking care of all edges with costs  $(0,0)$  and  $(1,1)$ . The resulting graph has edges with costs  $(0,1)$  or  $(1,0)$ . Efficient characterization and computation of all nondominated points for this and for the original graph can be achieved.

#### 3 - On the bicriterion — minimum cost/minimum label — spanning tree problem

*João Clímaco*, Faculdade de Economia da Universidade de Coimbra and INESC-Coimbra, 3004-512, Coimbra, Portugal, [jclimaco@fe.uc.pt](mailto:jclimaco@fe.uc.pt), *Maria Eugénia Captivo, Marta Pascoal*

In the bicriterion — minimum cost/minimum label — spanning tree problem, each edge of the network is assigned with a cost value and a label (such as a color). The first criterion intends to minimize the total cost of the spanning tree, while the second intends to determine a spanning tree with a minimum number of different labels. This problem has applications in telecommunication or transportation networks. As generally these are conflicting criteria, we developed algorithms to generate the set of non-dominated spanning trees. Computational experiments are presented and results discussed.

#### 4 - Numerical studies of tchebycheff-type approaches for solving multicriteria optimization problems

*Kerstin Daechert*, Department of Mathematics and Natural Sciences, University of Wuppertal, Gausstr. 20, 42119, Wuppertal, Germany, kerstin.daechert@math.uni-wuppertal.de, *Jochen Gorski*

Compromise programming and reference point methods have in common that weakly efficient solutions are generated by minimizing the distance between a feasible point in the decision space and a reference point. In Tchebycheff-type approaches a utopian point is typically chosen as this reference point. Another possibility consists in taking local utopian points with respect to the coordinates of a subset of (weakly) efficient solutions generated so far. We study the influence of the chosen reference points by comparing the quality of the generated solutions and computation time.

#### ■ TF-17

Tuesday 16:05-17:25

Rheinaue

### Cutting and Packing and Metaheuristics

Stream: Cutting and Packing

*Invited session*

Chair: *Marc Sevaux*, EU/ME, Université de Bretagne Sud - UEB, Lab-STICC - CNRS UMR 3192, Centre de Recherche - BP 92116, 56321, Lorient, France, marc.sevaux@univ-ubs.fr

#### 1 - Box loading optimization into containers via tabu search

*Vitoria Pureza*, Production Engineering, Universidade Federal de Sao Carlos, Via Washington Luiz, km 235, 13564-090, Sao Carlos, Sao Paulo, vpureza@dep.ufscar.br

In this paper, it is proposed a tabu search algorithm for arranging heterogeneous or homogeneous loads of rectangular boxes into containers. Computational results regarding volume utilization and stability measures are presented for sets of benchmark instances.

#### 2 - Enhancement of a commercial software for layout planning by a tabu search algorithm

*Axel Hennig*, rhenag Rheinische Energie Aktiengesellschaft, Cologne, Germany, 50937, Köln, Germany, axel-hennig@gmx.de, *Andreas Bortfeldt*, *Hermann Gehring*

The integration of a tabu search algorithm (TSA) into an existing commercial program for planning the layout of factories is investigated. The TSA places rectangular shaped facilities on a given factory area in such a way that the costs of specified material flows are minimised. It can be utilised both for automated calculations and as an assistance tool within interactive planning of layouts. Results will be reported concerning both operating modes of the TSA.

#### 3 - Hybrid parallel genetic approach for one-dimensional bin packing problem

*Roman Potarusov*, 87/40, Petrovskaya St., 347900, Taganrog, Russian Federation, potarusov.roman@gmail.com, *Gilles Goncalves*, *Hamid Allaoui*, *Victor Kureychik*

We propose the Hybrid Parallel Genetic Approach (HPGA) for one-dimensional Bin Packing Problem (BPP), which can compete with the best known solution methods and provides quasi-optimal and optimal BPP solutions for all benchmarks instances in an acceptable amount of computing time. HPGA was tested on 1370 benchmark test problem instances. We found optimal solutions for 1365 problem instances. For remaining 5 we obtained near optimal solutions. In the case of quasi-optimal solutions the absolute deviation from reference solution is at most one bin. The computing time doesn't exceed 30 seconds.

#### ■ TF-18

Tuesday 16:05-17:25

Lenné

### Parallel Nonlinear Programming Algorithms

Stream: Mathematical Programming

*Invited session*

Chair: *Figen Öztoprak*, Industrial Engineering, Sabanci University, Sabanci University, FENS 1021, Orhanli - Tuzla, 34956, Istanbul, Turkey, figen@su.sabanciuniv.edu

Chair: *S. Ilker Birbil*, Manufacturing Systems/Industrial Engineering, Sabanci University, Orhanli, 34956, Tuzla, Istanbul, Turkey, sibirbil@sabanciuniv.edu

#### 1 - Parallel programming approaches to nonlinear optimization

*Figen Öztoprak*, Industrial Engineering, Sabanci University, Sabanci University, FENS 1021, Orhanli - Tuzla, 34956, Istanbul, Turkey, figen@su.sabanciuniv.edu, *S. Ilker Birbil*

The common motivation for using parallel processing in nonlinear optimization is to speed up the execution of existing sequential algorithms. In this study, we argue that parallel processing can provide further performance improvements by means of parallel generation and exchange of information, which requires the design of appropriate interaction strategies and results in modifying the original algorithms. We apply our idea to some well-known methods of nonlinear optimization and present some numerical results.

#### 2 - A parallel version of the probabilistic method of feasible directions

*Art Gorka*, Department of Mathematics, Erskine College, 2, Washington Street, Box 338, 29630, Due West, SC, United States, art.gorka@erskine.edu, *Michael Kostreva*

A Parallel version of the Probabilistic Method of Feasible Directions, designed to solve nonlinear optimization problems with inequality constraints, is presented. The algorithm uses parallel processes to find multiple directions of search for Fritz John point. It is tested on a number of problems with known solutions to compare the method with earlier versions. An estimation of the speed of the algorithm is given.

#### 3 - On parallelization of ant colony-based algorithms

*Andrej Chu*, U Uranie 25, 17000, Prague, chu@fel.cvut.cz

This article deals with the problem of parallelization of algorithms based on ant colony optimization metaheuristics. It suggests some solutions on designing parallel ant colony systems. When implementing an ant colony based algorithm that should run on parallel systems, one should be aware of several problems that may arise. Also, an analysis is needed on such operations, which could be implemented either on the server and/or client side, as there always is a trade-off between the clients' memory consumption and communication resources consumption.

#### 4 - Formulating and solving non-standard model types using gams/emp

*Jan-Hendrik Jagla*, GAMS Software GmbH, 50933, Cologne, Germany, [jhagla@gams.com](mailto:jhagla@gams.com), *Michael Ferris*, *Alex Meeraus*

Many new model types are emerging that involve more complex features than current modeling systems are able to convey easily. We will outline an extended mathematical programming framework, as implemented in GAMS/EMP, that enables additional structural information to be described. We will demonstrate several examples of the use of EMP to formulate and solve problems (such as bilevel programs and variational inequalities) more reliably. The framework is easily extensible and also provides mechanisms to perform standard reformulations of models for solution by existing codes.

### ■ TF-19

Tuesday 16:05-17:25

Haber

#### Metaheuristics in scheduling and logistics

Stream: Metaheuristics

*Invited session*

Chair: *Ana Moura*, Economy, Management and Industrial Engineering, University of Aveiro, Campus Universitário de Santiago, 3810-193, Aveiro, Portugal, [ana.moura@ua.pt](mailto:ana.moura@ua.pt)

#### 1 - Climbing depth-bounded discrepancy search for solving two-stage hybrid flow shop scheduling problems

*Pierre Lopez*, LAAS-CNRS, 7 avenue du Colonel Roche, 31077, Toulouse, France, [lopez@laas.fr](mailto:lopez@laas.fr), *Abir Ben Hmida*, *Mohamed Haouari*, *Marie-José Huguet*

We propose a discrepancy-based method to solve 2-stage hybrid flow-shop scheduling with makespan minimization. The CDDS strategy is enhanced through the calculation of an SPT-rule based lower bound. We test our method on randomly generated instances with various processing times distributions. The results are weighed against those obtained with a similar approach developed for the general hybrid flow shop problem, as well as a Tabu Search. For all experiments, our proposition outperforms other methods in terms of number of problems solved to optimality and CPU time.

#### 2 - A matching and pairing based heuristic for scheduling in-flight catering service.

*Ada Suk Fung Ng*, Institute of Transport and Logistics Studies, University of Sydney, ITLS.C37, Faculty of Economics and Business, University of Sydney, 2006, University of Sydney, NSW, Australia, [adan@itls.usyd.edu.au](mailto:adan@itls.usyd.edu.au)

In-flight catering company has to transport meal from the kitchen to the apron in the airport. The loading scheduling is constrained by the service time window of an aircraft, the food exposure time limit of meals and the truck capacity. Since demand is spread unevenly across the day with peak and non-peak hours, a flexible shift pattern is applied, loading team can start and finish shift at different hour. A matching and pairing heuristic is developed to minimum manpower required in fulfilling demand across a 24 hours day. Computational result shows a 25 percent of manpower savings

#### 3 - A genetic algorithm approach to the container loading problem

*Ana Moura*, Economy, Management and Industrial Engineering, University of Aveiro, Campus Universitário de Santiago, 3810-193, Aveiro, Portugal, [ana.moura@ua.pt](mailto:ana.moura@ua.pt), *Rui Rijo*

The problem considered in this work is the Container Loading Problem. In this problem a set of rectangular boxes has to be packed in one rectangular container so that the available container space usage is maximized. The orientation constraints and the distinction between homogeneous and heterogeneous types of cargo are considered. We present the results obtained with a Genetic Algorithm approach. The good performance of this algorithm is shown by comparing them with well-known algorithms and results from the literature.

### ■ TF-20

Tuesday 16:05-17:25

Mann

#### DEA Applications II

Stream: DEA and Performance Measurement

*Invited session*

Chair: *Stella Sofianopoulou*, Industrial Management & Technology, University of Piraeus, 80 Karaoli & Dimitriou street, 18534, Piraeus, Greece, [sofianop@unipi.gr](mailto:sofianop@unipi.gr)

#### 1 - Thermal power plant efficiency evaluation using data envelopment analysis

*Stella Sofianopoulou*, Industrial Management & Technology, University of Piraeus, 80 Karaoli & Dimitriou street, 18534, Piraeus, Greece, [sofianop@unipi.gr](mailto:sofianop@unipi.gr), *Vassilis Dedoussis*, *Constantinos Conostas*, *Agelos Kasimis*

This paper evaluates the overall efficiency of a grid of thermal power plants using the DEA approach. Factors to be taken into account in assessing plant efficiency, such as net energy produced per year, number of times the plant is closed, capital expenditure, emissions, number of workers employed, etc., are discussed. A linear optimization model considering several of these factors is employed. The proposed approach also suggests 'corrective policies' to be followed by inefficient plants. Computational results of a real-world test case indicate that the approach is robust and versatile.

#### 2 - Adjusting for super efficiency and time lags in the regulation of electricity networks

*Mette Bjørndal*, Department of Finance and Management Science, Norwegian School of Economics and Business Administration, NHH, Helleveien 30, N-5045, Bergen, Norway, [mette.bjorndal@nhh.no](mailto:mette.bjorndal@nhh.no), *Endre Bjørndal*

We consider how DEA efficiency estimates can be used to determine revenue caps in a yardstick regulation model. The cost norms must be set such that they allow for super efficiency. This means that the averagely efficient company should earn the rate of return set by the regulator, and the companies should be allowed to realize extra profits if they improve their efficiency. If there are time lags with respect to the reporting of cost and production data, the revenue caps must be adjusted for this. We use data for Norwegian distribution and regional transmission companies in our analyses.

### 3 - Analyzing the performance of Indian maritime states using DEA

*Neelangshu Ghosh*, Business Administration, Siliguri Institute of Technology, Hill Cart Road, Sukna, Dist-Darjeeling, West Bengal, India, 734009, Siliguri, West Bengal, India, neelgh@rediffmail.com, *Ajit Kr Ray*

For understanding the scope of improvement and identifying the areas of inefficiencies of Indian Maritime States in marine fishery, we evaluated, compared and analyzed their performances for the years 2003 & 2005. We applied DEA BCC-O model with two contributing categories of resources as inputs- geographical & fishing fleet-against harvest as output. Inclusion of number of inputs in DEA model being limited by the conventional rule only those verified as independent by Frisch's Confluence Analysis are incorporated. The analysis may help in optimizing underperforming maritime states in future.

### 4 - DEA method in efficiency and productive analysis of Moldavian industry

*Tkacenko Alexandra*, Applied Mathematics, Moldova State University, Alexei Mateevici str. 60, 2009, MD, Chisinau, Moldova, Republic Of, tkacenko@moldovacc.md

In this work we will present an analysis of the economic situation of some branches in Moldova. This was possible using the DEA technique, based on mathematical programmer approach, especially the linear-fractional optimization models. We've provided an analysis of some certain data concerning 17 sectors of Moldavian industry. Using the Efficiency Measurement Programs (EMS) we calculate the indexes of efficiency scores of them, then, underlining their efficiency or inefficiency. The proposed studies cover the period after collapse of totalitarian system.

## TF-21

Tuesday 16:05-17:25

Hauptmann

### AHP II

Stream: Analytic Hierarchy Processes, Analytic Network Processes

*Invited session*

Chair: *Josef Jablonsky*, Dept. of Econometrics, University of Economics Prague, W.Churchill sq. 4, 13067, Prague 3, Czech Republic, jablon@vse.cz

### 1 - A two-stage ahp/dea model for evaluation of efficiency

*Josef Jablonsky*, Dept. of Econometrics, University of Economics Prague, W.Churchill sq. 4, 13067, Prague 3, Czech Republic, jablon@vse.cz

The paper presents a two-stage model for evaluation and ranking of decision making units based on the analytic hierarchy process (AHP) with interval pairwise judgments and data envelopment analysis (DEA) with weight restrictions. The first stage of the model consists in assessment of weights of input and outputs by means of the interval AHP model. The second stage uses a DEA model with weight restrictions for evaluation of efficiency. The proposed modeling approach is applied in assessing the efficiency of bank branches of one of the most important banks in the Czech Republic.

### 2 - Design and multiple criteria evaluation of alternative bicycle tracks in the mid-sized metropolitan area.

*Jacek Zak*, Faculty of Working Machines and Transportation, Poznan University of Technology, 3 Piotrowo street, 60-965, Poznan, Poland, jacekzak@put.poznan.pl, *Szymon Fierek*, *Dawid Nijak*

The paper presents the methodology of designing and evaluating alternative bicycle paths located in the urban transportation system. The authors design heuristically several comparable variants and evaluate them using a consistent family of criteria. The definition of variants includes alternative: routes, infrastructure, pavements, etc. The family of criteria is composed of parameters that represent interests of different stakeholders. Modeling of the DM's preferences and results of computational experiments carried out with the application of multiple criteria ranking methods are presented.

### 3 - An environmental risk assessment methodology proposal for industrial hazardous materials

*Emel Topuz*, Environmental Engineering, ITU, ITU Ayazaga Yerleskesi Insaat Fakultesi, Cevre Muhendisligi Bolumu Maslak, 34469, ISTANBUL, Turkey, topuze@itu.edu.tr, *Ilhan Talyinly*

This study aims to propose a methodology using AHP and fuzzy logic to assess environmental risk of industrial hazardous materials. AHP provides to organize the indicators of risk in a systematic way to simplify the assessment and decision making. This approach benefits from the ability of fuzzy logic to reflect expert opinion by depriving the effects of uncertainty and complexity in environmental issues. Following the hierarchical structure and output of methodology leads decision makers to the source of risk which provides to manage risk and allows the substance to be utilized safely.

## TF-22

Tuesday 16:05-17:25

Arndt

### Environmental Planing

Stream: OR and Environmental Management

*Invited session*

Chair: *Franz Nelissen*, GAMS Software GmbH, Eupener Str. 135-137, 50933, Cologne, Germany, FNelissen@gams.com

### 1 - Targeting the removal of artificial in-stream barriers for the benefit of resident fish

*Jesse O'Hanley*, Kent Business School, University of Kent, KBS, Canterbury, Kent, CT2 7PE, Canterbury, j.ohanley@kent.ac.uk, *Matthew Diebel*, *Mark Fedora*, *Jed Wright*

Using the "stream order range" metric to assess connectivity among different types of riparian habitat, we consider the problem of removing artificial in-stream barriers subject to a budget constraint in order to maximize restoration gains for resident fish species. Although naturally represented in nonlinear form, we succeed in deriving a linear mixed integer program that can be used to approximate an optimal solution to any arbitrary degree of accuracy. Results and analyses are presented for a real-world application to the Pine-Popple watershed located within the US State of Wisconsin.

## 2 - Environmental taxes and the choice of pollution-reducing technology

*Anton Ovchinnikov*, University of Virginia, Darden School of Business, 100 Darden Blvd, 22903, Charlottesville, VA, aovchinnikov@darden.virginia.edu

We study how environmental taxes affect the choice of pollution-reducing technology. In our model, the regulator sets the tax level, and the firm chooses production quantity and price, as well as chooses among production technologies that vary in efficiency, fixed and variable costs. We show that firm's reaction is non-monotone: as tax level increases the firm first switches from dirty to clean technology, but further increase motivates a reverse switch. This reverse effect could be avoided with subsidy. We finally discuss in a Stackelberg framework how the regulator sets the tax level.

## 3 - Choice of alternative environmental policies with quadratic costs under uncertainty

*Motoh Tsujimura*, Faculty of Economics, Ryukoku University, Fukakusa Fushimi-ku, 612-8577, Kyoto, Kyoto, Japan, tsujimura@econ.ryukoku.ac.jp, *Makoto Goto*

This paper investigates the environmental policy designed to reduce emissions of a pollutant under uncertainty. We consider that the costs to implement the policy are divided into the fixed cost, the proportional cost, and the quadratic adjustment cost. Further, we consider the agent has two policy options. Then, the agent must decide that which policy he implements and when he implements the policy to maximize his benefit. To solve the agent's problem, we formulate it as an optimal stopping problem. Furthermore, we present the comparative-static analysis of the thresholds.

## ■ TF-23

Tuesday 16:05-17:25

Planck

## Social Collaboration & Network-based Decision Systems

Stream: Decision Support Systems

Invited session

Chair: *Pascale Zaraté*, Institut de Recherche en Informatique de Toulouse, 118 route de Narbonne, 31062, Toulouse, France, zarate@irit.fr

### 1 - E-government: a comparative study of the g2c online services progress using multi-criteria analysis

*Denis Yannacopoulos*, TECHNOLOGICAL EDUCATIONAL INSTITUTE OF PIRAEUS, 12244, EGALIO, Greece, dgian@teipir.gr, *Panagiotis Manolitzas*, *Athanasios Spyridakos*

In this paper we investigate the progress of on line services delivery. We will analyze the web services that the governments of European Union providing to citizens. Besides a comparative measurement of the progress of online services delivery is presented using MINORA System (Multi-criteria Interactive Ordinal Regression Analysis) Weights criteria and a global utility function, emerged by the application of MINORA system have argued and justified the classification proposed by the EU officers.

### 2 - Web-based decision support through kernel density estimation and combination

*Antonio Rodrigues*, CIO-FCUL, University of Lisbon, Edificio C6, Campo Grande, 1749-016, Lisboa, Portugal, ajrodrigues@fc.ul.pt

We present and describe a simple web-based application demo, for demand forecasting, risk analysis and optimal decision-making. In this, we demonstrate two possible uses of kernel density estimation and combination: in the context of expert opinions elicitation and aggregation, and in the context of time series density forecasting. We also seek to demonstrate how users can benefit from sophisticated decision aid with minimum hassle through a simple web browser interface.

### 3 - Towards a collaboration network for the euro working group on dss (ewg-dss)

*Fatima Dargam*, SimTech Simulation Technology, Ries Strasse 120, 8010, Graz, Austria, F.Dargam@SimTechnology.com, *Rita Ribeiro*, *Pascale Zaraté*

The objective of this work is to create a social-academic network for the EWG-DSS, using as its defined population, the academic members of the group. The main motivation is to analyse and represent the various relationships that link academically the almost 100 members of the Group. We will evaluate the group's collaboration dynamics since 1989. We aim to encourage new research and promote further collaboration among the academic members of the group in common projects and joint-publications, since their current areas of research will be revisited and focused by this study.

## ■ TF-24

Tuesday 16:05-17:25

GSI - S 20

## Particle Swarm Optimization

Stream: Nonlinear Programming

Invited session

Chair: *Takeshi Matsui*, Department of Artificial Complex Systems Engineering, Graduate School of Engineering, Hiroshima University, 1-4-1, Kagamiyama, 739-8527, Higashi-Hiroshima, tak-matsui@hiroshima-u.ac.jp

### 1 - A hybrid particle swarm optimisation for mixed discrete nonlinear programming

*Salam Nema*, Department of Electrical Engineering and Electronics, The University of Liverpool, Liverpool, United Kingdom, salam75@liv.ac.uk, *John Goulermas*

This paper contributes to the development of the field of general Mixed Discrete Non-Linear Programming (MDNLP) by introducing a new hybrid algorithm that combines particle swarm optimisation (PSO) method with a negative subgradient search technique to balance exploration and exploitation. The PSO is used mainly to determine the optimal feasible region surrounding the optimum point. Then, the best known solution of all the swarm particles is chosen as a starting search point for the iterative gradient method that is subsequently used to replace PSO to find the final optimum solution.

### 2 - Computational methods through particle swarm optimization for obtaining Stackelberg solutions to two-level nonlinear programming problems

*Takeshi Matsui*, Department of Artificial Complex Systems Engineering, Graduate School of Engineering, Hiroshima University, 1-4-1, Kagamiyama, 739-8527,

Higashi-Hiroshima, tak-matsui@hiroshima-u.ac.jp,  
Masatoshi Sakawa, Kosuke Kato

In this research, we focus on two-level nonlinear programming problems, in which there is not coordination between the decision maker at the upper level (the leader) and the decision maker at the lower level (the follower), and propose a computational method using particle swarm optimization (PSO) for obtaining Stackelberg solutions to two-level nonlinear programming problems. Moreover, we carry out numerical experiments in order to demonstrate feasibility and effectiveness of the proposed method by comparing with existing methods.

## ■ TF-25

Tuesday 16:05-17:25

GSI - S 25

### Game Theory

Stream: Dynamical Systems and Game Theory

Invited session

Chair: *Flávio Ferreira*, Mathematics, ESEIG - Instituto Politécnico do Porto, R. D. Sancho I, 981, 4480-876, Vila do Conde, Portugal, flavioferreira@eu.ipp.pt

#### 1 - Hotelling's duopoly and location game on the plane

*Vladimir Mazalov*, Institute of Applied Mathematical Research, Karelia Research Center, 185090, Petrozavodsk, Karelia, Russian Federation, vmazalov@krc.karelia.ru, *Julia Tokareva*

We analyze Hotelling's duopoly model on the plane. There are two firms located in different points inside a circle and the customers are distributed with some density in it. The players declare the prices for the goods. The customers compare the costs for a visit of each firm. The costs consist on price plus the distance from the customer to the firm. The solution of two game-theoretic problems is derived. The first problem is to find the equilibrium prices for the homogeneous goods and the second is to find the equilibrium allocation of the players.

#### 2 - Simple bargaining problems and Shapley rule

*Francesc Carreras*, Applied Mathematics II, Technical University of Catalonia, ETSEIAT, P.O. Box 577, E-08220, Terrassa, francesc.carreras@upc.edu

The domain of the proportional rule is that of simple bargaining problems (SBPs), defined by the individual utilities and the utility of the grand coalition. The idea of "closure" of a SBP leads to quasi-additive games and to define a Shapley rule for SBPs. Several axiomatizations are given. Among the axioms, the proportional rule fails to satisfy additivity. Although this property might seem a "mathematical delicatessen", its lack makes inconsistent the proportional rule when dealing e.g. with cost-saving related problems or added-costs problems. No inconsistency arises for the Shapley rule.

#### 3 - A game theoretical model of planned behavior

*Helena Ferreira*, Rua Dr. José Sampaio nº 861, 4810-275, Guimarães, helenaisafer@gmail.com, *Leandro Almeida*, *José Cruz*, *Alberto A. Pinto*

We introduce, in the literature, a Game Theoretical Model of Planned Behavior in which we propose Bayesian-Nash Equilibria as one, of many, possible mechanisms of transforming human intentions in behavior. This model establishes an analogy between the Theory of Planned Behavior that analyses the decision-making mechanisms of individuals and Game Theory concepts. We study the best strategic individual decision taking in account the collective response and consequently the use of a constant strategy in no saturation situations and splitted strategies in boredom and frustration situations.

## ■ TF-26

Tuesday 16:05-17:25

GSI - S 35

### Graph Algorithms I

Stream: Discrete Optimization

Contributed session

Chair: *Alireza Ghaffari Hadigheh*, Math., Azarbaijan University of Tarbiat Moallem, 35 Km. Tabriz-Maraghe Road- Azarbaijan University of Tarbiat Moallem, Dept. of Mathematics, 5375171379, Tabriz, East Azarbaijan, Iran, Islamic Republic Of, hadigheha@azaruniv.edu

#### 1 - A linear algorithm for computing the biclique cover number of a series-parallel graph

*Victor Lepin*, Institute of Mathematics, National Academy of Sciences of Belarus, 11 Surganova str, 220072, Minsk, Belarus, lepin@im.bas-net.by

The biclique cover number of a graph is the minimum number of bicliques, that is, complete bipartite subgraphs, needed to cover all edges of the graph. The problem of computing the biclique cover number is NP-hard even for chordal bipartite graphs. A linear-time algorithm for computing the biclique cover number of a (simple) series-parallel graph is given.

#### 2 - An efficient asymptotically optimal algorithm for the maximum-weight m-peripatetic salesman problem in the k-dimensional Euclidean space

*Edward Gimadi*, Discrete Analysis and Operations Research, Sobolev Institute of Mathematics, Prospekt Akad. Koptyuga, 4, 630090, Novosibirsk, Russian Federation, gimadi@math.nsc.ru

The m-Peripatetic Salesman Problem consist in finding of m edge-disjoint Hamiltonian circuits in graph with the maximum (or minimum) total weight of chosen edges. We consider the maximum-weight problem in a complete graph, where a vertex corresponds to a point, and the weight of an edge equals the length of an appropriate interval in the k-dimensional Euclidean space. Earlier the asymptotic optimality in the case of  $m=2$  was established. In this paper we give an efficient algorithm for  $m>2$  and prove its asymptotic optimality. The work is supported by RFBR (projects 08-01-00516 and 07-07-00222).

#### 3 - Semidefinite optimization approach towards domination number in graphs

*Alireza Ghaffari Hadigheh*, Math., Azarbaijan University of Tarbiat Moallem, 35 Km. Tabriz-Maraghe Road- Azarbaijan University of Tarbiat Moallem, Dept. of Mathematics, 5375171379, Tabriz, East Azarbaijan, Iran, Islamic Republic Of, hadigheha@azaruniv.edu, *Behzad Ashayeri*, *Tamas Terlaky*

For a given graph  $G = (V, E)$ , a set  $S \subseteq V$  of vertices is called a dominating set if every vertex  $v \in V$  is either an element of  $S$  or is adjacent to an element of  $S$ . The domination number  $\gamma(G)$  of a graph  $G$  equals the cardinality of a minimal dominating set in  $G$ . Finding the domination number in general graphs are known as an NP-hard problem. Here, we present a semidefinite optimization relaxation for computing domination number of a general graph that is solvable in polynomial time.

## ■ TF-27

Tuesday 16:05-17:25

GSI - S 21

### Combinatorial Optimization

Stream: Discrete Optimization

*Contributed session*

Chair: *Igor Grebennik*, System engineering, Kharkov national university of radioelectronics, flat 130, Geroev Truda str, 45, 61129, Kharkov, Ukraine, grebennik@onet.com.ua

#### 1 - Integer partitions into arithmetic progressions

*Sadek Bouroubi*, Faculty of Mathematics, Dept of Operations research, USTHB University, Laboratory LAID3, BP32 Bab Ezzouar 16111, 16111, Algiers, Algeria, bouroubis@yahoo.fr, *Nesrine Benyahia Tani*

Every number not in the form  $2k$  can be partitioned into two or more consecutive parts. Thomas E. Mason has shown that the number of ways in which a number  $n$  may be partitioned into consecutive parts, including the case of a single term, is the number of odd divisors of  $n$ . This result is generalized by determining the number of partitions of  $n$  into arithmetic progressions with a common difference  $r$ , including the case of a single term.

#### 2 - Robustness tolerances for combinatorial optimization problems.

*Marek Libura*, Systems Research Institute, Polish Academy of Sciences, Newelska 6, 01-447, Warszawa, Poland, libura@ibspan.waw.pl

In the framework of robust optimization we consider so-called robustness tolerances, defined in analogous way as widely used tolerances of coefficients in standard sensitivity analysis. They provide maximum perturbations of single optimization problem coefficients, preserving the robustness of the solution considered. For the generic combinatorial optimization problem we give formulae for computing the robustness tolerances of all the objective function coefficients and we prove that this can be done in polynomial time whenever the optimization problem is polynomially solvable itself.

#### 3 - Enumeration and constructive tools of generating special combinatorial sets

*Igor Grebennik*, System engineering, Kharkov national university of radioelectronics, flat 130, Geroev Truda str, 45, 61129, Kharkov, Ukraine, grebennik@onet.com.ua, *Yuri Stoyan*

The report is devoted to a problem of generating combinatorial sets of special structure. A concept of the composition  $k$ -image of combinatorial sets (the  $k$ -CICS) generated by primary combinatorial sets is proposed. Permutations, combinations and  $n$ -tuples are considered as the primary combinatorial sets. Classes of the  $k$ -CICS are defined depending on types of the primary combinatorial sets. For enumeration of the  $k$ -CICS we construct combinatorial species of each class of the  $k$ -CICS and corresponding generating series. Examples of the  $k$ -CICS and its applications are given.

## ■ TF-28

Tuesday 16:05-17:25

GSI - S 1

### In-Store Logistics and Demand Management

Stream: Demand and Supply in Consumer Goods and Retailing

*Invited session*

Chair: *Heinrich Kuhn*, Chair of Production Management, Catholic University of Eichstaett-Ingolstadt, Auf der Schanz 49, 85049, Ingolstadt, Germany, heinrich.kuhn@ku-eichstaett.de

#### 1 - Listing, facing and pricing in consumer goods industry

*Alexander Hübner*, WFI - chair of production management Prof. Dr. Kuhn, Catholic University Eichstätt-Ingolstadt, Auf der Schanz 49, 85049, Ingolstadt, alexander\_huebner@mckinsey.com, *Heinrich Kuhn*

The objective is to generate an optimization model which supports to define the right products to offer ("listing"), the right space to allocate ("facing") and the right price to set for each product ("pricing") in consumer goods industries. The profitability for producers and retailers should be maximized under limited shelf space. A literature review shows that either only models used for isolated sales effects or they are not based on real optimization. The model will be tested with real data to provide a practical tool and compare the results with other commonly used methods.

#### 2 - Perishable inventory control under handling and storage constraints

*Rob Broekmeulen*, OPAC, TU Eindhoven, P.O. Box 516, Pav. E10, 5600 MB, Eindhoven, -, Netherlands, r.a.c.m.broekmeulen@tue.nl

We consider a retailer that sells perishable inventory from a capacitated storage space in the store. The customers prefer to withdraw the products Last In First Out. The supplier delivers the products to the backroom from where the products are replenished to the sales area. We investigate control policies that rely on in-store operations to reduce the effects of the withdrawal behavior on outdating by and the handling costs for the retailer.

#### 3 - Identifying the cooperative advertising multi-player game-solution in supply chain using genetic algorithms

*Chen Chie-Bein*, Logistics Management, Takming University of Science and Technology, 56, Sec. 1, Huanshan Rd., Neihu, Taipei 11451, Taiwan R. O. C., 11451, Taipei, Taiwan, cbchen@mail.takming.edu.tw, *Yuanchau Liour*, *Lin Chin-Tsai*, *Chun Hsien*, *Yang-Chieh Chin*

Supply chain members, manufacturers and retailers, usually share common responsibility on national and local advertising for sales promotion. The primary objective of this research is to construct the mathematic models in different market response functions associated with the hierarchical Stackelberg game and then to identify its equilibrium. This research will implement a real case and its numerical results will present the cooperative advertising in Stackelberg game using intelligent genetic algorithm to solve the multi-objective and multi-disciplinary optimization problem in supply chain.

## ■ TF-29

Tuesday 16:05-17:25

GSI - S 2

### Risk Modelling and Management

Stream: Financial Modelling

*Invited session*

Chair: *Georg Pflug*, Department of Statistics and Decision Support Systems, University of Vienna, Universitaetsstrasse 5, A-1010, Vienna, Austria, georg.pflug@univie.ac.at

#### 1 - Probability unbiased value-at-risk (var) estimators

*Florian Herzog*, swissQuant Group AG, Universitätsstr. 9, 8006, Zurich, Switzerland, herzog@swissquant.ch

We show that plug-in estimators for quantiles at a given probability (VaR) are not unbiased w.r.t. the property that a quantile estimator should be probability unbiased. We introduce unbiasedness as the measure for quantile estimators, since the estimate of a quantile should only be exceeded with the same probability as the quantile is constructed. Estimating a quantile needs to be corrected for observing only finitely many samples to get a unbiased estimator. Estimating the VaR of a normal distributed random variable, the distortion function is calculated via the distribution of VaR.

#### 2 - The role of market-implied severity modeling for credit var

*Susana Alvarez*, Department of Quantitative Methods, University of Murcia, Faculty of Economics. Campus de Espinardo, Department of Quantitative Methods, 30100, Murcia, salvarez@um.es, *J. Samuel Baixauli*

We propose to use beta-component mixtures to model the market-implied severity. In our analysis we extract recovery rates from CDS versus using defaulted bonds. Extracting implied, endogenous and dynamic functions of recovery rates from CDS is that it allows to identify recovery rates of low probability of default companies. Our results show that a single beta distribution is rejected as a correct specification for implied recovery rates while a beta-component mixture is accepted. Furthermore, we highlight the importance of this modeling approach by focusing on its role for credit VaR.

#### 3 - Portfolio symmetry and momentum

*Ludovic Cales*, Maison des Sciences Economiques, University Paris-1 Pantheon-La Sorbonne, 106, avenue de l'hopital, 75013, Paris, France, ludovic.cales@univie.it, *Dominique Guegan*, *Monica Billio*

This paper presents a framework to model the evolution of a dynamic portfolio (a portfolio whose weights vary over time), for a given investment strategy. We represent the strategy as a graph whose vertices are the investable portfolios. And we model the evolution of the portfolio as a random walk on this graph. Using quantum probability, we compute the probabilities for the portfolio to be in different regions of the graph. The resulting distribution depending on the properties of the graph, we found that a strategy similar to the one of Jeegadeesh and Titman (1993) is a source of momentum.

#### 4 - Value functions, risk utility functions and their use in concepts for decision making under risk

*Kathrin Fischer*, Institut fuer Quantitative Unternehmensforschung und Wirtschaftsinformatik, Kuehne School of Logistics and Management, TU Hamburg-Harburg, Schwarzenbergstrasse 95, D-21073, Hamburg, Germany, kathrin.fischer@tu-harburg.de

An in-depth analysis of problems resulting from not distinguishing between value and utility functions in decision making under risk is presented. First, the concepts of value and (risk) utility functions are reviewed. Afterwards, by a detailed discussion of different recent publications, it is pointed out why ignoring the difference between the concepts is problematic. It is concluded that — in order to gain valid results — it is vital to use the correct type of function in the analysis of known and in the development of new concepts, especially in descriptive decision theory.

## ■ TF-30

Tuesday 16:05-17:25

GSI - S 26

### Nonlinear Optimization I

Stream: Engineering Optimization

*Invited session*

Chair: *Alexander Tarakanov*, Belskogo, 53-255, 220015, Minsk, alex.tarakanov@gmail.com

Chair: *Jose Herskovits*, COPPE, Federal University of Rio de Janeiro, Caixa Postal 68503, 21945970, Rio de Janeiro, RJ, Brazil, jose@optimize.ufrj.br

#### 1 - Faipa\_mdo, a mathematical programming algorithm for multidisciplinary design optimization

*Jose Herskovits*, COPPE, Federal University of Rio de Janeiro, Caixa Postal 68503, 21945970, Rio de Janeiro, RJ, Brazil, jose@optimize.ufrj.br

FAIPA\_MDO is based on FAIPA, the Feasible Arc Interior Point Algorithm, and employs a Mathematical Programming Model that works with linking variables to introduce the interaction between disciplines. The state variables of each discipline are considered unknowns of the Mathematical Program and the state equations are included as additional equality constraints. FAIPA\_MDO interacts with the Simulation Code of each of the disciplines to compute the state, the state derivatives and solve the tangent state equation. Our approach is strong and efficient for real size applications.

#### 2 - First and second directional derivatives of value functions in nonlinear programming problems with perturbations

*Alexander Tarakanov*, Belskogo, 53-255, 220015, Minsk, alex.tarakanov@gmail.com

Sufficient conditions of directional differentiability of value functions were obtained in the well-known works by Demyanov, Shapiro, Bonnans, Ioffe, Auslender and Cominetti and other authors. As a rule these works investigate problems with single solutions and utilize (explicitly or implicitly) some types of Lipschitz continuity of optimal solutions. In our paper we extend the method of first-order approximations by Demyanov and Rubinov to study directional differentiability of value functions in optimization problems with non-single solutions.

#### 3 - Handling manufacturing restrictions in sheet metal design by mixed integer programming

*Ute Guenther*, Mathematics, TU Darmstadt, Schlossgartenstrasse 7, 64289, Darmstadt, Germany, ugenther@mathematik.tu-darmstadt.de, *Alexander Martin*

We investigate an application from mechanical engineering where the aim is to find design plans for branched sheet metal structures. The problem is modeled as a directed Steiner tree with additional constraints such as on the diameter. To model all features from the engineering side we introduce new classes of variables for the tree which in return enables us to formulate connectivity constraints in a new way via facet-defining inequalities. We will also show how manufacturing restrictions for real-life examples can be handled using branch-and-cut approaches and new graph algorithms.

#### 4 - A modified relaxation method for mathematical programs with complementarity constraints (mpccs)

*Abdeslam Kadrani*, Mathématiques et Informatiques, Université de Limoges, 123, Av. Albert Thomas, 87060, Limoges, abdeslam.kadrani@usherbrooke.ca

In this talk, we present a modified relaxation method for solving mathematical programs with complementarity constraints (MPCCs). We show that this method has strong convergence properties. A penalty active set algorithm is proposed, which solves a sequence of relaxed penalized problems derived from MPCC. Global convergence results are deduced without assuming strict complementarity. Under very general assumptions, the algorithm can always find some point with strong or weak stationarity. Numerical results will be presented.

#### ■ TF-31

Tuesday 16:05-17:25

GSI - S 34

### Knowledge Discovery, Management and Optimization

Stream: Optimization and Data Mining

*Invited session*

Chair: *Emilio Carrizosa*, Estadística e Investigación Operativa, Universidad de Sevilla, Matemáticas, Reina Mercedes s/n, 41012, Sevilla, Spain, Spain, ecarrizosa@us.es

#### 1 - Self-organizing maps for data mining

*Enrique Dominguez*, Dept. of Computer Science, E.T.S.I.Informática - University of Malaga, Campus Teatinos s/n, 29071, Malaga, Spain, enriqued@lcc.uma.es

Self-organizing maps (SOMs) constitute an excellent tool for knowledge discovery in a data base, extraction of relevant information, detection of inherent structures in high-dimensional data and mapping these data into a two-dimensional representation space. However, one of the drawbacks arises because the network architecture has to be established in advance, and this task is usually difficult in a lot of problems of the real world due to the high dimensionality of the input data. Another drawback is the hierarchical relationships among input data.

#### 2 - Dimensionality reduction for linear support vector machines using column generation

*Richard Weber*, Department of Industrial Engineering, University of Chile, Republica 701, 2777, Santiago, Chile, rweber@dii.uchile.cl, *Jaime Miranda*

Many applications require the analysis of large data sets. Several methods exist for this task being Support Vector Machines (SVM) of particular interest from an optimization point-of-view. A major problem, however, when applying SVM is the computational time which increases exponentially with the observed data points. We present a column generation approach for linear SVM which reduces considerably computational time. The respective results show that the correct solution or a very close approximation can be obtained using very few data points thus providing fast results for large data sets.

#### 3 - Binarized support vector machine and extensions

*Belen Martin-Barragan*, Dpto. Estadística, Universidad Carlos III de Madrid, c/Madrid 126, 28903, Getafe, Madrid, Spain, belen.martin@uc3m.es, *Dolores Romero Morales*, *Emilio Carrizosa*

The interpretation ability of a data mining tool is an important factor to explain its success, as for example in algorithms as Classification and Regression Trees (CART) and Logical Analysis (LAD) of Data. Margin-based classifiers, as Support Vector Machines (SVM), have become a very powerful tool for classification and regression. However, the classifier produced by crude Support Vector Machines is not as interpretable as CART or LAD.

In this work we present various SVM-based tools for classification and regression problems where interpretability is an important issue.

#### ■ TF-32

Tuesday 16:05-17:25

GSI - S 4

### Data mining methodology

Stream: Data Mining

*Contributed session*

Chair: *Davide Magatti*, Department of Information, Systems and Communication, Università degli Studi di Milano Bicocca, Edificio U14, Viale Sarca 336/14, 20126, Milan, Italy, magatti@disco.unimib.it

#### 1 - Analysing databases of quantitative and qualitative data with missing qualitative values

*Fabiola Portillo*, Economics and Business Administration, Universidad de La Rioja, Edificio Quintiliano, C/ Ciguena 60, 26004, LOGROÑO, La Rioja, fabiola.portillo@unirioja.es, *Cecilio Mar-moliner*

The analysis of databases with qualitative and quantitative data is complex. A new procedure was applied for the estimation of qualitative missing values: we first applied optimal scaling (OS) to complete data; next, correlations between variables were studied; third, the relationships between variables were explored using Path Analysis; and, finally, a homogeneity analysis based procedure was followed in order to obtain the imputations that were used in the final OS analysis. The OS analysis was performed a second time, and the results were interpreted using CATPCA and Property Fitting.

#### 2 - Hierarchical topic extraction

*Davide Magatti*, Department of Information, Systems and Communication, Università degli Studi di Milano Bicocca, Edificio U14, Viale Sarca 336/14, 20126, Milan, Italy, magatti@disco.unimib.it, *Fabio Stella*

Topic Extraction (TE) is a form of document clustering and organization which has become particularly important in the last years. Starting from a documents corpus, TE is concerned with the problem of discovering which are the mentioned topics. In this talk the authors extend topic extraction by allowing topics to be organized according to an unknown hierarchy. A quantitative model to infer the topics hierarchy is described and the corresponding learning algorithm is presented. The proposed approach is supported by a set of numerical experiments.

#### 3 - Misclassification probability bounds in multinomial case

*Victor Nedelko*, Siberian Branch of Russian Academy of Science, Institute of Mathematics, Zolotodolinskaya 29-315, 630090, Novosibirsk, nedelko@math.nsc.ru

A problem of construction bounds for misclassification probability is considered for the multinomial case with one discrete variable given. The bounds are constructed as functions of certain statistics such as empirical risk (resubstitution error) or leave-one-out misclassification rate. Some properties of these statistics were investigated, namely the highest possible bias of empirical risk was obtained and the distribution that provides such bias was found. Effectiveness of leave-one-out and empirical risk statistics was also compared.

#### 4 - Specification of rank scaled expert estimations using measured data

*Anton Strizhov*, Faculty of Mechanics and Mathematics, Lomonosov Moscow State University, Klara Zetkin 13-79A, 127299, Moscow, anton.strizhov@gmail.com, *Vadim Strijov*

One has to find linear-scaled estimations of integral indicators which does not contradict expert estimations. Rank-scaled expert estimations of objects quality and features importance together with measured data table are given. Rank estimations define a polyhedral cone of weights and a cone of indicators. The linear operator maps the cone of weights to a cone in the space of indicators. If this cone intersects the cone of indicators, then the required estimations belongs to this intersection. Otherwise, we must find a compromise between the specified and mapped estimations.

## TF-33

Tuesday 16:05-17:25

GSI - S 7

### Economic Modelling

Stream: Linear Optimization

Contributed session

Chair: *Nicolas Omont*, Artelys, 12 rue du 4 septembre, 75002, Paris, nicolas.omont@artelys.com

#### 1 - Multilateralism and regionalism — statistical relationship

*Eva Cihelkova*, Department of World Economy, University of Economics, Prague, Winstona Churchill 4, 130 67, Prague 3, Czech Republic, cihelka@vse.cz

The paper describes the mutual relationship between multilateralism and regionalism using the tools of statistical approaches. The mathematical model is created, which serves as a base for further study of the mutual relationship of both tendencies by empirical analyses and regression analyses. The variables characterizing preferential against non-preferential tariffs are used to verify a mutual support/concurrence of relations in question. The results allowed to characterize the mutual relationship of both tendencies authoritatively. Prepared under GA 402/07/0253 and MSM6138439909.

#### 2 - National economy challenges in croatia within global crisis environment

*Elza Jurun*, Faculty of Economics, University of Split, Department of Quantitative Methods in Economics, Matice hrvatske 31, 21000, Split, Croatia, elza@efst.hr, *Josip Arneric*, *Lana Kordic*

This paper is a part of an extensive scientific research about modern trends in Croatian national economy within environment of global crisis. For this purpose real retail trade turnover, average monthly real wages and household loans are chosen for multiple econometric analysis. Original national statistics data of retail trade turnover were deflated using consumer price indices and process of seasonally adjustment of its contemporary behavior was provided. The modeling is based on the real Croatian national economy time-series.

#### 3 - Towards electricity transmission tariffs based on long term marginal pricing

*Nicolas Omont*, Artelys, 12 rue du 4 septembre, 75002, Paris, nicolas.omont@artelys.com, *Jérôme Dejaegher*, *Arnaud Renaud*

Electricity transmission prices impacts two different objectives: ensuring economic sustainability (cost recovery) and sending incentives to actors to adjust their production/consumption level (overall efficiency of the system).

We propose a methodology to build temporally and spatially differentiated tariffs that send incentives to producers and consumers in order to reach an optimal social surplus while ensuring cost recovery. This methodology is based on long term marginal prices derived from a neoclassical economic equilibrium.

#### 4 - Efficiency of fdi inflows supporting gdp. central European economies.

*Vaclava Pankova*, Dept. of Econometrics, University of Economics Prague, W.Churchill sq. 4, 13067, Prague 3, Czech Republic, PANKOVA@VSE.CZ, *Roman Husek*

Relationship between FDI and GDP of middle European new EU members, compared to Austria, is studied by the help of panel data techniques. Two approaches are applied. (1) VAR model looking for causality between both entities, (2) efficiency measurement of influence of FDI on GDP. Evidence of a relationship between FDI and level of capital is strong, relevancy of labor productivity to FDI inflows is not confirmed. The results found show that in the followed region FDI support an economic growth and vice versa. Prepared under GACR 402/07/0049, 402/09/0273.

## TF-34

Tuesday 16:05-17:25

GSI - S 8

### Business Rules: Extraction, Modelling and Integration

Stream: Applications in Business Intelligence and Knowledge Discovery

Invited session

Chair: *Jose C. Gonzalez*, DAEDALUS, S.A., Avda. Albufera 321, 28031, Madrid, Spain, jgonzalez@daedalus.es

#### 1 - Extraction of business rule from unstructured text

*Thierry Declerck*, Language Technology Lab, DFKI, Stuhlsatzenhausweg, 3, D-66123, Saarbrücken, Germany, declerck@dfki.de

We present a strategy for extracting business rules from unstructured text. For this we submit regulatory texts to a parser, which detects and marks syntactic "constituency" structures (words, phrases, clauses and sentences) and "dependency" relations in the input. "Dependency" is about relations between the identified syntactic constituents on the base of grammatical functions played by the constituents in relation to each other within the larger constituent they are embedded in. Those relations are mapped onto a formal representation language, in which Business Rules can be expressed.

#### 2 - Harnessing business rules in software development processes

*Jose C. Gonzalez*, DAEDALUS, S.A., Avda. Albufera 321, 28031, Madrid, Spain, jgonzalez@daedalus.es, *José Luis Martínez-Fernández*, *Paloma Martínez*

This contribution describes an approach to support business rules design and development, assuring an easy integration in the software development process. When there is a need to introduce decision support in Information Technology systems, Business Rules are a good alternative. Two main goals are pursued: 1. Business Rules should be defined in an independent way, i. e., the definition should be valid for any BRE considered 2. The tasks related to the definition and management of new Business Rules should be easily integrated in the software development process implemented in an organization.

**3 - Protune: rule based policies on the semantic web**

*Daniel Olmedilla*, Telefonica R&D, Emilio Vargas 6, E28043, Madrid, danieloc@tid.es

This talk will present part of the work performed within the EU REVERSE Network of Excellence (Reasoning on the Web with Rules and Semantics) and in particular the Protune policy framework ([www.l3s.de/web/protune](http://www.l3s.de/web/protune)). The work performed in the Protune framework offers a high flexibility for specifying any kind of policy, offers mechanisms to write policies in a controlled natural language, and integrates external systems such as relational databases at the policy level. It also provides facilities for increasing user awareness such as explanations of the policies in natural language.

**4 - Success monitoring in transportation**

*Heribert Kirschfink*, momatec GmbH, Weiern 171, 52076, Aachen, heribert.kirschfink@momatec.de

Transportation networks have the goal to ensure mobility. This means to serve transport demand under the constraint of ensuring traffic safety. To reach that goal, capacity bottlenecks caused by high demand, incidents and "planned" capacity bottlenecks like road work have to be managed. In particular road work may cause conflicts for the network operator as cost of maintenance correlate with traffic flow quality. So, characteristic figures for mobility services, the value of the network and the performance of the underlying processes are needed to monitor and control the economic success.

**TF-35**

Tuesday 16:05-17:25

GSI - S 9

**Commodity Prices and Procurement**

Stream: Value and Risk in Incomplete Markets

*Invited session*

Chair: *Peter Kelle*, ISDS, Louisiana State University, CEBA, 70810, Baton Rouge, Louisiana, United States, qmkell@lsu.edu

Chair: *Martin Rainer*, ENAMEC, Glockengasse 15, D-97070 Würzburg, 97070, Würzburg, Germany, martin.rainer@enamec.de

**1 - The framework for evaluation of the communication bandwidth market models**

*Wojciech Stanczuk*, Institute of Telecommunications, Warsaw University of Technology, ul. Nowowiejska 15/19, Warszawa, 00-665, Warszawa, w.stanczuk@tele.pw.edu.pl, *Piotr Palka*, *Jozef Lubacz*, *Eugeniusz Toczylowski*

The paper presents the framework for studying and analyzing the properties of market models for bandwidth allocation in communication networks - the family of Balancing Communication Bandwidth Trade models, combinatorial auction based c-SeBiDA model etc. A set of bandwidth allocation indicators defined for comparing test results is described. Network topologies for test cases come from the SNDLib database. Buy and sell offers are generated according to assumed market conditions. Test cases are modeled in the XML-based Multicommodity Market Model. Some examples of test results are presented.

**2 - A combined capacity reservation and spot market procurement policy under stochastic demand and spot-market price uncertainty**

*Karl Inderfurth*, Faculty of Economics and Management, Otto-von-Guericke University of Magdeburg, Universitaetsplatz 2, 39106, Magdeburg,

Germany, [inderfurth@ww.uni-magdeburg.de](mailto:inderfurth@ww.uni-magdeburg.de), *Peter Kelle*

In an inventory system with uncertain demand the cost-effective management of the combined use of a short-term (spot-market with a random spot-market price) and long-term procurement option (wholesale price contract with a capacity reservation level) is considered. The task is to fix a long-term capacity reservation level and to decide period-by-period on how to combine the two supply options. Analytical results are developed for a simple two-parameter base stock policy. It is investigated how capacity reservation and sourcing decisions depend on the level of both demand and price uncertainty.

**3 - Integrating commodity markets in the optimal procurement policies of a stochastic inventory system**

*Ankur Goel*, Operations, Case Western Reserve University, 10900 Euclid Avenue, Peter B Lewis Building, 44106, Cleveland, OH, [ankur.goel2@case.edu](mailto:ankur.goel2@case.edu)

In this paper we develop optimal procurement policies for traded commodities; our model incorporates the market determined term structure of commodity prices. The actual cost of holding a commodity is determined by the spread between the spot and futures prices. In order to achieve an optimal stocking level firm needs to balance this exogenously imposed holding cost with the marginal benefit of stocking an additional unit of inventory. We model transaction costs associated with procurement, and we characterize optimal procurement policies from both spot and forward markets.

**TF-36**

Tuesday 16:05-17:25

GSI - S 11

**Stochastic Modelling 3**

Stream: Stochastic Modelling

*Contributed session*

Chair: *Frank Beichelt*, School of Statistics and Actuarial Science, University of the Witwatersrand, Private Bag 3, WITS 2050, 2050, Johannesburg, South Africa, [Frank.Beichelt@wits.ac.za](mailto:Frank.Beichelt@wits.ac.za)

**1 - Ordering of utility functions of weighted random variables and its financial application.**

*Elena Almaraz Luengo*, Estadística e Investigación Operativa, Facultad de Ciencias Matemáticas, U.C.M., Plaza de Ciencias, 3, 28040, Madrid, Spain, [calmarazluengo@mat.ucm.es](mailto:calmarazluengo@mat.ucm.es)

It's established order relations between particularly utility functions applied to random weighted variables (rwv), knowing the existing relations between the original random variables (rv) from which we've built the rwv. The utility functions we used are based in the mean of the rv and in another risk measure different from the variance, because the use of this last caused inconsistency with the stochastic dominance rules. The results obtained have applications in assets selection and we pretend to generalize these results to obtain the efficient portfolio in continuous time.

**2 - Benefits of partial product flexibility**

*Ashis Chatterjee*, Operations Management, Indian Institute of Management Calcutta, Indian Institute of Management Calcutta, D.H.Road, Joka, Kolkata-700104, 700104, Kolkata, West Bengal, India, [ac@iimcal.ac.in](mailto:ac@iimcal.ac.in), *Dipankar Bose*

In this paper, we develop a single period model for multi-product-multi-plant scenario to determine the plant capacities and the product-plant assignments that optimize expected profit under demand uncertainty. Due to analytical intractability, simulated data based optimization has been used for the purpose of the solution. The solutions give insights on the economics of product flexibility. Specifically, conditions under which investment in partial flexibility may be a better strategy have been examined under various levels of demand uncertainty and correlation of demand among products.

### 3 - Maximal system availability under cost restrictions

*Frank Beichelt*, School of Statistics and Actuarial Science, University of the Witwatersrand, Private Bag 3, WITS 2050, 2050, Johannesburg, South Africa, Frank.Beichelt@wits.ac.za

Repair cost limit replacement policies are user-friendly maintenance policies for a wide variety of technical systems. So far their analysis has been restricted to the application of constant repair cost limits and the minimization of the maintenance cost rate. The talk investigates the effect of age-dependent repair cost limits and age-dependent repair costs on the system availability. Under the assumptions made it is shown that the application of decreasing repair cost limits is more efficient than applying a constant repair cost limit.

## TF-37

Tuesday 16:05-17:25

GSI - S 12

### Strategic Planning and Management

Stream: Decision Analysis

Contributed session

Chair: *Jin Young Choi*, 134 Shinchon-dong, Seodaemun-Gu, 120-749, Seoul, Korea, Republic Of, gksniper@naver.com

#### 1 - Improving the alignment of strategic objectives in the outsourced projects management

*Edilson Giffhorn*, Production Engineering, Santa Catarina Federal University, Rod. Amaro Antônio Vieira, 655, apt. 106-E, Bairro Itacorubi, 88034-101, Florianópolis, Santa Catarina, Brazil, edilson.giffhorn@gmail.com, *William Vianna*, *Leonardo Ensslin*, *Sandra Ensslin*, *Rogério Lacerda*

This paper presents a research developed in a Brazilian telecom system operator and aims to build a personalized performance assessment model. The intervention instrument used was the MCDA-C. The built model made possible: 1) to align the strategic objectives; 2) to measure and to compare the performance of the companies; 3) to have a process for monitoring and improvement of the outsourced companies. As result, the decision-maker become to have a management practice, consistent and scientifically well-founded that allows disseminating to outsourced companies how to improve their performance.

#### 2 - Multi-objective optimization for planning of central it resources with focus on green it

*Marc Klages*, Universität Hannover, Institut für Wirtschaftsinformatik, Königsworther Platz 1, 30167, Hannover, klages@iwi.uni-hannover.de, *Hans-Jörg von Mettenheim*, *Michael H. Breitter*

Recently, an additional variable is introduced when planning central IT resources: ecologically sound purchases. With the ongoing internalization of ecological costs we need a framework to provide the ground for economically viable solutions. Using multi-objective optimization we provide a reference model for optimization of capacity dependent electricity consumption in clusters and grid computers. Two case-studies conclude our research: Optimizing a cluster of CPUs which allow load based deactivation of cores and optimizing the decision of choosing between fat and thin client architecture.

#### 3 - A decision-analytic approach to blue-ocean strategy development

*Thorsten Staak*, Department of Economics, Otto-von-Guericke University, Postfach 4120, 39016, Magdeburg, Germany, thorsten.staak@ovgu.de, *Matthias Raith*, *Helge Wilker*

The "Blue Ocean" strategy development approach (Kim, Mauborgne 2005) is based on the realization that it is much more valuable to find uncontested market space than to compete against incumbent firms. The main instrument used is the strategy canvas, a visual depiction of strategy profiles. The approach leaves unclear how a blue-ocean strategy is recognized among multiple alternatives. Therefore, we consider the selection of a strategy profile as a multi-attribute decision problem. This decision-analytic approach allows the entrepreneur to quantitatively derive the optimal market strategy.

#### 4 - Developing the tradeoff between personal fulfillment and competitiveness in venture creation

*Simon Halberstadt*, Lehrstuhl für Entrepreneurship, Otto-von-Guericke Universität Magdeburg, Postfach 4120, 39016, Magdeburg, Sachsen-Anhalt, Germany, simon.halberstadt@ovgu.de, *Matthias Raith*, *Thomas Zomack*

Venture creation is usually associated with an entrepreneur's opportunity of achieving personal fulfillment. In reality many nascent entrepreneurs discover that much of their vision is sacrificed in the process of creating a startup. We address the conflict between personal fulfillment and the startup's competitiveness from a negotiation-analytic perspective. We show how the conflict is transformed in the planning process, and demonstrate how a purely market-oriented focus on expansion serves to enhance personal fulfillment. Finally, we discuss practical implications for business development.

## TF-38

Tuesday 16:05-17:25

GSI - S 13

### Strategic optimization in supply chains and risk management II

Stream: Variational Problems - Theory, Methods and Applications

Invited session

Chair: *Cedric Yiu*, Applied Mathematics, The Hong Kong Polytechnic University, Hunghom, -, Kowloon, macyiu@polyu.edu.hk

#### 1 - Optimal inventory strategies with fixed order cost under value-at-risk constraint

*Shuoyu Wang*, Industrial and Manufacturing Systems Engineering, The University of Hong Kong, Pokfulam, -, Hong Kong, Hong Kong, wsyu@hkusua.hku.hk, *Cedric Yiu*, *Kl Mak*

The underlying idea of this paper is to consider the raw material inventories of a manufacture as a part of investment. Then the inventory control problem can be treated from the point of financial risk management. A portfolio consisting of the risky raw material inventory and the risk free bank account is studied and the VaR of the portfolio is analyzed and imposed as a risk control constraint. The objective function is to maximize the utility of total portfolio value. In this model, the ordering cost is assumed to be fixed and the selling cost is proportional to the value.

## 2 - Risk constrained optimal portfolios with jumps

*Cedric Yiu*, Applied Mathematics, The Hong Kong Polytechnic University, Hunghom, -, Kowloon, [macyiu@polyu.edu.hk](mailto:macyiu@polyu.edu.hk), *Jingzhen Liu*

In this article, we impose the VaR as a dynamic constraint to the optimal portfolio problem with jumps. At each instant, the VaR is estimated and is applied to influence the investment decision. The optimal portfolio problem is formulated as a constrained maximization of the expected utility, with the constraint being the VaR level. Dynamic programming is applied to reduce the whole problem to solving the Hamilton-Jacobi-Bellman equation coupled with the VaR constraint, and the method of Lagrange multiplier is then applied to handle the constraint. A numerical method is proposed.

## 3 - Optimal policy for an insurer via martingale methods

*Jingzhen Liu*, Applied Mathematics, The Hong Kong Polytechnic University, Hunghom, -, Kowloon, Hong Kong, 06902020r@polyu.edu.hk, *Cedric Yiu*

In this paper, the optimal investment and proportional reinsurance policy are considered with the objective to increase the expected utility for the terminal wealth. The mathematical model of the surplus process is developed and the problem is formulated as a stochastic optimal control. By using martingale methods, this stochastic optimal control problem is reduced to solving a deterministic problem, which can then be tackled numerically by the control parametrization method.

## 4 - Integrated design in service support supply chains

*Alexander Richter*, Business Administration and Production Management, Ruhr University Bochum, Universitätsstraße 150, 44801, Bochum, Germany, [alexander.richter@rub.de](mailto:alexander.richter@rub.de), *Marion Steven*

This paper focuses Industrial Product-Service Systems which consist of customized configurations of product and service parts tailor-made to meet individual customer needs. These product and service parts exert a mutual influence on each other, owing to an integrated development and operation. By following such customer-oriented strategies the service support supply chain needs to be reshaped, striving at reallocating risks and incentives. In an incomplete contract framework, we analyze the design of both Industrial Product-Service Systems, the supply chain, and their interrelation.

## ■ TF-39

Tuesday 16:05-17:25

GSI - S 14

### Simulation 2

Stream: Simulation

*Contributed session*

Chair: *Ulf Lotzmann*, Institute of Information Systems Research, University of Koblenz-Landau, Universitaetsstr. 1, 56070, Koblenz, [ulf@uni-koblenz.de](mailto:ulf@uni-koblenz.de)

## 1 - Variance reduction methods for t-copula based risk models

*Halis Sak*, Department of Statistics and Mathematics, WU Vienna University of Economics and Business,

Augasse 2-6, 1090, Wien, Austria, [halis.sak@gmail.com](mailto:halis.sak@gmail.com), *Wolfgang Hörmann, Josef Leydold*

It is well known that modeling the log-return of several assets by a multinormal model is not adequate; especially the tails of portfolio returns are much too low in that model due to the tail dependence real data exhibit. Modeling the log-returns by a t-copula with generalized hyperbolic marginals is considered as a realistic model in the literature. That model is little used in practice as it is difficult to calculate risk measures. In the talk we present efficient Monte Carlo algorithms for calculating the tail loss probabilities of stock portfolios for the mentioned model.

## 2 - Optimizing systems performance exploring the timed state space of coloured petri nets

*Miguel A. Mujica*, Telecommunications and Engineering Systems, Universitat Autònoma de Barcelona, campus univ edif q, bellaterra, 08193, barcelona, Spain, [el\\_mota2000@yahoo.com.mx](mailto:el_mota2000@yahoo.com.mx), *Miquel Angel Piera*

Coloured Petri Nets is a formalism which has been used for validation and verification of systems. One tool used for these purposes is the reachability tree which is a graph that stores all the states of the model. In systems performance studies, an attachment of time characteristics must be done to the model. State Explosion is a problem in state space analysis making some problems intractable due to the size of the state space. It is presented an approach which deals with T-State Spaces and selects the best paths based in time analysis avoiding the exploration of the whole T- State Space.

## 3 - Simulating normative behaviour and norm formation processes

*Ulf Lotzmann*, Institute of Information Systems Research, University of Koblenz-Landau, Universitaetsstr. 1, 56070, Koblenz, [ulf@uni-koblenz.de](mailto:ulf@uni-koblenz.de)

We describe the design of an agent-based model for simulating normative behaviour and norm formation processes, grounded in a scientific theory of norm innovation (EU-Project EMIL - EMergence In the Loop). Based on a message concept, the behavior of an agent is influenced by events perceived from concrete actions in a given scenario as well as by the valuation of events received from other agents related to performed actions. The evaluation of these different event types triggers a norm formation and learning process and determines the normative behavior of agents.

## ■ TF-40

Tuesday 16:05-17:25

GSI - S 27

### Modeling and simulation for management training and learning in emergency situations

Stream: Simulation Based Decision Support

*Invited session*

Chair: *Viveca Asproth*, Information Technology and Media, Mid Sweden University, 83125, Östersund, Sweden, [viveca.asproth@miun.se](mailto:viveca.asproth@miun.se)

Chair: *Stig C Holmberg*, Information Technology and Media, Mid Sweden University, Mid Sweden University, ITM - Q351, 83125, Östersund, Sweden, [shbg@ieee.org](mailto:shbg@ieee.org)

### 1 - Simulated decision learning in a multiactor setting

Viveca Asproth, Information Technology and Media,  
Mid Sweden University, 83125, Östersund, Sweden,  
viveca.asproth@miun.se, Stig C Holmberg

The idea of decision analysis — and subsequent learning from the outcomes — is old within OR. Here this approach to continuous improvement of decision outcomes is put one step further within the area of crisis and disaster management. This is done by introducing multiactors making simultaneous decisions with just partial information about each other. Further, decision outcomes are achieved from a simulation model rather than from the real object system.

### 2 - Modelling and simulation for training of disaster management

Andrej Skraba, Faculty of Organizational Sciences,  
University of Maribor, Kidriceva cesta 55a, 4000,  
Kranj, Slovenia, Slovenia,  
andrej.skraba@fov.uni-mb.si, Miroljub Kljajic

Proposed paper will address development of a modular immersive simulation platform, which can be used by trainers to introduce unexpected impacts within the scenario. Effective training systems for crisis managers are necessary to provide decision support during relief operation following security incidents on critical trans european transport networks. Development of new interactive simulation systems capable to provide large-scale simulations of inter-modal traffic and emergency units that can dynamically adjust to events introduced in real-time by operators will be described

### 3 - Disaster management simulation debriefing: a prototype of an integrated statistical analysis tool

Knut Ekker, Information Technology, Nord-Trøndelag  
University College, PO box 2501, 7729, Steinkjer,  
Norway, knut.ekker@hint.no

This paper explores the use of an open source statistical tool integrated in a disaster management simulation. The purpose of the integrated tool is to provide an on-the-fly analysis of simulation data for the debriefing session immediately following a disaster management simulation. A prototype of such a tool will be developed and tested with computer generated data on communication among simulation participants, media handling agility of the participants as well as individual and organisational learning effects.

## ■ TF-41

Tuesday 16:05-17:25

GSI - S 28

## Production and Operations Management 1

Stream: Production and Operations Management

Contributed session

Chair: Anja Klein, SAP Research CEC Dresden, SAP AG,  
Chemnitz Str. 48, 01187, Dresden, Germany,  
anja.klein@sap.com

### 1 - Minimizing electrical losses in long-term power planning

Mathilde Drouineau, Center for Applied Mathematics,  
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mathilde.drouineau@mines-paristech.fr, Vincent  
Mazauric, Nadia Maïzi

2/3 of global electricity generation relies on fossil fuels and losses rise with the consumption. A thermodynamic approach shows that power systems can provide the best power transactions. Thus lowering electrical losses could mitigate GHG and we aim at minimizing them in long-term planning. Losses are twofold: the conveyance ones, occurring during transmission, lowered when capacities are close to the loads; and the reliability-induced ones, needed to handle dynamic management, lowered with conventional plants. The latter affect the mix itself whereas the first are assessed for a given mix.

### 2 - Henry ford revisited: one more generalization of the assignment problem

Stanislaw Walukiewicz, Systems Research Institute,  
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Warsaw, Stanislaw.Walukiewicz@ibspan.waw.pl

One among many origins of the assignment problem is the Classical Production Line (CPL), introduced by Henry Ford in auto industry in 1913. In 2006 Walukiewicz introduced the idea of Virtual Production Line (VPL) as a model for the analysis of problem solving processes and demonstrated that it is as an expansion of the CPL concept. In contrast to CPL however, experts on VPL are chiefly thinking, among others, about how to organize the creative processes - we will call this self-organisation of VPL. It matters very much on VPL. We define the problem of assignment of experts to tasks on VPL.

### 3 - Operations research for quality improvement of sensor data

Anja Klein, SAP Research CEC Dresden, SAP AG,  
Chemnitz Str. 48, 01187, Dresden, Germany,  
anja.klein@sap.com

Sensor data is recorded and processed to support business decisions in manifold applications. However, data quality problems due to limited sensor precision and sensor failures result in faulty decisions. To improve the data quality of processing results, we present the quality-driven optimization. A study of sensor quality aspects and processing operators revealed a multi-objective, non-linear optimization problem. We extend heuristic optimization algorithms to solve this problem and compare performance and obtained quality improvement at real-life data from the contact lens production.

## ■ TF-42

Tuesday 16:05-17:25

GSI - S 3

## Optimal Control II

Stream: Optimal Control

Invited session

Chair: Raouf Boucekkine, Université catholique de  
Louvain, B-1348, Louvain-La-Neuve, Belgium,  
Raouf.Boucekkine@uclouvain.be

### 1 - Economic modelling of optimal investment into long-term redevelopment in disaster-impacted regions

Natali Hritonenko, Mathematics, Prairie View A&M  
University, PO Box 0519, 77446, Prairie View, TX,  
nahritonenko@pvamu.edu, Yuri Yatsenko

A vintage capital model is used to describe the investment into new capital, infrastructure and migration with goals of creating disaster—resilient regional economy. A natural disaster is depicted as a sharp decrease of capital assets which causes a deviation of optimal trajectory from a balanced growth path to capital shortage and higher unemployment area. Such perturbations are similar to technological shocks in labour-saving technical change. Anticipation effects are discussed. Analysis reveals new general strategies to develop a disaster—resilient economy of the impacted region.

## 2 - Maintenance and investment in an optimal growth vintage capital model

*Raouf Boucekkine*, Université catholique de Louvain, B-1348, Louvain-La-Neuve, Belgium,  
Raouf.Boucekkine@uclouvain.be, *Fausto Gozzi*,  
*Giorgio Fabbri*

In a vintage capital framework, we postulate that once machines installed, firms devote resources to keep them operational over time. Machines are kept until this maintenance cost exceeds productivity. Within an optimal control set-up, we determine the properties of optimal investment and maintenance paths. Since the optimal lifetime of machines is finite, we deal with an optimal control of a differential-difference equation, yielding an infinite dimensional problem. We end up applying an appropriate dynamic programming approach. Optimal dynamics are studied numerically.

## 3 - Forest management for timber and carbon in the presence of climate changes

*Renan Goetz*, Department of Economics, University of Girona, Campus Montilivi, s/n, 17071, Girona, Spain,  
renan.goetz@udg.edu, *Natali Hritonenko*, *Rubén*  
*Javier Mur Torrentó*, *Yuri Yatsenko*, *Àngels Xabadia*

This paper analyzes the optimal forest management for timber and carbon sequestration. It employs a distributed opt. control model based on a partial integral-differential equation. It examines the effects of rising carbon prices and incorporates the effect of different climate change scenarios on forest growth. Maybe these aspects have received little attention as it requires a complete integration of the biophysical and economic model. Evaluating the principal valuation methods for carbon sequestration shows that one of them is only correct if the growth rate is equal to the discount rate.

## 4 - Managing level of vendor-managed inventory with manufacturer's warehouse capacity constraint

*Wenyih Lee*, Department of Business Administration, Chang Gung University, 259 Wenhua 1st Rd.,  
Kweishan, 333, Taoyuan, Taiwan,  
leewe@mail.cgu.edu.tw, *Sheng-Pen Wang*

We consider a single-supplier, single-buyer vendor-managed inventory problem. An integrated inventory control model, making joint economic lot sizes of the manufacturer's production batch and the replenishment lot, subject to manufacturer's warehouse space capacity constraint, is constructed to minimize the system total cost. The model developed is a general model from which known results in specific cases can be deduced. The characteristics of the model and the impact of warehouse capacity on the system total cost, production batch, and replenishment lot sizes are also discussed.

## ■ TF-43

Tuesday 16:05-17:25  
GSI - S 10

### Application, Methodology, and Framework

Stream: System Dynamics Modelling

Invited session

Chair: *Stefan Groesser*, Institute of Management, University of St. Gallen, Dufourstrasse 40a, 9000, St. Gallen, Switzerland, stefan.groesser@web.de

## 1 - Flower dynamics: fixing unfairness perception among farmers

*Camilo Olaya*, Ingeniería Industrial, Universidad de los Andes, Calle 19A No. 1-37 Este, Bogota, Colombia, colaya@uniandes.edu.co, *Hans Jordan*

GR Chía is a firm that connects supply (Colombian flower growers) with demand (importers); it gathers orders made by customers and allocates them among producers. However, they get different revenues because of both price dynamics and different types of possible orders. A SD model was built for GR Chía; historical data fed the model. Our results show the importance of dynamic thinking (price dynamics vs. each farm's policies), the contribution of simulation to enhance policy making and the counterintuitive effects of a balancing loop – a simple decision rule led to bad results.

## 2 - Discrete vs. continuous simulation: when does it matter?

*Onur Ozgün*, Industrial Engineering Dept., Bogazici University, Bebek, 34342, Istanbul, Turkey,  
onur.ozgun@boun.edu.tr, *Yaman Barlas*

This study shows the similarities & differences between discrete event simulation and continuous simulation modeling. A simple M/M/2 queuing system with crowd-dependent arrival rate is used. In the first part, arrival rate decreases instantly as the number of people in system rises. In the second part, number in system affects the arrival rate first with continuous then with discrete delay. Discrete and continuous simulations give very similar results in terms of behaviors. Increasing proportionately all parameters reduces the discreteness of the system, bringing two simulation results closer.

## 3 - On the necessity of quantitative strategy evaluation in combating industrial counterfeiting and product piracy. a system dynamics approach.

*Oliver Kleine*, Industry and Service Innovations, Fraunhofer Institut for Systems and Innovation Research, Breslauer Straße 48, 76139, Karlsruhe, Germany, oliver.kleine@isi.fraunhofer.de, *Marcus Schröter*

Counterfeiting and product piracy are not just an issue for the consumer goods industry, but have become an increasing malady for capital goods manufactures as well. However, recent research in Germany indicates that decision makers have not yet been enabled to fully understand the scope and underlying dynamic complexity of that particular business risk. They are in need of appropriate decision support tools. Therefore, the paper investigates the potential contribution of structural theory in this respect, presents a preliminary system dynamics model and evaluates some basic strategic options.

## 4 - Model-based management (mbm): a research agenda

*Stefan Groesser*, Institute of Management, University of St. Gallen, Dufourstrasse 40a, 9000, St. Gallen, Switzerland, stefan.groesser@web.de, *Markus Schwaninger*

The paper's aim is to highlight the importance of qualitative and quantitative models for management and to propose a research agenda for the topic of model-based management. This way, a contribution to the use of models for higher managerial effectiveness should be made. The role of models for managerial purposes has been under-researched and often misunderstood. In this paper, an analysis of the concept, role and function of models in the context of management and organization is undertaken. Both theory and practice can benefit from the envisaged research.

## ■ TF-44

Tuesday 16:05-17:25

GSI - S 16

### Migration, Education and Sustainable Development 3

Stream: Migration, Education and Sustainable Development

*Invited session*

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

Chair: *Hanife Akar*, Department of Educational Sciences, Middle East Technical University, Orta Dogu Teknik Universitesi, Egitim Fakultesi EF 316, 06531, Ankara, Turkey, hanif@metu.edu.tr

#### 1 - Applying linear response surface analysis to investigate the effects of telecommunication proliferation and other factors on economic growth and social benefits

*Zenzo Polite Ncube*, Computer Science & Information Systems, North-West University, Private Bag X6001, 2520, Potchefstroom, South Africa, ncubezp@nwu.ac.za, *Giel Hattingh*, *Albert Helberg*

The rapid advances made in telecommunication and mobile phone technology have made developing nations feel that these technologies can offer them untold benefits in the areas of economic growth and social development. In this research we focus on models suggested in the literature that relate some attributes of growth in a country to factors like telecommunications proliferation, regulatory policies, etc. The use of regression modelling and interpretive techniques like linear response surface analysis is considered. Empirical analysis based on data from the World Bank, ITU, etc are presented

#### 2 - An optimization model to site solar and wind generators in a village electrification project

*Laia Ferrer-Martí*, IOC, UPC, Av. Diagonal 647, pav F, planta 0, 08028, Barcelona, Spain, laia.ferrer@upc.edu, *Rafael Pastor*

Isolated electrification systems that use renewable energy are a suitable option to provide electricity to rural villages in development countries. This work presents a mixed and integer linear programming (MILP) model to design an electrification project that uses solar and microwind generators. The model considers the location of the demand points, the detailed map of the wind potential of the village and the use of microgrids. Comparing with real cases implemented in Peru, the solutions obtained with this model reduce the initial investment costs and produce significantly more energy.

#### 3 - Coordination of collaborative development processes

*Kerstin Schmidt*, Institute of Automotive Management and Industrial Production, Technische Universität Braunschweig, Katharinenstraße 3, 38106, Braunschweig, Germany, kerstin.schmidt@tu-bs.de, *Grit Walther*, *Thomas Spengler*, *Rolf Ernst*

Current development processes, e.g. of complex embedded systems for automobile electronics, are often conducted corporately by various partners. If inappropriate contract structures are used within such collaborations, inefficiencies in the design process as well as in the technical configurations of the embedded system occur due to uncertainties and differing objectives of the partners. Hence, different kinds of contracts are analyzed with regard to their coordination capability in collaborative development processes and applied to a case study.

## ■ TF-45

Tuesday 16:05-17:25

GSI - S 33

### Ethics and OR II

Stream: OR and Ethics

*Invited session*

Chair: *Fred Wenstøp*, Strategy and Logistics, Norwegian School of Management BI, Nydalsveien 37, 0484, Oslo, Norway, fred.wenstop@bi.no

#### 1 - Ethical values beyond the objective function: towards a theory of behavioral or/ms

*Marc Le Menestrel*, Department of Economics and Business, University Pompeu Fabra, Ramon Trias Fargas 25-27, 08005, Barcelona, Spain, marc.lemenestrel@upf.edu, *Luk Van Wassenhove*

We propose theoretical foundations for OR/MS models that combine an objective function with a behavioral biasing factor. The objective function links with standard models of operations research based on the maximization of the value of the alternatives of choice. The biasing factor reflects the extent to which observation of behavior departs from the maximization of such objective function. It can be interpreted as reflecting ethical values, i.e. values that are not necessarily reducible to the value of the alternatives but pertain to the subject who is carrying out the choice

#### 2 - Janus-faced moral mathematics

*Haavard Koppang*, Gimle Terrasse 3., 0264, Oslo, Norway, haavard.koppang@bi.no, *Fred Wenstøp*

We focus on ethical principles and consequences, starting with a version of the self-interest theory via Parfit's story of the man stranded in the desert, by claiming a conflict between myopic self-interest and altruism. Yet, in game theory the parties behave according to a broader version the self-interest theory, knowing that consequences depend on the choice of the other, and thus self-interest requires altruism. Even ethical principles might be adapted to self-interest through persuasive language. We claim that it is rational to combine different perspectives to guide ethical behavior.

#### 3 - Facts, values and the rules of institutionalised dialogue.

*Emmanuel Picavet*, Philosophy (UFR 10), Université Paris-1 Panthéon-Sorbonne, 17 rue de la Sorbonne, 75005, Paris, France, France, Emmanuel.Picavet@univ-paris1.fr

Institutionalised dialogue processes and ethical argument have become crucial to sustainable policies and regulatory frameworks in the medical sciences and medical practice. Special attention will be paid to the current process of the 'Etats-Généraux de la bio-éthique' in France, 2009. We focus on the following features: (1) The emergence of the rules of dialogue and social capacities in dialogue; (2) the use of information and expertise in deliberative processes of this kind. We'll argue that these issues are pivotal for normative advice about the institutional design of such debates.

#### 4 - OR and ethics — development trends 1966 — 2009

*Fred Wenstøp*, Strategy and Logistics, Norwegian School of Management BI, Nydalsveien 37, 0484, Oslo, Norway, fred.wenstop@bi.no

The paper tracks development trends in the literature on OR and ethics from Kenneth Boulding's vision in 1966 of OR as a future tool for benevolent decision making where the needs of all stakeholders are taken into account to today's mature papers in special issues of OMEGA and ITOR. Four main themes seem to emerge: 1) Guidelines for the practice of OR, 2) How OR can be applied for good purposes, 3) Whether OR and ethics should be separated or integrated, 4) Ethical processes.

## Tuesday 17:40-18:25

### ■ TG-01

Tuesday 17:40-18:25

Beethoven

#### Optimization Modeling in Practice III

Stream: OR Applications in Industry

*Invited session*

Chair: *Bjarni Kristjansson*, Maximal Software, Ltd.,  
Boundary House, Boston Road, W7 2QE, London, Iceland,  
bjarni@maximalsoftware.com

##### 1 - Roadef/euro challenge 2010: a large scale energy management problem with diversified constraints, proposed by edf

*Christian Artigues*, LAAS, CNRS, 7 avenue du  
Colonel Roche, 31077, Toulouse Cedex 4,  
artigues@laas.fr, *Eric Bourreau*, *Guillaume Dereu*

The French OR Society (ROADEF) along with EURO, organizes periodically an OR challenge dedicated to industrial applications. This year, the challenge subject will be proposed by industrial partner (EDF) and will concern a large-scale energy management problem with diversified constraints. The challenge is open to everyone, and particularly to young researchers. The challenge problem will be presented during EURO 2009 and the results will be announced at EURO 2010 in Lisbon. A prize of 10000 Euros will be awarded to the best teams. Contact: challenge@roadef.org / challenge.roadef.org

##### 2 - Comparing the practice of OR in the private and not-for-profit sectors

*Peter Bell*, Richard Ivey School of Business,  
University of Western Ontario, N6A 3K7, London,  
Ontario, Canada, pbell@ivey.ca

We have conducted a longitudinal study of more than 100 important OR applications documenting the history of these works for many years. In this presentation we discuss our findings on the practice of OR in the private sector, the military, government, and in other not-for-profits. The not-for-profit sector has been an important consumer of OR work, but our comparison of the practice of OR across sectors suggests that, with a few exceptions (some military and a few other special projects), this sector has not done as well with OR as the corporate world.

### ■ TG-02

Tuesday 17:40-18:25

Schumann

#### Collaborative Transportation Planning II

Stream: Transportation Planning

*Invited session*

Chair: *Giselher Pankratz*, Dept. of Information Systems,  
FernUniversität - University of Hagen, Profilstrasse 8,  
58084, Hagen, Germany,  
giselher.pankratz@fernuni-hagen.de

##### 1 - Collaborative vehicle routing in less-than-truckload networks

*Julia Rieck*, Department for Operations Research,  
Clausthal University of Technology, Julius-Albert-Str.

2, 38678, Clausthal-Zellerfeld, Germany,  
 julia.riek@tu-clausthal.de, *Jürgen Zimmermann*

In an effort to reduce costs, Less-than-truckload (LTL) carriers are searching for ways to cooperate. A LTL cooperation provides line-haul services between depots of different carriers. The local deliveries and pickups in a fixed region around the depot are performed independently by each carrier. Collaborative vehicle routing planning incorporating dynamic allocation of orders to carriers would improve the territorial allocations and reduce the overall transportation costs. We present an auction based coordination method for collaborating among carriers.

## 2 - Collaborative optimization of last mile networks for parcel and express delivery services

*Michael Schwind*, BISOR, Technical University  
 Kaiserslautern, Erwin-Schroedinger Strasse, Gebäude  
 42, 67653, Kaiserslautern, schwind@wiwi.uni-kl.de,  
*Marcel Kunkel*

Rising energy costs and fierce competition urge carriers to increase transportation network efficiency. KolOptNet focuses on creation of sustainable, energy efficient logistics by designing algorithms and implementing methods for optimized network and tour planning within parcel/express delivery networks. We present the research project's objectives and solution approaches. KolOptNet integrates dynamic tour planning heuristics and combinatorial auctions to ensure the long-term participation of the service providers by using incentive compatible distribution mechanisms for the cost savings.

## ■ TG-03

Tuesday 17:40-18:25

*Reger*

### Wireless ad hoc networks

Stream: Network Optimization

*Invited session*

Chair: *Mohamed Saad*, Electrical and Computer  
 Engineering, University of Sharjah, P.O. Box 27272,  
 27272, Sharjah, msaad@sharjah.ac.ae

#### 1 - Gateway discovery for ad hoc nodes

*Adel-aissanou Karima*, Laboratory of modelisation and  
 optimisation of systems, Laboratoire LAMOS  
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 algérie, 06000, bejaia, Algeria, ak\_adel@yahoo.fr,  
*Djamil Aissani*

Wireless Ad Hoc networks are becoming ideals to get an internet connection. If an ad hoc node has an Internet connection, it is interesting that this node offers the connection to others nodes which by becoming a gateway. In this paper, we present an algorithm for gateway discovery in Ad Hoc networks. To discover a gateway to the fixed network, the mobile node must ask its cluster-head and this one gives a solicitation message to the gateway. The performance of our algorithm is compared to the well known methods using NS-2 simulations.

## ■ TG-04

Tuesday 17:40-18:25

*Liszt*

### Network design 2

Stream: Network Optimization

*Invited session*

Chair: *Eric Gourdin*, DAC/OAT, France Telecom R&D, 38,  
 rue du General Leclerc, 92794, Issy-les-Mx Cedex 9,  
 France, eric.gourdin@orange-ftgroup.com

#### 1 - Developing a ring-based optical network structure - a case study

*Silvia Schwarze*, Institute of Information Systems,  
 University of Hamburg, Von-Melle-Park 5, 20146,  
 Hamburg, Germany, schwarze@econ.uni-hamburg.de,  
*Marco Caserta, Matthias Fricke, Stefan Voss*

We consider structural properties of optical networks. It is common that 1+1 protection is required in telecommunication applications. That is, for each origin-destination-pair, two node-disjoint paths have to be established. This property is naturally ensured by ring structures and we address the questions of how to design ring networks and if they show a good behavior in terms of hardware and handling costs. We present ongoing research based on a case study with Deutsche Telekom. Within this study, we have applied ring generation and ring selection as well as interring traffic approaches.

#### 2 - A taxonomy of multicommodity flow and related multicut models

*Eric Gourdin*, DAC/OAT, France Telecom R&D, 38,  
 rue du General Leclerc, 92794, Issy-les-Mx Cedex 9,  
 France, eric.gourdin@orange-ftgroup.com

The Maximum Multicommodity Flow (MMF) and Maximum Concurrent Flow (MCF) problems have been considerably studied with a primal-dual perspective: the Minimum Multicut problem and the Sparsest Cut problem are weak duals of MMF and MCF. Based on these duality results, many approximation results have been derived for both problems.

In this talk, we will show that similar primal/dual relations can be derived for many other multicommodity flow problems. We will also provide valid Mixed Integer models for the new (multi)-cut problems and show how some approximation results can be extended.

## ■ TG-05

Tuesday 17:40-18:25

*Haydn*

### ANP IV

Stream: Analytic Hierarchy Processes, Analytic  
 Network Processes

*Invited session*

Chair: *Erdem Aksakal*, Engineering and Architecture  
 Faculty, 06570, Ankara, Turkey, eaksakal@gazi.edu.tr

#### 1 - A model for personnel selection: an integrated approach with ANP and axiomatic design

*Erdem Aksakal*, Engineering and Architecture Faculty,  
 06570, Ankara, Turkey, eaksakal@gazi.edu.tr, *Metin  
 Dagdeviren, Ergun Eraslan*

This study described a hybrid model for supporting the personnel selection process in manufacturing systems. Personnel selection is a very important issue for an effective manufacturing system, since the improper personnel might cause many problems affecting productivity, precision, flexibility and quality of the products negatively. Selecting the best personnel among many alternatives is a multi-criteria decision making problem. In this study, a hybrid model which employs analytic network process and fuzzy axiomatic design together, is proposed for the personnel selection problem.

## 2 - Moderating effect of relationship investment on logistics outsourcing risk

Ming-Chih Tsai, 205, Kuo Kuang Rd., Taichung 402, Taiwan, R.O.C., 402, Taichung, Taiwan, g9644009@mail.nchu.edu.tw, Wan-Ling Zhuang

This study constructs a risk model to examine logistics outsourcing based on transaction cost economics and resource based view. Risk perception of 42 Taiwanese wholesalers was collected and classified into three levels by relation investment. By using Analytical Network Process, we calibrated risk magnitude. The result indicates that opportunism was the main reasons for relational failure and ineffective asset utilization and deterioration of operation were most significant for risk impact. ANOVA concludes the importance of risk factors was insignificantly varied by relation investment level.

## ■ TG-06

Tuesday 17:40-18:25

Koch

### Delegation and Incentives

Stream: Delegation and Incentives

*Invited session*

Chair: *Christian Hofmann*, Accounting, University of Mannheim, Schloss, 68131, Mannheim, Germany, Hofmann@bwl.uni-mannheim.de

Chair: *Peter Letmathe*, Chair of Value Chain Management, University of Siegen, Hoelderlinstr. 3, 57076, Siegen, Peter.Letmathe@uni-siegen.de

Chair: *Jan Bouwens*, Tilburg University, CentER and Department of Accountancy, PO Box 90153, 5000, Tilburg, Netherlands, j.bouwens@uvt.nl

#### 1 - Accounting earnings, market price, and decentralized managerial compensation contracts

*Christian Hofmann*, Accounting, University of Mannheim, Schloss, 68131, Mannheim, Germany, Hofmann@bwl.uni-mannheim.de

This paper employs a multi-tier agency model where the shareholders delegate contracting with a manager to a board of directors to initially provide a characterization of the relative weights assigned to two performance measures in the manager's optimal linear compensation contract. I apply this characterization to a setting in which the compensation contract is based on accounting earnings and market price. I show that delegating the design of the manager's contract to a board of directors substantially affects the characteristics of compensation contracts based on earnings and price.

#### 2 - The economics of full cost transfer pricing

*Jan Bouwens*, Tilburg University, CentER and Department of Accountancy, PO Box 90153, 5000, Tilburg, Netherlands, j.bouwens@uvt.nl

Full cost transfer pricing has been criticized for providing production units with too few incentives to economize on costs. Our empirical study shows that charging too high a price for products has the potential to send a production unit into a death spiral. However we also find evidence that production unit managers take cost reduction measures to stay in business. They shift the fixed cost burden imposed on particular products and manage (down) variable costs in order to use the resulting transfer price changes for enhancing internal demand.

## ■ TG-07

Tuesday 17:40-18:25

GSI - S 29

### MCDA: Portfolio Decision Analysis (Panel Discussion)

Stream: Multiple Criteria Decision Analysis

*Invited session*

Chair: *Alec Morton*, Management/ Operational Research, London School of Economics, Houghton St, London, wc2a2ae, London, England, United Kingdom, a.morton@lse.ac.uk

Chair: *Ahti Salo*, Systems Analysis Laboratory, Helsinki University of Technology, P.O. Box 1100, Otakaari 1 M, 02015, TKK, Finland, ahti.salo@tkk.fi

Chair: *Jeff Keisler*, Boston College of Management, University of Massachusetts, 100 Morrissey Blvd., 02125-3393, Boston, MA, United States, jeff.keisler@umb.edu

#### 1 - Panel discussion: portfolio decision analysis - bridging theory and practice

*Ahti Salo*, Systems Analysis Laboratory, Helsinki University of Technology, P.O. Box 1100, Otakaari 1 M, 02015, TKK, Finland, ahti.salo@tkk.fi, *Alec Morton*, *Don Kleinmuntz*, *Valerie Belton*, *José Rui Figueira*, *Larry Phillips*, *Alexis Tsoukiàs*

An indicator of the liveliness of any area of OR is a healthy interaction between practice and theory. In an applied discipline, practice provides the ultimate motivation for theoretic questions, but an excessive reverence for practice can block learning and hinder interdisciplinary innovation. Theory underpins the development of methods and tools, but theoretic inquiry can lose sight of application and become an end in itself. As an emerging subfield of Decision Analysis, has Portfolio Decision Analysis got the balance right, and, if not, what should we do about it?

## ■ TG-08

Tuesday 17:40-18:25

GSI - S 30

### Procurement and Pricing

Stream: Supply Chain Management

*Invited session*

Chair: *Christian Lohmann*, Ludwig-Maximilians-Universität München, Institut für Produktionswirtschaft und Controlling, Ludwigstraße 28 RG/V, D-80539, München, Germany, lohmann@bwl.lmu.de

#### 1 - The utility of compensatory payments between independent companies of one value network

*Christian Lohmann*, Ludwig-Maximilians-Universität München, Institut für Produktionswirtschaft und Controlling, Ludwigstraße 28 RG/V, D-80539, München, Germany, lohmann@bwl.lmu.de

Inter-company dependencies determine the nature of their ability to collaborate, as well as the coordination instruments that may be applicable. This article examines a scenario under which two independent companies with pre-existing sales interdependencies may elect to form a value network. Revenue-based and quantity-based compensatory payments are analyzed and compared in terms of the extent to which they result in efficient investment and production decisions. We thereby identify conditions under which the selected compensatory payments can increase the expected profits of both companies.

## ■ TG-09

Tuesday 17:40-18:25

GSI - S 5

### Task/Event Timetabling

Stream: Timetabling and Rostering

*Invited session*

Chair: *O.t. Arogundade*, Computer Science, University of Agriculture, 2240, Abeokuta, Nigeria, arogundadeo@acm.org

#### 1 - Insight from visualisation and the travelling tournament problem

*Mark Johnston*, School of Mathematics, Statistics and Operations Research, Victoria University of Wellington, PO Box 600, 6140, Wellington, New Zealand, mark.johnston@msor.vuw.ac.nz

The Travelling Tournament Problem (TTP) involves constructing a double round robin sports tournament to minimize the total distance travelled by teams, with side constraints. Although the TTP is extremely difficult to solve, metaheuristics expect to find good solutions in reasonable computation time, by balancing between brute-force neighbourhood search and insightful rules-of-thumb. We propose novel local search neighbourhoods, and show that visualisation of neighbourhoods and solutions leads to interesting insights into the geometric structure of good solutions.

#### 2 - On demand conference planning

*Eric Bourreau*, COCONUT, LIRMM, 161 Rue Ada, 34000, Montpellier, France, eric.bourreau@lirmm.fr

ECAP (European conference on Computing And Philosophy) planning is a hard problem due to 2 major specificities: 1/It is not easy to restrict new philosophic theory with only few available keywords and allocate each talk in predefined session streams. 2/During the month before the conference, accepted papers are available on a wiki debate platform and open to discussion. As usual in conference, parallel sessions bring conflicting presentations, but due to debates, we are able to estimate interests for the expected participants. We propose to deliver an "On Demand Conference Planning"!

## ■ TG-10

Tuesday 17:40-18:25

GSI - S 6

### Disaggregation Theory and Applications I

Stream: Multiple Criteria Decision Analysis

*Invited session*

Chair: *Yannis Siskos*, Department of Informatics, University of Piraeus, Karaoli Dimitriou 80, 18534, Piraeus, Greece, ysiskos@unipi.gr

#### 1 - Toward a satisfaction barometer of mobile telephony in greece.

*Dimitrios Drosos*, Department of Business Administration, Graduate Technological Education Institute of Piraeus, 250, Thivon ave., 12244, Aigaleo, Greece, drososd@in.teipir.gr, *Yannis Siskos, Nikos Tsotsolas, Antonis Zervos*

A satisfaction barometer is a significant tool for an organisation because of emphasise on meeting the expectations and needs of customers. This paper presents an original study that measures the customer satisfaction of mobile telephony services in Greece. For the analysis of the survey results the multicriteria methodology MUSA (Multicriteria Satisfaction Analysis) was applied. The most important results are focused on the determination of the weak and the strong points of the mobile telephony companies and the analysis of customers' behavior.

#### 2 - Measuring the robustness of multicriteria decision models in uta-type disaggregation procedures.

*Yannis Siskos*, Department of Informatics, University of Piraeus, Karaoli Dimitriou 80, 18534, Piraeus, Greece, ysiskos@unipi.gr

A major problem that any disaggregation procedure in MCDA has to face is the robustness of preference models inferred mainly through linear programming mechanisms. This paper measures the robustness of additive value models inferred from UTA-type procedures by means of LP's post optimality analysis in which the main proposed measure is the average stability index (ASI). The paper is illustrated by numerical examples where several proposed rules increase the model robustness.

## ■ TG-11

Tuesday 17:40-18:25

GSI - S 17

### Clustering Techniques for MCDA

Stream: Multiple Criteria Decision Analysis

*Invited session*

Chair: *Yves De Smet*, SMG - CODE, Université Libre de Bruxelles, Boulevard du Triomphe CP 210-01, 1050, Bruxelles, Belgium, yves.de.smet@ulb.ac.be

#### 1 - Multicriteria ordered clustering

*Yves De Smet*, SMG - CODE, Université Libre de Bruxelles, Boulevard du Triomphe CP 210-01, 1050, Bruxelles, Belgium, yves.de.smet@ulb.ac.be, *Philippe Nemery, Ramkumar Selvaraj*

We propose a new approach for the detection of ordered clusters in multicriteria decision aid problems. This is referred to as the multicriteria ordered clustering problem. At first, preference degrees between pairs of alternatives are computed. Based on the definition of two indicators characterizing the quality of partitions, an optimization problem is formalized and an exact algorithm is proposed. Our approach is tested on artificial data sets and illustrated on a pedagogical example.

#### 2 - Relational multicriteria clustering: the case of valued outranking matrices

*Stefan Eppe*, Engineering Faculty, CoDE-SMG,, Université Libre de Bruxelles, Boulevard du Triomphe CP 210-01, 1050, Brussels, Belgium, stefan.eppe@ulb.ac.be, *Julien Roland, Yves De Smet*

This presentation addresses the question of relational multicriteria clustering. Our previously developed approach for handling binary outranking matrices will be extended to the case of valued outranking relations. After discussing the implications and consequences of this widening, the k-means algorithm will be applied on it. Validation results of tests performed on artificial data sets will be presented. Special emphasis will be put on comparing the results obtained with the valued and the binary version of the algorithm.

## ■ TG-12

Tuesday 17:40-18:25

GSI - S 18

### Location and routing

Stream: Location Analysis

*Invited session*

Chair: *Carlos Ferreira*, Dep. of Economics, Management and Industrial Engineering, University of Aveiro, Campus Universitário de Santiago, 3810-143, Aveiro, Portugal, carlosf@ua.pt

Chair: *Rui Borges Lopes*, Dep. of Economics, Management and Industrial Engineering, University of Aveiro, Campus Universitário de Santiago, 3810-143, Aveiro, Portugal, rui.borges@ua.pt

#### 1 - A lower bound and upper bound for the capacitated location-routing problem

*Zhen Yang*, 12, rue Marie Curie, BP2060, 10010, Troyes, zhen.yang@utt.fr, *Feng Chu*, *Chen Haoxun*

This paper studies a logistic network design problem, the capacitated location-routing problem (CLRP) NP-hard, which simultaneously considers the location of facilities and the management of vehicle fleets subjected to capacity constraints. A cutting plane method is present to obtain a lower bound (LB). Based on the LB solution, an initial feasible solution is constructed by a heuristic. A TABU search heuristic is then proposed to improve the initial feasible solution. Benchmarked on classical instance, computational results manifest that this method can obtain high quality solutions.

#### 2 - A capacitated location-routing problem: a heuristic approach and decision support

*Rui Borges Lopes*, Dep. of Economics, Management and Industrial Engineering, University of Aveiro, Campus Universitário de Santiago, 3810-143, Aveiro, Portugal, rui.borges@ua.pt, *Carlos Ferreira*, *Beatriz Sousa Santos*

We consider a discrete Capacitated Location-Routing Problem (CLRP) with two levels (depots and clients) and a capacitated and homogeneous vehicle fleet. For this model a decision support tool is presented supporting a newly developed metaheuristic. The metaheuristic, composed of two stages, is based on guided local search (GLS) providing best average results for two out of three benchmark instances for the CLRP. The GLS is used to guide a composite local search, both embedded in a hybrid extended savings algorithm in the first stage and, on the second stage, to conduct a more thorough search.

## ■ TG-13

Tuesday 17:40-18:25

GSI - S 31

### Covering location models

Stream: Location Analysis

*Invited session*

Chair: *Ioannis Giannikos*, Business Administration, University of Patras, University of Patras, GR-26500, Patras, Greece, I.Giannikos@upatras.gr

#### 1 - Wireless local area network planning robustness

*Alexandre Gondran*, SET, UTBM, Université des Technologies de Belfort, 90000, Belfort, alexandre.gondran@utbm.fr

WLAN planning consists in selecting a location for each transmitter and allocating frequency used by all sites in order to provide users a wireless access to their local network. The objective is to guaranty a given Quality of Service (QoS). Our optimization algorithm tackles location selection and frequency assignment together. In this presentation we evaluated a robust aspect of our planning. The QoS evaluation is based on given input data : users demand and power maps (received signals strength from all transmitters). We study quality of our solutions across changing those input data.

#### 2 - Partial coverage-based maximal demand covering models

*Ioannis Giannikos*, Business Administration, University of Patras, University of Patras, GR-26500, Patras, Greece, I.Giannikos@upatras.gr, *Georgios Alexandris*

In this paper we concentrate on the well known Maximal Coverage Location Problem and demonstrate that alternative representations of the demand space may lead to largely fluctuating as well as misleading results. We introduce a family of models based on the notion of complementary partial coverage and exploit the capabilities of Geographic Information Systems in order to better represent demand. Results of empirical studies indicate that the proposed models are less susceptible to fluctuations for alternative representations of the demand space.

## ■ TG-14

Tuesday 17:40-18:25

GSI - S 32

### Inventory Management II

Stream: Inventory Management

*Invited session*

Chair: *John J. Kanet*, Operations Management - Niehaus Chair in Operations Management, University of Dayton, 300 College Park, 45469, Dayton, OH, United States, kanet@udayton.edu

#### 1 - Interpretation of classical eoq model as the object of discrete control in a spreadsheet

*Slobodan Antic*, Department of operations management, Faculty of organizational sciences, Jove Ilica 154 Street, Belgrade, Serbia, 11000, Belgrade, Serbia, Serbia, antics@fon.rs, *Dragan Vasiljevic*

The paper describes the way how basic EOQ model can be presented as object of discrete control and simulation model of inventories in a spreadsheet. Model can be developed in a spreadsheet in order to perform simulation, and table analysis. EOQ model belongs to group deterministic, continuous models, where inventory dynamics is observed for one period of time. Results of model output are the fixed amount of order quantity per year and number of orders per year. Continuous time period, we can present as the sequence of discrete time periods with discrete quantities of inventories in it.

## 2 - Dynamic planned safety stocks in supply networks

*John J. Kanet*, Operations Management - Niehaus Chair in Operations Management, University of Dayton, 300 College Park, 45469, Dayton, OH, United States, kanet@udayton.edu, *Michael Gorman*, *Martin Stoesslein*

We introduce a new line of research in inventory management: the notion of planning time phased safety stocks. We assert that planning a time phased set of safety stocks (SS) over a planning horizon makes sense because larger SS are appropriate in times of greater uncertainty while lower SS are more appropriate when demand and/or supply are more predictable. We perform an empirical study of US industry, which demonstrates that significant savings can be achieved by employing dynamic planned safety stocks. We provide a optimization model for the problem of minimizing inventory.

## ■ TG-15

Tuesday 17:40-18:25

Einstein

### Multicriteria Decision Making

Stream: Multi-Objective Optimization and Decision Theory 2

*Invited session*

Chair: *Boglarka G.-Toth*, Differential Equations, Budapest University of Technology and Economics, Egrý József u. 1., 1111, Budapest, Hungary, bog@math.bme.hu

#### 1 - "overview algorithms in multicriteria optimization"

*Claudia Margarita Villagran de Leon*, Faculty of Medicine., University San Carlos of Guatemala, 9 Avenida 9-45 Zona 11, Centro Universitario, CUM, Colonia Roosevelt., 01011, Guatemala, Guatemala, Guatemala, margavilla2008@hotmail.com

Several Criteria quantitative, qualitative, dependent, independent, hard or software & all together are handled at the same time. Multi causes & effects of decision cases are examined from different DB & opposite objectives. Efficient software for (MCO), by means of (MOO), Vector and (CO). Using math formulation & procedures, we reach Optimality Criteria depending on (MCDM), simulation.

We set main objectives, algo. & opposite criteria. (MCO) paradigm is for diverse applications: design Urban city plan, airplanes, turbines, bridges use (GIS) system. Medical Cancer examples to discuss.

#### 2 - A reliable method for obtaining the complete weakly efficient set of nonlinear biobjective optimisation problems

*Boglarka G.-Toth*, Differential Equations, Budapest University of Technology and Economics, Egrý József u. 1., 1111, Budapest, Hungary, bog@math.bme.hu, *Jose Fernandez*

obtaining the complete efficient set of nonlinear multiobjective optimisation problems is a very difficult task, that some people think to be impossible to achieve. However, a recent interval branch-and-bound method has been proposed in the literature (see COAp, doi:10.1007/s10589-007-9135-8) which is able to obtain a superset containing the complete weakly efficient set of (nearly) any nonlinear biobjective optimisation problem, up to a pre-specified accuracy. In the talk we will present the method, and will discuss its applicability to general nonlinear biobjective problems.

## ■ TG-16

Tuesday 17:40-18:25

Koenig

### Multicriteria Location and Routing

Stream: Multi-Objective Optimization and Decision Theory 1

*Invited session*

Chair: *Utpal Bhattacharya*, OM&QT Area, Indian Institute of Management Indore, IIM Indore, 453331, Indore, India, 453331, Indore, MP, India, utpalb@iimdr.ac.in

#### 1 - Multicriteria capacitated redistricting problem

*Paulo Morelato França*, Dept. Matemática, Estatística e Computação, Universidade Estadual Paulista, Av. 11 de maio 2137, apto. 172 B, 19061-360, Presidente Prudente, SP, Brazil, paulo.morelato@gmail.com, *Laura Assis*, *Fábio Usberti*, *Vinícius Garcia*

The capacitated version of a redistricting problem with three objectives is addressed. The solution approach divides the problem into two hierarchical phases. First, a given original districting solution is optimized with respect to the two initial criteria, treated as a weighted single criterion and solved by a GRASP method. Afterwards the third objective, which corresponds to seek for the minimum deviation between the solution found in the first step and the original one is optimized by a heuristic and also by an exact method. Computational experiments are provided.

#### 2 - A multi-objective vertex covering obnoxious facility location problem on a plane

*Utpal Bhattacharya*, OM&QT Area, Indian Institute of Management Indore, IIM Indore, 453331, Indore, India, 453331, Indore, MP, India, utpalb@iimdr.ac.in

In this article a new Vertex Covering Obnoxious Facility Location problem on a Plane has been designed by considering it as a MCDM problem.

The problem has been dealt as a pure planar location problem. A modified linear programming algorithm based on Drezner and Wesolowsky [1983] has been designed.

The basic difference in this model than the existing obnoxious facility location models is that the weights or importance are assigned to the various demand points instead of assigning to the various distances.

## ■ TG-18

Tuesday 17:40-18:25

Lenné

### Various New Achievements in Mathematical Programming II

Stream: Mathematical Programming

*Invited session*

Chair: *Klaus Meer*, Computer Science Institute, Technical University Cottbus, Konrad-Wachsmann-Allee 1, 03046, Cottbus, Germany, [meer@informatik.tu-cottbus.de](mailto:meer@informatik.tu-cottbus.de)

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, [gweber@metu.edu.tr](mailto:gweber@metu.edu.tr)

#### 1 - On a recursive approach to solve some unconstrained quadratic optimization problems

*Jose Neto*, RS2M, TELECOM & Management SudParis, 9, rue Charles Fourier, 91011, Evry, [Jose.Neto@it-sudparis.eu](mailto:Jose.Neto@it-sudparis.eu), *Walid Ben-ameur*

Consider an unconstrained  $(-1,1)$ -quadratic optimization problem (QP) expressed as follows:  $\min x^T Qx$ :  $x$  is a  $n$ -dimensional vector with entries in  $-1,1$ . We slightly extend the known polynomially solvable cases of (QP) to when the matrix  $Q$  has fixed rank and the number of positive diagonal entries is  $O(\log(n))$ . We describe a new polynomial-time algorithm for (QP) when it corresponds to such cases. Preliminary experiments are reported and indicate that the proposed method may be computationally efficient by comparison with other approaches that are present in the literature.

#### 2 - A modified newton direction for unconstrained optimization

*Theodoula N. Grapsa*, Department of Mathematics, University of Patras, University Campus, 26500, Rio, Greece, [grapsa@math.upatras.gr](mailto:grapsa@math.upatras.gr)

In this paper we propose a modification on Newton's direction for solving problems of unconstrained optimization. As known, a major disadvantage of the Newton's method is its non convergence when the initial point is not close to the optimas' neighborhood. The proposed method guarantees the decrement of the objective function at every iteration. The quadratic convergence of the proposed iterative scheme is proved. The new algorithm has been implemented and tested on several well-known test functions.

## ■ TG-19

Tuesday 17:40-18:25

Haber

### Ant colony optimization

Stream: Metaheuristics

*Invited session*

Chair: *Paola Pellegrini*, Dipartimento di Matematica Applicata, Università Ca' Foscari, Dorsoduro 3825/E, 30123, Venezia, Italy, [paolap@unive.it](mailto:paolap@unive.it)

#### 1 - Bees algorithm for two-sided assembly line balancing problem

*Pınar Tapkan*, Industrial Engineering, Erciyes University, KAYSERI, Turkey, [pinartan@erciyes.edu.tr](mailto:pinartan@erciyes.edu.tr), *Lale Özbakır*, *Adil Baykasoglu*

Two-sided assembly lines are generally occurred in assembly of large-sized products such as buses and trucks. In a two-sided assembly line, different assembly tasks are carried out on the same product in parallel at both left and right sides of the line. In this study Bees Algorithm is adopted to solve two-sided assembly line balancing problem with zoning constraints so as to minimize the number of stations for a given cycle time. The efficiency and robustness of the proposed algorithm is tested on benchmark problems existing in the literature.

#### 2 - On the behavior of an aco algorithm

*Paola Pellegrini*, Dipartimento di Matematica Applicata, Università Ca' Foscari, Dorsoduro 3825/E, 30123, Venezia, Italy, [paolap@unive.it](mailto:paolap@unive.it), *Daniela Favaretto*, *Elena Moretti*

Wolpert and McReady state that for any algorithm, any elevated performance over one class of problems is exactly paid for in performance over another class. For selecting the best algorithm for a problem, it is crucial to investigate the explorative behavior of various approaches. The definition of exploration must be both independent on the specific procedure considered, and coherent with the behavior of the algorithm. Such a definition is provided and the consequent measurement methodology is used for observing the behavior of MAX—MIN Ant System.

## ■ TG-20

Tuesday 17:40-18:25

Mann

### AHP VII

Stream: Analytic Hierarchy Processes, Analytic Network Processes

*Invited session*

Chair: *Alessio Ishizaka*, Portsmouth Business School, University of Portsmouth, Richmond Building, Portland Street, PO1 3DE, Portsmouth, Hampshire, [alessio.ishizaka@port.ac.uk](mailto:alessio.ishizaka@port.ac.uk)

#### 1 - Does AHP help us make a choice? - an experimental evaluation

*Alessio Ishizaka*, Portsmouth Business School, University of Portsmouth, Richmond Building, Portland Street, PO1 3DE, Portsmouth, Hampshire, [alessio.ishizaka@port.ac.uk](mailto:alessio.ishizaka@port.ac.uk)

We use experimental economic methods to test how well AHP fares as a choice support system in a real decision problem involving a dominant criteria. The AHP ranking is statistically compared with three successive rankings given by the subjects in the experiments themselves (one at the beginning, one after using AHP and one after learning the ranking provided by AHP). We observe all four rankings are similar but the rankings provided by the subjects are closer to each other than the AHP ranking. However, AHP rankings help the decision-maker to reformulate his choice.

## ■ TG-21

Tuesday 17:40-18:25

Hauptmann

### ANP V

Stream: Analytic Hierarchy Processes, Analytic Network Processes

*Invited session*

Chair: *Gwo-Hshiung Tzeng*, College of Management, Hsinchu 300, National Chiao Tung University, Kainan University, Taoyuan 338, Taiwan, [ghtzeng@cc.nctu.edu.tw](mailto:ghtzeng@cc.nctu.edu.tw)

### 1 - Combined dematel technique with a novel MCDM model for bridges improvement

*Gwo-Hshiung Tzeng*, College of Management, Hsinchu 300, National Chiao Tung University, Kainan University, Taoyuan 338, Taiwan, ghtzeng@cc.nctu.edu.tw, *Yi-Chun Chen*

Local scour of channels usually affect and destroy the structures' foundations of bridges. Therefore, prioritizing which bridges to be enhanced is the most critical issue. An ANP based hybrid MCDM framework is proposed and verified by an empirical case study.

### 2 - Fuzzy MCDM approach for selecting the best environment-watershed plan

*Yi-Chun Chen*, Graduate Institute of Civil and Hydraulic Engineering, Feng Chia University, No. 100 Wenhwa Rd., Seatwen, 40724, Taichung, Taiwan, chen.vivien@gmail.com, *Gwo-Hshiung Tzeng*

The most criteria in the real world decision problems are vague, interdependent and interactive which cannot be evaluated by conventional measures method. Thus, this paper intends to propose a fuzzy multi-criteria decision making (FMCDM) framework to select the best alternatives/strategies in environment-watershed. This framework will be verified by a real-world environment-watershed plan.

### 3 - Evaluation and enhancement of the best environment watershed plan using a novel hybrid MCDM model

*Yi-Chun Chen*, Graduate Institute of Civil and Hydraulic Engineering, Feng Chia University, No. 100 Wenhwa Rd., Seatwen, 40724, Taichung, Taiwan, chen.vivien@gmail.com, *Gwo-Hshiung Tzeng*

An environment watershed plan is usually affected by various factors including human life, property, nature ecologic, etc. However, how to prioritize the factors for further plan improvement is critical and seldom be addressed. Thus, the authors proposed an ANP based hybrid MCDM model for defining strategies to close the gaps between the current states as well as the aspired levels of the factors. A real world case study is used to demonstrate the proposed model.

## ■ TG-22

Tuesday 17:40-18:25

Arndt

### Sustainability & Closed Loop Supply Chains

Stream: OR and Environmental Management

*Invited session*

Chair: *Erwin van der Laan*, RSM Erasmus University, P.O.Box 1738, 3000DR, Rotterdam, Netherlands, elaan@rsm.nl

Chair: *Jo van Nunen*, Department Decision and Information Sciences, RSM Erasmus University, Burgemeester Oudlaan 50, 3062 PA, Rotterdam, Netherlands, jnunen@rsm.nl

### 1 - Alternative actions for sustainability in a weee closed-loop supply chain in greece

*Maria Besiou*, Department of Mechanical Engineering, Aristotle University of Thessaloniki, P.O. Box 461, 54124, Thessaloniki, Thessaloniki, Greece, mmpesiou@auth.gr, *Patroklos Georgiadis*

In this paper we examine the environmental, social and economical sustainability of a closed-loop supply chain with recycling activities. We develop a dynamic model using System Dynamics methodology. The developed model is implemented to a real world electrical and electronic equipment recovery system in Greece. We present its current status and the barriers constraining its sustainability. Numerical analysis examines alternative actions to achieve a sustainable future from an environmental, social and economical approach.

## ■ TG-23

Tuesday 17:40-18:25

Planck

### Portfolio Management

Stream: Financial Modelling

*Invited session*

Chair: *David Wozabal*, ISDS, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, david.wozabal@univie.ac.at

### 1 - Using black & litterman framework for stress testing analysis in asset management

*Rosella Giacometti*, Mathematics and Statistics, University of Bergamo, via dei Caniana 2, 24127, Bergamo, Italy, rosella.giacometti@unibg.it, *Domenico Mignacca*

In this paper, starting from the Black and Litterman model, we propose a stress test methodology of the current managed portfolio. More precisely we shocks a set of factors which affect the asset returns, imposing the analysts' views on their variation form the current level. We assume that a mixture of normal distributions can describe the presence of high volatility periods and low volatility periods, taking in account extreme movements in the market. We then derive the conditional moments of the posterior distribution combining views on the factors and market information.

## ■ TG-24

Tuesday 17:40-18:25

GSI - S 20

### Abnormal Extrema in Nonlinear Problems

Stream: Nonlinear Programming

*Invited session*

Chair: *Tatiana Tchemisova*, Departamento de Matemáticas, University of Aveiro, Campus Universitario de Santiago, 3810-193, Aveiro, Portugal, tatiana@ua.pt

Chair: *Aram Arutyunov*, the Department of Nonlinear Analysis, Peoples Friendship University of Russia, Lomonosovski prospect, 18, apt 396, 119296, Moscow, Russian Federation, arutun@orc.ru

### 1 - Second-order necessary optimality conditions for abnormal problems with equality and inequality constraints

*Aram Arutyunov*, the Department of Nonlinear Analysis, Peoples Friendship University of Russia, Lomonosovski prospect, 18, apt 396, 119296, Moscow, Russian Federation, arutun@orc.ru, *Dmitry Karamzin*, *Fernando Pereira*

This talk concerns second-order necessary conditions for an abnormal local minimizer of nonlinear optimization problem with equality and inequality constraints. The obtained optimality conditions improve the ones available in the literature in that the associated set of Lagrange multipliers is the smallest possible.

## 2 - Optimality conditions in discrete optimal control problems: the abnormal case

*Boban Marinkovic*, Applied Mathematics, Faculty of Mining and Geology, Djusina 7, 11000, Belgrad, mboban@verat.net, *Aram Arutyunov*

We consider discrete optimal control problems with equality control constraints and mixed initial and final state equality constraints. We derive first-order optimality conditions which are meaningful under the new nontriviality condition. Note that by nontriviality we mean Lagrange multiplier which corresponds to the cost functional is nonzero.

## ■ TG-25

Tuesday 17:40-18:25

GSI - S 25

### Industrial Organization

Stream: Dynamical Systems and Game Theory

*Invited session*

Chair: *Fernanda A. Ferreira*, Mathematics, ESEIG - Instituto Politécnico do Porto, R. D. Sancho I, 981, 4480-876, Vila do Conde, Portugal, fernandaamelia@eu.ipp.pt

#### 1 - Duopoly model with technology transfer

*Fernanda A. Ferreira*, Mathematics, ESEIG - Instituto Politécnico do Porto, R. D. Sancho I, 981, 4480-876, Vila do Conde, Portugal, fernandaamelia@eu.ipp.pt

We study the optimal patent licensing under Cournot duopoly where the technology transfer takes place from an innovative firm, which is relatively cost-inefficient in the pre-innovation stage compared to the recipient firm. We determine the output levels at the Nash equilibrium and the corresponding profits of the firms. We found that the optimal licensing arrangement often involves a two part tariff, fixed fee plus a linear per unit output royalty.

#### 2 - Dumping in an international trade

*Flávio Ferreira*, Mathematics, ESEIG - Instituto Politécnico do Porto, R. D. Sancho I, 981, 4480-876, Vila do Conde, Portugal, flavioferreira@eu.ipp.pt, *Nilanjan Banik*, *Fernanda A. Ferreira*, *Alberto A. Pinto*

The literature of international trade mentions the following way in which the domestic firm can make its government impose a tariff: the domestic firm strategically alter its behavior (trying to make the foreign firm deviate) and thereby influence antidumping outcome in the second stage of the game. In this paper, we consider different firms' behaviors and we will study when there are, or not, advantages to deviate.

## ■ TG-26

Tuesday 17:40-18:25

GSI - S 35

### Packing problems

Stream: Discrete Optimization

*Contributed session*

Chair: *Vladimir Kotov*, Discrete Math. and Algorithmica, Belarus State University, Independence avenue 4, 220030, Minsk, Belarus, kotovvm@yandex.ru

## 1 - Polynomial optimal algorithm for solving subset vector problem in the space with fixed dimension.

*Ivan Rykov*, Theoretical cybernetics, Sobolev Institute of Mathematics, 4 Acad. Koptyug avenue, 630090, Novosibirsk, Russian Federation, rykov@ngs.ru, *Edward Gimadi*, *Artem Pyatkin*

We consider the following problem: given a finite set  $V = \{v_1, v_2, \dots, v_n\}$  in Euclidean space  $R^k$  and a natural number  $m < n$ . Find a subset of  $m$  vectors from  $V$  with maximal norm of sum. This problem is NP-hard [1]. We provide an optimal combinatorial algorithm with the time complexity  $O(k^2 * n(2k))$ . So the problem is polynomially solved for each fixed dimension  $k$ . 1. Baburin, Gimadi, Glebov, Pyatkin. The problem of finding a subset of vectors with the maximum total weight. // J. Appl. Industr. Math. 2008. V2, N1. The work is supported by RFBR (projects 08-01-00516, 07-07-00222).

## 2 - Approximation algorithms for the $k_j$ partitioning problem

*Vladimir Kotov*, Discrete Math. and Algorithmica, Belarus State University, Independence avenue 4, 220030, Minsk, Belarus, kotovvm@yandex.ru, *Hans Kellerer*

We consider the problem of assigning  $n$  independent items to  $m$  parallel machine, each having an associated machine dependent cardinality limit, such that the maximum completion time is minimized and the number of items on each machine does not exceed the corresponding cardinality limit. We present approximations algorithm for this problem in case of identical and a uniform machines.

## ■ TG-27

Tuesday 17:40-18:25

GSI - S 21

### Routing Problems

Stream: Discrete Optimization

*Contributed session*

Chair: *Aydin Sipahioglu*, Industrial Engineering, Osmangazi University, Meselik, 26480, Eskisehir, Turkey, asipahi@ogu.edu.tr

#### 1 - Branch-and-price for a split pickup and split delivery problem

*Frank Hennig*, Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred getz veg 3, NO-7491, Trondheim, Norway, frank.hennig@iot.ntnu.no, *Marco Lübbecke*, *Bjørn Nygreen*

In industrial shipping a problem arises in which multiple products are shipped between several origins and destinations. Product quantities are given in pickup and delivery time windows. In case of multiple time windows for a product no origin-destination pairs are specified. Pickup and delivery quantities can be split among heterogeneous ships. Restrictions lead to arc dependent ship capacity constraints. We present results for a column generation approach. The pricing problem is solved by branch-and-price itself and has to find optimal routes, schedules and cargo amounts for each ship.

#### 2 - A new heuristic for multi-depot & heterogonous fleet capacitated arc routing problem

*Aydin Sipahioglu*, Industrial Engineering, Osmangazi University, Meselik, 26480, Eskisehir, Turkey, asipahi@ogu.edu.tr, *Gokhan Kirlik*

It is known that one of the most successful heuristic algorithms for solving Capacitated Arc Routing Problem (CARP) is Ulusoy's algorithm which was proposed in 1985. However, Ulusoy's algorithm doesn't consider multi-depot case, although it considers heterogeneous fleet case by using branch and bound type procedure. In this study, a new approach, which allows multi depot and heterogenous fleet cases together, is proposed by developing Ulusoy's algorithm. The approach consist a mathematical model to solve shortest path problem which is different from classical shortest path problem.

## ■ TG-28

Tuesday 17:40-18:25

GSI - S 1

### Channel Coordination

Stream: Demand and Supply in Consumer Goods and Retailing

*Invited session*

Chair: *Alexander Hübner*, WFI - chair of production management Prof. Dr. Kuhn, Catholic University Eichstätt-Ingolstadt, Auf der Schanz 49, 85049, Ingolstadt, alexander\_huebner@mckinsey.com

#### 1 - Optimal bundling for single-period inventory problem

*Gregory Gurevich*, Industrial Engineering and Management, Sami Shamoon College of Engineering, Byalik str., 84100, Beer Sheva, Israel, gregoryg@sce.ac.il, *Baruch Keren*, *Yuval Cohen*, *Yossi Hadad*

Discount bundles are common strategy of producers, wholesaler and retailers. The paper explores the producer/wholesaler profit maximizing bundle content (the ratio among the products in the bundle) and the bundle price. A general analytic solution for two items is described. Numerical examples demonstrate the solution for special cases of uniform distribution and the importance of bundle optimization (content and price). The analysis reveals that bundling can be a coordination tool which may increase the expected profit for both parties: producer and retailer alike.

#### 2 - Optimal order and production policies in a vmi

*Deniz Kubali*, GSSE Industrial Engineering, Koc University, Rumelifeneri Yolu, Sariyer, 34450, istanbul, denizkubali@gmail.com, *Onur Kaya*, *E. Lerzan Ormeci*

Our study focuses on the coordination of order and production policies between a supplier and a retailer when the production and demand rates of a specific product are known and constant. We consider a vendor-managed inventory system, where supplier determines the length of the inventory replenishment cycle and the order quantity of the retailer. We prove that the optimal shipment dispatch policy is non-stationary and we derive algorithms for both capacitated and infinite cargo capacity. Their performances are discussed through a numerical study.

## ■ TG-29

Tuesday 17:40-18:25

GSI - S 2

### Computational Economics 1

Stream: Financial Modelling

*Invited session*

Chair: *Ronald Hochreiter*, Statistics and Decision Support Systems, University of Vienna, Universitaetsstrasse 5, 1010, Vienna, Austria, ronald.hochreiter@univie.ac.at

#### 1 - A scenario based approach to analyze innovation performance of countries

*Gündüz Ulusoy*, Industrial Engineering, Sabanci University, Orhanli, Tuzla, 34956, Istanbul, Turkey, gunduz@sabanciuniv.edu, *Fusun Ulengin*, *Emel Aktas*, *Sule Onsel*, *Özgür Kabak*

This study proposes a scenario based approach to analyze innovation performance of countries. Initially a workshop is gathered to revise the indicators used in European Innovation Scoreboard and to reveal dependencies among them. Related indicators can be classified into 5 dimensions: innovation drivers, knowledge creation, innovation & entrepreneurship, applications, and intellectual property. Then, a Bayesian Belief Net is developed to create and analyze different scenarios for the transition of countries between 4 categories such as leaders, followers, moderates, and catching-up countries.

#### 2 - Generating artificial macroeconomic frameworks: an expert-driven approach based on artificial intelligence

*Esther Arenas-Arroyo*, Economy, ETEA, Business Administration Faculty, University of Cordoba, Spain, Escritor Castilla Aguayo 4, 14004, Cordoba, Cordoba, Spain, esarar85@hotmail.com, *Carlos Ramón García Alonso*, *Gabriel M. Pérez-Alcalá*

Based on System Analysis, an artificial macroeconomic model has been designed and studied overtime using Monte-Carlo Simulation, Fuzzy Inference and Bayesian statistics. Not only economical variables but also demographic, technological, political and legal variables as well as their dependence relationships are taken into account. This model allows us to analyse artificial macroeconomic environments when some variables are modified. When a dependence relationship is fuzzy a new way for representing massive fuzzy relationships is introduced and checked with or without a priori information.

## ■ TG-30

Tuesday 17:40-18:25

GSI - S 26

### Nonlinear Optimization II

Stream: Engineering Optimization

*Invited session*

Chair: *Abdeslam Kadrani*, Mathématiques et Informatiques, Université de Limoges, 123, Av. Albert Thomas, 87060, Limoges, abdeslam.kadrani@usherbrooke.ca

Chair: *Paola Zuddas*, Dep. of Land Engineering, University of Cagliari, Piazza d'armi, 09123, Cagliari, Sardinia, Italy, zuddas@unica.it

#### 1 - Network optimization for decisions under uncertainty conditions

*Massimo Di Francesco*, Department of Land Engineering, UNIVERSITY OF CAGLIARI, Piazza d'armi, 09123, CAGLIARI, Italy, mdifrance@unica.it, *Teodor Gabriel Crainic*, *Paola Zuddas*

We present a time-extended multi-scenario approach to address network optimization for decisions under uncertainty conditions and data shortage. This formulation can exploit the subjective knowledge of decision makers to generate a set of scenarios and determine decisions, when historical data are inadequate. We investigate its effectiveness in terms of total operating costs and demand fulfillment by a validation testing phase in synthetic instances and real word applications. First results show that this approach allows improving demands fulfillment minimizing consequences of scarce resources.

## 2 - An interior-point algorithm for mixed complementarity problems

*Sandro Mazonche*, Matematica, Universidade Federal de Juiz de Fora, Campus Universitario - Bairro Martelos, 36036-900, Juiz de Fora, MG, Brazil, sandro.mazonche@ufjf.edu.br, *Jose Herskovits*

Complementarity problems arise in mathematical models of several applications in Engineering, Economy and different branches of Physics. We mention contact problems and dynamic of multiple body systems in Solid Mechanics. In this paper we present a new feasible directions interior-point algorithm for mixed nonlinear complementarity problems that we have called FDA-MNCP. Results about global and asymptotic convergence for the FDA-MNCP algorithm are stated. Numerical results obtained with the proposed algorithm for several well known benchmark problems are presented.

## ■ TG-31

Tuesday 17:40-18:25  
GSI - S 34

### Large Scale Feature Selection and Classification

Stream: Optimization and Data Mining  
*Invited session*

Chair: *Giovanni Felici*, Istituto di Analisi dei Sistemi ed Informatica, Consiglio Nazionale delle Ricerche, Viale Manzoni 30, 00185, Roma, Italy, felici@iasi.cnr.it

#### 1 - Support vector machine and integer programming for time series predictions

*Renato De Leone*, Dipartimento di Matematica e Informatica, Università di Camerino, via Madonna delle Carceri 9, 62032, Camerino, MC, Italy, renato.deleone@unicam.it, *Emilia Marchitto*, *Risi Arnaldo*, *Riccardo Bilancioni*

In this talk we will present a novel approach based on Support Vector Machines and Integer Programming formulation for feature selection and multivariate time series prediction. Given a multivariate time series, and some aggregate information on these data, the objective is to determine future aggregate values using a subset of the components of the multivariate time series. This will be achieved using an Integer Linear Programming approach and Support Vector Machines. An application to prediction of aggregated sales in high-fashion industry will be presented.

## ■ TG-32

Tuesday 17:40-18:25  
GSI - S 4

### Data mining in production

Stream: Data Mining  
*Contributed session*

Chair: *Yulia Rudinskaya*, Lessingstr. 45, 09599, Freiberg, yulia.rudinskaya@bwl.tu-freiberg.de

#### 1 - Usage of business intelligence for the optimisation of the steel research process

*Yulia Rudinskaya*, Lessingstr. 45, 09599, Freiberg, yulia.rudinskaya@bwl.tu-freiberg.de, *Carsten Felden*

The project is being conducted in cooperation with the institute of molding of the (Technical University) Freiberg, Germany. Since the experiments are very costly, due to high energy consumption and the environmental effects, the research aim is to develop a human-independent solution that allows a reduction of the number of experiments or at least its length. This could be achieved by using analytical methods known from Business Intelligence that support the reuse of knowledge gathered within former experiments.

## ■ TG-33

Tuesday 17:40-18:25  
GSI - S 7

### Case Studies

Stream: Linear Optimization  
*Contributed session*

Chair: *Suliadi Firdaus Sufahani*, Applied Mathematics, University Of Sheffield, Hicks Building, Hounsfield Road, S3 7RH, Sheffield, United Kingdom, app08sfs@sheffield.ac.uk

#### 1 - A diet planning model for malaysian schools using linear programming

*Suliadi Firdaus Sufahani*, Applied Mathematics, University Of Sheffield, Hicks Building, Hounsfield Road, S3 7RH, Sheffield, United Kingdom, app08sfs@sheffield.ac.uk

This study aims to develop further a mathematical model for diet planning that meets the required nutrient intake for the secondary school student for a two week period, as well as minimizing the catering budget per a day. Diet planning is an optimization problem in which the set of feasible solutions subject to constraints, and the goal is to find the best possible optimal solution. The problem is quite large and integer programming will be used. An automatic decision support system will be developed by using the LPSolve or similar programming language.

#### 2 - A multicriteria model for the design and arrangement of vehicle's maintenance and repair centers: the case of athens municipality

*Athanasios Spyridakos*, Mathematics, Graduate Technological Institute of Piraeus, P. Ralli & Thivon 250, Aigaleo, 12244, Athens, Greece, tspyr@teipir.gr, *Panagiotis Kyriazopoulos*, *Lazaros Vryzidis*, *Maria Litsardaki*, *Maria Litsardaki*

The plan and the arrangement of subunits in metropolitan repair and maintenance centers for vehicles is a complicated procedure while conflicting characteristics are involved. In this research work a multicriteria model based on UTA(\*) method and MINORA is presented for the arrangement of specialised units in different locations, aiming to their effective operation and the rational exploitation of the available means. For the evaluation of alternative arrangements, UTA\* was utilised. The model is illustrated through a real world study for the Athens Metropolitan Municipality.

## ■ TG-34

Tuesday 17:40-18:25

GSI - S 8

### I Application of Fuzzy Logic & Real Options to Corporate Management Decision-Making

Stream: Application of Fuzzy Logic & Real Options to Corporate Management Decision-Making

*Invited session*

Chair: *Mikael Collan*, Institute for Advanced Management Systems Research, Joukahaisenkatu 3-5 A 4th floor, 20520, Turku, Finland, mikael.collan@gmail.com

#### 1 - Economic hysteresis effects and hitting time densities for CIR diffusions

*José Carlos Dias*, Department of Finance, ISCAC Business School, Quinta Agrícola, Bencanta, 3040-316, Coimbra, jdias@iscac.pt

Using the so-called mean-reverting square-root process of Cox et al. (1985b) we generalize the work of Dias and Shackleton (2005) by introducing the mean reversion feature into the economic hysteresis analysis under stochastic interest rates and show that such issue highlights a tendency for a widening effect on the range of inaction, though both thresholds have risen when compared with the no mean-reverting case.

#### 2 - A real options game: investment on the project with operational options and fixed costs

*Makoto Goto*, Graduate School of Finance, Accounting and Law, Waseda University, 1-4-1 Nihombashi, 103-0027, Chuo-ku, Tokyo, Japan, mako.50@aoni.waseda.jp, *Ryuta Takashima*, *Motoh Tsujimura*

In this paper, we analyze investment decision on the 'entry-exit' project, which can be active and suspended by paying some cost, in a duopoly setting. The model incorporates Dixit (1989) and Huisman and Kort (1999). That is, we propose a new extension of the model that captures competitive nature in the recent trend. Then we show it is optimal that the firm must start producing at the beginning of the project, and the leader is more encouraged to invest in a duopoly than monopoly while the follower is more discouraged.

## ■ TG-35

Tuesday 17:40-18:25

GSI - S 9

### General Valuation Techniques

Stream: Value and Risk in Incomplete Markets

*Invited session*

Chair: *Martin Rainer*, ENAMEC, Glockengasse 15, D-97070 Würzburg, 97070, Würzburg, Germany, martin.rainer@enamedec.de

#### 1 - On the relation between zipf's principle and the maximum entropy principle

*Alin Rusu*, Faculty of Mathematics and Computer Science, University of Bucharest, Academiei Street, no. 14, sector 1, 010014, Bucuresti, Romania, rusualinmarian@yahoo.com

The principle of maximum entropy maximizes the entropy subject to the constraint that the effort remains constant. The principle of least effort or the Zipf's optimization principle minimizes the effort subject to the constraint that the entropy remains constant. In this paper, I shall investigate the relation between these two principles by using a weighted entropy frame.

Thus, some equivalence between these principles are stated.

#### 2 - Derivatives pricing in incomplete markets

*Martin Rainer*, ENAMEC, Glockengasse 15, D-97070 Würzburg, 97070, Würzburg, Germany, martin.rainer@enamedec.de

When a market is incomplete, equivalent martingale measures give derivative prices within an arbitrage-fee (bid-ask) price interval. Its stochastic model must be calibrated dynamically to the current market state, then the price within the arbitrage-free interval is determined by the measure. Indifference pricing based on utility and risk are an alternative to the extremal scenarios of super/sub-hedging. Applications include traditionally incomplete markets (e.g. energy) and incomplete traditional markets (interest/credit). [Inst. Appl. Mathematics/METU Ankara; ENAMEC Würzburg]

## ■ TG-36

Tuesday 17:40-18:25

GSI - S 11

### Stochastic Modelling 4

Stream: Stochastic Modelling

*Contributed session*

Chair: *Srinivas R. Chakravarthy*, Industrial and Manufacturing Engineering, Kettering University, 1700 W. University Avenue, 48504, Flint, Michigan, United States, schakrav@kettering.edu

#### 1 - A queueing network with bulk service policy

*Juan Mejia -Tellez*, Departamento de Sistemas, Universidad Autonoma Metropolitana, Av. San Pablo # 180, Col. Reynosa Tamaulipas, 02200, Distrito Federal, Mexico, jmt@correo.azc.uam.mx

A bulk service queueing network is analysed as if it were a Jackson network. Applying a numerical algorithm in discrete time for the system  $M/G(a_i, b_i)/1$  for the  $i$ -th service station, steady state numerical results are given for service time probability distributions like: negative exponential, Erlang- $k$ , constant. Results are also presented for a proper Jackson network.

#### 2 - A disaster queue with markovian arrivals and impatient customers

*Srinivas R. Chakravarthy*, Industrial and Manufacturing Engineering, Kettering University, 1700 W. University Avenue, 48504, Flint, Michigan, United States, schakrav@kettering.edu

We consider a single server queueing system where arrivals occur according to a Markovian arrival process. The system is subject to disastrous failures removing all customers in the system. Arrivals occurring during the time the system undergoes repair are stored in a buffer of finite capacity. These customers can become impatient after waiting a random amount of time and leave. When the system is operable, there is no limit on the number of customers who can be admitted. The model is analyzed in steady state and a number of useful performance measures and illustrative examples are reported.

## ■ TG-37

Tuesday 17:40-18:25

GSI - S 12

### Decision Support Systems

Stream: Decision Analysis

*Contributed session*

Chair: *Fábio Romeu de Carvalho*, Paulista University, Rua Dr Bacelar 1212, 04026-002, São Paulo, SP, Brazil, fabioromeu@unip.br

#### 1 - Functionalities of machining optimizer system in relation to the decision support system

*Elesandro Baptista*, Industrial Engineering Department of Uninove University, Universidade Nove de Julho, 05001-100, São Paulo, SP, Brazil, elesandro@uninove.br, *Luciana Baptista, Nivaldo Coppini*

Currently, the authors see different approaches to developing optimization of machining processes. The procedures created or modified, based on the appropriateness of cutting parameters according to the binomial cost/productivity. Alongside this, the authors developed, a system called Machining System Optimizer (MOS), which was developed to assist the complicated task of optimization of machining processes. The aim of this paper is to present the features of MOS for decision support system and how it helps in the process of machining to make the most correct decision for the production line.

#### 2 - Decision making method with paraconsistent annotated logic tools and its application in selection of investment by financial institutions

*Fábio Romeu de Carvalho*, Paulista University, Rua Dr Bacelar 1212, 04026-002, São Paulo, SP, Brazil, fabioromeu@unip.br, *Jair Minoro Abe*

New types of logics are capable of handling with contradiction and uncertainty without becoming trivial. One of them is the annotated paraconsistent evidential logic  $E?$ . A proposition of  $E?$  is of the type  $p(a, b)$ , in which  $a$  and  $b$  belong to interval  $[0,1]$  and represent respectively the degrees of favorable and contrary evidence expressed by  $p$ . The set  $\mathcal{P}$  of all pairs  $(a, b)$  constitutes a lattice of output values. In this work we present an application of the Paraconsistent Decision Method (PDM) in selection of investments, managed by the para-analyzing algorithm based on this logic.

## ■ TG-38

Tuesday 17:40-18:25

GSI - S 13

### Strategic optimization in supply chains and risk management I

Stream: Variational Problems - Theory, Methods and Applications

*Invited session*

Chair: *Cedric Yiu*, Applied Mathematics, The Hong Kong Polytechnic University, Hunghom, -, Kowloon, macyiu@polyu.edu.hk

#### 1 - Distributed optimization for a network of cooperative agents

*Yapeng Lu*, Industrial and Manufacturing Systems Engineering, The University of Hong Kong, Room823, 8/F, Haking Wong Building, Pokfulam Road, Hong

Kong, Nil, Hong Kong, Hong Kong, steven.lu@hku.hk, *Henry Lau*

The paper introduces a hybrid algorithm which combines Lagrangian decomposition and artificial immune systems. First of all, we obtain the Lagrangian decomposition of the original problem by relaxing the constraints that intertwine two or more sub-problems. Then, it works through a search-propagation-and-updating scheme where each agent starts with a tentative local decision by searching its finite domain, progresses to an immunity-inspired constraint propagation process, and then updates its decision according to some rule-base that is equivalent to the gradient descent method.

#### 2 - Immune network theory based multi-objective optimization algorithm with approximate dominance consideration

*Wilburn Tsang*, The University of Hong Kong, Department of IMSE, Pokfulam Road, Hong Kong, 000, Hong Kong, hyklau@hkucc.hku.hk, *Henry Lau*

In a multi-objective optimization, it is difficult to find one single solution that is optimum for all considerations. A set of solution is identified to represent the trade-off between different considerations. Multi-objective optimization problems are difficult to solve. In this respect, this study focuses on the development of new multi-objective optimization algorithms for the effective evaluation of optimal solutions. This study develops an optimization algorithm which adopts the engineering analogue of the human immune system to new multi-objective optimization algorithm.

#### 3 - Financial management in global supply chains

*Bajis Dodin*, Anderson Graduate School of Management, University of California, Anderson Graduate School of Management, University of California, 92521, Riverside, California, United States, bajis.dodin@ucr.edu, *Abdelghani Elimam*

Global supply chains (SC) have branches (rings) with multiple currencies. Fluctuations in currency exchange rates over time lead to more difficulties in managing such SC. Long cycle times may impact the value of material as well as the various costs incurred within the SC rings. In this paper, we investigate the impact of currency fluctuations on the SC, and analyze the relationship between these fluctuations and the SC cycle time and its corresponding costs. This analysis led to establishing optimal and near optimal cash management policies for all the SC rings.

## ■ TG-39

Tuesday 17:40-18:25

GSI - S 14

### Simulation 1

Stream: Simulation

*Contributed session*

Chair: *Ion Ioan Ferdinand Lancranjan*, Optoelectronics, CSA-INCAS, 220 Iuliu Maniu Boulevard, Sector 6, Bucharest, Romania 061126, 061126, Bucharest, J\_J\_F\_L@yahoo.com

#### 1 - The analysis of the spatial variation of the ground-water level with geostatistical methods

*Mevlut Uyan*, University of Selcuk, Dep. of Geodesy and Photogrammetry, 42031, Konya, Turkey, muyan\_42@hotmail.com, *Tayfun Cay*

The groundwater is one of the most important resources used for drinking, utility and irrigation purposes within the borders of Konya province as in other areas. The purpose of this study is to evaluate the spatial changes in the level of the groundwater by using geostatistical methods. Cross-validation and kriging methods were applied in this study to evaluate the accuracy of the variogram selected for the estimate of the level of the groundwater. The results obtained from the kriging method are fairly useful for the determination of the threatening areas in terms of the groundwater.

## 2 - Numerically investigated of laser passively q-switching regime

*Ion Ioan Ferdinand Lancranjan*, Optoelectronics, CSA-INCAS, 220 Iuliu Maniu Boulevard, Sector 6, Bucharest, Romania 061126, 061126, Bucharest, J\_J\_F\_L@yahoo.com, *Camelia Gavrilă*

In this paper the technique of solid-state lasers passive optical Q-switching is numerically investigated considering the case of longitudinally and transversally uniform photon, population inversion and absorption centres densities. The coupled differential equations defining photon, population inversion and absorption centres densities are numerically solved being the basis of laser functional simulation. For validating the results, the numerical simulations are performed using the SCILAB programs.

## ■ TG-40

Tuesday 17:40-18:25

GSI - S 27

### Simulation based learning of complex system management

Stream: Simulation Based Decision Support

*Invited session*

Chair: *Mirjana Kljajic-Borstnar*, Laboratory for Decision Processes and Knowledge-based systems, University of Maribor, Faculty of Organizational Sciences, Kidriceva 55a, 1000, Ljubljana, Slovenia, Slovenia, mirjana.kljajic@fov.uni-mb.si

Chair: *Andrej Skraba*, Faculty of Organizational Sciences, University of Maribor, Kidriceva cesta 55a, 4000, Kranj, Slovenia, Slovenia, andrej.skraba@fov.uni-mb.si

### 1 - Developmental aspects of macro-decisions in social systems

*Kazimierz Turkiewicz*, Independent, 61 currey Ave, Moorooka, Qld, 4105, Brisbane, Qld, kazt3@mail2me.com.au, *Dominika Turkiewicz*

The current global economic crisis shows that macro-decisions are very important to stimulate effectively suitable economical activity in a society. Primarily the quality of such decisions depends on the understanding of dynamics of the natural process of society's development. Our work presents the outline of an abstract-syntactic model of an elementary cycle of development of an autocratic system, which commonly functions in societies. This model can lead to the development of simulation models for appropriate decision support.

### 2 - Business simulator a tool to improve learning process

*Mirjana Kljajic-Borstnar*, Laboratory for Decision Processes and Knowledge-based systems, University of Maribor, Faculty of Organizational Sciences, Kidriceva 55a, 1000, Ljubljana, Slovenia, Slovenia,

mirjana.kljajic@fov.uni-mb.si, *Andrej Skraba*, *Davorin Kofjač*

The methodology in the decision assessment of complex systems using simulation model is described. Students took part in the experiment with the task of solving a management problem. Experimental results were analyzed and discussed in the students' projects. After the experiment, students had to complete an opinion questionnaire. The results of Criteria Function and student's opinion support the hypothesis that simulation model application contributes to greater understanding of the problem and greater confidence in the decision-making process.

## ■ TG-41

Tuesday 17:40-18:25

GSI - S 28

### Production and Operations Management 2

Stream: Production and Operations Management

*Contributed session*

Chair: *Smail Adjabi*, Recherche Opérationnelle, Laboratory LAMOS, University of bejaia, 6000, Bejaia, Algeria, adjabi@hotmail.com

### 1 - Optimizing the shovel-truck operation in open-pit mine based on fuzzy lp model: cased by chogart iron ore mine

*Farhad Samimi Namin*, Faculty of Mining and Metallurgical Engineering, Amirkabir University of Technology, 424 Hafez Ave., -, 15875-4413, Tehran, -, Farhad\_S\_n@yahoo.com, *Alireza Cheniany*

Assignment of the proper number of trucks to a shovel, based on event time studies and shifting of trucks between loading units, when any breakdowns or delays occur, optimize the overall fleet performance. Dispatching system involves uncertainty. The most important theories addressing uncertainty are fuzzy sets theories. This paper presents method for optimizing shovel truck operations using fuzzy LP model and discusses dispatching in a fuzzy environment. The uncertainty of the activities within a shovel truck system make fuzzy model more appropriate, compared with deterministic calculations.

### 2 - Value of quality information of returns in product recovery management

*Z. Pelin Bayindir*, Department of Industrial Engineering, Middle East Technical University, Middle East Technical University, Department of Industrial Engineering, 06531, Ankara, Turkey, bayindir@ie.metu.edu.tr, *Altan Atabarut*

We consider a recovery system where end-of-life products are converted to a number of different recovered products. Recovery options for a return depend on its level of quality, i.e., grade. The main objective of the study is to investigate the benefits of quality grade information on the profitability of recovery business. Linear programming models for alternative testing strategies under different information schemes are built for a generic multistage recovery system in a multi-period setting. An extensive computational study is carried out to quantify the value of quality information.

## ■ TG-42

Tuesday 17:40-18:25

GSI - S 3

### Optimal Control I

Stream: Optimal Control

*Invited session*

Chair: *Erik Kropat*, Department of Mathematics, Friedrich-Alexander University Erlangen-Nuremberg, Martensstraße 3, 91058, Erlangen, Germany, kropat@am2.am.uni-erlangen.de

#### 1 - Nonsmooth switching optimal control problem

*Shahlar Maharramov*, math, Yasar university, Selcuk yasar camp, Univers.str, No:35-37, Bornova, 35500, Izmir, Izmir, Turkey, shahlar.maharramov@yasar.edu.tr

In this paper, results for nonsmooth optimal control of switching systems are reported. Application of necessary optimality condition for the switching optimal control problem is also reported. The author's main aim is to formulate necessary optimality conditions for smooth case and extended this result nonsmooth case (switching cost functional has Frechet superdifferential and then switching cost functional has uniformly upper subdifferentiable) and extend necessary optimality for switching control problem to the exhausters.

#### 2 - Homogenization of differential equations on networks

*Erik Kropat*, Department of Mathematics, Friedrich-Alexander University Erlangen-Nuremberg, Martensstraße 3, 91058, Erlangen, Germany, kropat@am2.am.uni-erlangen.de

Many applications in science and engineering lead to differential equations on very large networks with a periodic microstructure. As these problems are hard to solve we replace the local model by approximating macroscopic models. Firstly, we analyze diffusion-advection-reaction problems on graphs and derive global models based on asymptotic expansions and two-scale convergence. Then, we turn to the homogenization of optimal control problems on networks. With a combination of the two-scale convergence and the concept of S-homogenization we can determine a homogenized optimal control problem.

## ■ TG-43

Tuesday 17:40-18:25

GSI - S 10

### Various Aspects of System Dynamics

Stream: System Dynamics Modelling

*Invited session*

Chair: *Stefan Groesser*, Institute of Management, University of St. Gallen, Dufourstrasse 40a, 9000, St. Gallen, Switzerland, stefan.groesser@web.de

#### 1 - Modelling inflation targeting

*Ondrej Cizek*, Praha 9, Cerny Most, Trytova 1119, 198 00, Praha, Czech Republic, cizeko@vse.cz

With the help of the small open economy model, the effect of diverse random shocks is analyzed. The optimal response of the central bank upon this shock is also studied, namely behind different inflation targeting regimes. The comparison of the optimal reaction function with the Taylor rule reveals dramatic differences, which is in line with the generally accepted opinion about inadequacy of the Taylor rule in small open economies.

#### 2 - Clostridium difficile: system dynamics modelling of hospital infection outbreaks

*David Lane*, Interdisciplinary Institute of Management, London School of Economics and Political Science, Houghton Street, WC2A 2AE, London, United Kingdom, d.c.lane@lse.ac.uk

In 2008 the UK National Audit Office began work on Clostridium difficile infections. Staff at NAO and LSE constructed a simulation model to understand outbreaks. The stages of patient contamination, various transmission mechanisms and the cleaning of beds, toilets and staff hands are represented. The model synthesised information from a wide range of sources. It provides a formal theory of epidemic outbreaks and allows users to understand the complex consequences of the interaction of a number of transmission vectors and policy interventions aimed at combating outbreaks.

## ■ TG-44

Tuesday 17:40-18:25

GSI - S 16

### Migration, Education and Sustainable Development 2

Stream: Migration, Education and Sustainable Development

*Invited session*

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

Chair: *Hanife Akar*, Department of Educational Sciences, Middle East Technical University, Orta Dogu Teknik Universitesi, Egitim Fakultesi EF 316, 06531, Ankara, Turkey, hanif@metu.edu.tr

#### 1 - A systems dynamics model for the creation of a co-operative, non-competitive environment

*Luisa Fernanda Rodriguez Valbuena*, Instituto Superior de Pedagog, Universidad Autonoma de Colombia, Clle. 175 17A-11 Casa 68 Alameda Resrvada, 1213, Bogot, D.C., Colombia, luisa\_frv@yahoo.com

The research for this presentation was conducted in order to suggest a new concept of entrepreneurship as a collective awareness and exercise of civil rights and duties guided by collective and individual initiative as opposed to the traditional concept. In order to materialize this innovative image, the term 'entrepreneur' had to be linked up with the ability on behalf of the students to develop the cooperation among individuals and the attainment of common goals, an attitude for which we coined the term 'associability'. The key used for this analysis was a system dynamics model.

#### 2 - Index development for performance analysis of accreditation for engineering education

*Yong Han Ju*, Department of Information and Industrial Engineering Industrial Statistics Lab., 134 Shinchon-dong, Seodaemun-Gu, 120-749, Seoul, juyonghan@yonsei.ac.kr, *Jin Young Choi*, *Jin Sook Ahn*, *So Young Sohn*

Engineering is a critical component of modern industries and plays a core role in advancing the technical and scientific knowledge of those industries. Due to the increase in importance of engineering, additional focus such as accreditation system has been placed on engineering education. In this paper we develop performance evaluation indices for accreditation system to see if there are significant differences between graduates from accredited and non-accredited programs. Some empirical study results will be shared.

## Wednesday 08:00-09:20

### ■ WA-01

Wednesday 08:00-09:20

Beethoven

#### Airline problems

Stream: Combinatorial Optimization

*Invited session*

Chair: *Juan José Salazar González*, Estadística e Investigación Operativa, Universidad de La Laguna (Tenerife), Av. Astrofísico Francisco Sánchez, s/n, 38271, La Laguna, Tenerife, Spain, [jjsalaza@ull.es](mailto:jjsalaza@ull.es)

#### 1 - A short term approach for the collision avoidance for air traffic management problem

*Francisco Javier Martin-Campo*, Statistics and Operations Research, University Rey Juan Carlos, C/ Tulipán s/n Departamental II Building, Office 045., 28933, Móstoles, Madrid, Spain, [javier.martin.campo@urjc.es](mailto:javier.martin.campo@urjc.es), *Alba Agustin, Celeste Pizarro Romero*

We develop a pure 0-1 model based on geometric transformations for collision avoidance between any number of aircrafts in the airspace. The problem consists of deciding the optimal maneuver (velocity and altitude changes) avoiding all conflicts between aircrafts. Knowing initial coordinates, angle direction and level flight we decide the new configuration for each aircraft minimizing several objectives like velocity variation, total number of changes and returning to the original flight configuration when each aircraft is not in conflict. We suppose each aircraft goes along a straight line.

#### 2 - On the collision avoidance for air traffic management problem. a large scale mixed 0-1 program approach

*Pablo Olaso*, Department of Statistics and Operations Research, Universidad Rey Juan Carlos, c Tulipán s/n, 28933, Móstoles, [pablo.olaso@urjc.es](mailto:pablo.olaso@urjc.es), *Celeste Pizarro Romero, Francisco Javier Martin-Campo*

We propose a large-scale linear mixed 0-1 programming model for collision avoidance among any number of aircrafts. Only vertical manoeuvres and speed changes are allowed. Each aircraft is given a series of fixed points to traverse in its route. We then decide the flight level and speed for each aircraft at every time period, guaranteeing that collisions are avoided and trying that the aircrafts do not arrive earlier nor later than the scheduled time to their destination points, thus avoiding to spread collisions to other zones by altering the aircrafts' scheduled routes.

#### 3 - Cargo and passengers air transport: a hub location problem in brazil

*Rafael M. A. de Figueiredo*, Pontifical Catholic University of Rio de Janeiro, Industrial Engineering Department, Marques de Sao Vicente Street, 225, 950L, Gavea, 22453900, Rio de Janeiro, Brazil, [rafaelmaf@gmail.com](mailto:rafaelmaf@gmail.com), *Madiagne Diallo, Nélio Pizzolato, Morton E. O'Kelly*

This paper explores the expected growth rates in passenger and freight air transportation, describing the hub-and-spoke model, its main characteristics and advantages, and makes an application of a hub location model in the Brazilian market of passenger and freight, through the concept of WLU (Work Load Unit) and using the optimization software AIMMS. The model pursue to locate 3 and 4 hubs and the results for these 2 scenarios will be discussed, followed by an analysis of the main flows in the linkages made through software TRANSCAD. Key words: hub-and-spoke, location, facilities

## ■ WA-02

Wednesday 08:00-09:20

Schumann

### Robust Approaches to Airline Optimization Problems

Stream: Transportation Planning

*Invited session*

Chair: *Ibrahim Muter*, Industrial Engineering, Sabanci University, Orhanli, Tuzla, 34956, Istanbul, Turkey, imuter@su.sabanciuniv.edu

#### 1 - Robust airline crew pairing model for managing extra flights

*Ibrahim Muter*, Industrial Engineering, Sabanci University, Orhanli, Tuzla, 34956, Istanbul, Turkey, imuter@su.sabanciuniv.edu, *Duygu Tas*, *Elvin Coban*, *S. Ilker Birbil*, *Kerem Bulbul*, *Guvenc Sahin*, *Dilek Tuzun Aksu*, *Husnu Yenigun*

We discuss the management of potential extra flights that can possibly be introduced to the regular flight schedule during operation at a later point in time. We try to handle these extra flights within the regular schedule and refer to the resulting model as a robust airline crew pairing model. Before applying column generation, we discuss procedures to cover the extra flights by a given set of feasible pairings. These procedures introduce extra column-dependent constraints to the model. To handle this dynamic change in the size of the model, we propose two column generation approaches.

#### 2 - Pricing in column generation for a robust airline crew pairing problem

*Duygu Tas*, Industrial Engineering and Innovation Sciences, TU/e Eindhoven University of Technology, Eindhoven, Netherlands, duygut@su.sabanciuniv.edu, *Ibrahim Muter*, *S. Ilker Birbil*, *Kerem Bulbul*, *Guvenc Sahin*, *Dilek Tuzun*, *Husnu Yenigun*

In the robust crew pairing problem (RCPP) the selected pairings cover the regular flights and the extra flights which may be introduced into the flight schedule during the operation. The crew pairing problem is usually solved by column generation methods where pricing subproblem becomes a multi-label shortest path problem (MLSP). To solve RCPP, we propose two approaches and present modifications required in MLSP. The complexity of MLSP is exponential in the number of flights. We propose one exact and two approximate rules and present our solutions through a computational study.

#### 3 - Multi-objective strategic robust airline scheduling

*Geert De Maere*, School of Computer science, University of Nottingham, Jubilee Campus, 1, Wollaton road, NG81BB, Nottingham, United Kingdom, gdm@cs.nott.ac.uk, *Edmund Burke*, *Patrick De Causmaecker*

We introduce the multi-objective approaches based on re-timing and integrated re-timing and re-routing that enabled us to investigate the mutual interaction between robustness influencing characteristics in airline schedules, and their simultaneous influence on a schedule's operational performance. Exact and approximate solution methods are introduced. Results for real world data from a major European airline are presented and discussed. The key observations are summarised and a brief overview of promising directions for future research is provided.

## ■ WA-03

Wednesday 08:00-09:20

Reger

### FREIGHT TRANSPORTATION

Stream: Transportation

*Invited session*

Chair: *Jacek Zak*, Faculty of Working Machines and Transportation, Poznan University of Technology, 3 Piotrowo street, 60-965, Poznan, Poland, jacekzak@put.poznan.pl

#### 1 - A two-level freight distribution problem: formulations and heuristic approach

*Claudio Sterle*, Dipartimento di Informatica e Sistemistica, Università degli Studi di Napoli, Via Claudio 21, I-80125, Napoli, Italia, Italy, claudio.sterle@unina.it, *Teodor Gabriel Crainic*, *Antonio Sforza*

A multi-level freight distribution problem within a city logistic system is presented. It is formulated as a two-level location-routing model with capacitated facilities and capacitated routes. Three different formulations are proposed, aimed at determine the number and the locations of primary and secondary facilities, the fleet size for two different kind of trucks and the related routing on each level. A two phase tabu search heuristic working sequentially on the two levels is proposed. Results obtained on several test cases and comparison with exact solutions are presented.

#### 2 - Mathematical and simulation based modeling of the distribution system of goods

*Jacek Zak*, Faculty of Working Machines and Transportation, Poznan University of Technology, 3 Piotrowo street, 60-965, Poznan, Poland, jacekzak@put.poznan.pl, *Hanna Sawicka*

The authors present the essence of modeling of the real distribution system of goods. This system consists of a central distribution center (dc), 12 regional dc and 11 local dc. All crucial areas have been included within the system's analysis, such as transportation, warehousing, as well as flows of information and goods. Based on this analysis the mathematical model, including: several evaluation criteria and constraints, has been constructed. The model has been represented in the object-oriented simulation tool ExtendSim. The results of the simulation experiments have been presented.

## ■ WA-04

Wednesday 08:00-09:20

Liszt

### Scheduling and Transportation

Stream: Scheduling

*Invited session*

Chair: *Sigrid Knust*, Institute of Mathematics, Technical University of Clausthal, Erzstr. 1, 38678, Clausthal-Zellerfeld, Germany, sigrid@informatik.uni-osnabrueck.de

#### 1 - Integrated production and distribution scheduling

*Christian Viergutz*, Institute of Computer Science, University of Osnabrück, Albrechtstraße 28, 49076, Osnabrück, Germany, christian.vierygutz@uos.de

We will discuss a model for integrated production and distribution scheduling for a perishable product, a limited-production-rate facility and non-negligible traveling times for transportation. Initially, a fixed customer sequence with time windows is considered. After that, extensions of this model will be offered such as allowing arbitrary customer sequences or multi-vehicle scenarios with the aim of incorporating more realistic restrictions from practice. We will present heuristics to solve this problem and illustrate that the combined scheduling is beneficial for the considered models.

## 2 - Optimization of train planning at intermodal terminals

*Florian Bruns*, Department of Mathematics/Computer Science, University of Osnabrueck, Hunteburger Weg 56, 49088, Osnabrück, Germany, flbruns@uos.de

Train planning is the scheduling of the load plan for a train at an intermodal terminal. The train plan assigns load units like containers to rail cars. The aim of train planning is to maximize utilization of the train and minimize the cost of the terminal. The train plan accounts for various constraints. Most of these constraints model the restrictions of loading a rail car. This includes weight restrictions for the rail cars. The problem is defined as an ILP and also solved with a local search, a heuristic and a decomposition approach.

## 3 - Robotic cycles in cyclic flow-shop and job-shop problems without buffers and one transport robot

*Sven Groenemeyer*, Automated Scheduling, Optimisation & Planning (ASAP), The University of Nottingham, School of Computer Science, Wallaton Road, NG8 1BB, Nottingham, Nottinghamshire, United Kingdom, svg@cs.nott.ac.uk, *Peter Brucker*, *Edmund Burke*

For large scale production the study of cyclic scheduling problems can be beneficial. In assembly lines the material handling is usually done automatically by transport robots. In the literature most authors assume that a fixed robotic cycle is given in advance. Therefore, we analyse the probabilities of feasible robotic cycles for cyclic flow-shop and job-shop problems with one transport robot and blocking. We present a general method to construct feasible robotic cycles and give an overview of how to develop local search methods to determine good quality solutions for these problems.

## 4 - Online scheduling a fleet of transportation robots

*Jens Poppenborg*, University of Osnabrück, 49069, Osnabrück, Germany, jpoppenb@uos.de

A fleet of transportation robots is scheduled by modeling the problem as a hybrid job shop with transportation. Jobs only become available for scheduling at their respective release dates, i.e. schedules have to be extended and modified by an online scheduling algorithm as new jobs become available. The objective function consists of the total weighted tardiness as primary objective and the total distance as secondary objective. Results for problem instances are included.

## WA-05

Wednesday 08:00-09:20

Haydn

### Scheduling Applications 1

Stream: Scheduling

Invited session

Chair: *Adam Wojciechowski*, Mathematical Sciences, Chalmers University of Technology and University of Gothenburg, Chalmers University of Technology, 412 96, Göteborg, Sweden, wojcadam@chalmers.se

## 1 - Modelling target volume flows in harvest scheduling subject to maximum area

*Maria da Conceicao Fonseca*, Departamento de Estatística e Investigação Operacional, Universidade de Lisboa, Faculdade de Ciências and Centro de Investigação Operacional, Bloco C/6 Campo Grande, Cidade Universitária, 1749-016, Lisboa, Portugal, mdfonseca@fc.ul.pt, *Miguel Constantino*, *Isabel Martins*, *Jorge Cadima*, *Mujing Ye*

In Integer Programming models for harvest scheduling with restrictions on the clearcut areas (ARM), volume constraints are used to meet a non-declining flow of timber harvested over the planning horizon. In general they increase the difficulty of solving the ARM problems and do not always guarantee an acceptable deviation of the harvested volume from the first to the last periods. We propose two model approaches, in integer and multi-objective programming, to overcome these obstacles. We report a comparative study.

## 2 - A branch-and-price algorithm for harvest scheduling subject to maximum area restrictions

*Isabel Martins*, Departamento de Matemática, Instituto Superior de Agronomia, Centro de Investigação Operacional, Tapada da Ajuda, 1349-017, Lisbon, Portugal, isabelinha@isa.utl.pt, *Filipe Alvelos*, *Miguel Constantino*

We consider forest management problems with constraints on the clearcut size, using the most recent approach, the so-called area restriction model. Three main basic integer programming models for these problems have been discussed in the literature. Solving those formulations via branch-and-bound is well suited for real problems of small to medium size but not for larger problems. We describe a branch-and-price approach for that model whose number of variables is exponential. This technique was tested with both real and hypothetical forests ranging from 45 to 10901 stands.

## 3 - Scheduling of market processes in energy balancing market

*Kamil Smolira*, Institute of Control & Computation Engineering, Warsaw University of Technology, ul. Nowowiejska 15/19, 00-665, Warszawa, Poland, ksmolira@ia.pw.edu.pl, *Mariusz Kaleta*, *Eugeniusz Toczyłowski*

The time structure of market processes has big influence on the whole system efficiency, especially in case of complex markets, like an electric power market. Because market processes' scheduling is very complicated task, we propose an approach to this problem, which consists of many multiply time repeated phases. Main of them are: sub-problem specification, definition of requirements and evaluation criteria, generation schedules propositions, simulation of obtained schedules. For each of these phases we present detailed mechanisms, which may be used during power market processes scheduling.

## 4 - Optimal maintenance scheduling of multicomponent systems with stochastic life limits

*Adam Wojciechowski*, Mathematical Sciences, Chalmers University of Technology and University of Gothenburg, Chalmers University of Technology, 412 96, Göteborg, Sweden, wojcadam@chalmers.se, *Michael Patriksson*, *Ann-Brith Strömberg*

For many companies maintenance is viewed as a large source of cost, while it should rather be viewed as an investment in availability. Previously, little optimization has been performed on maintenance planning problems over a finite horizon. We focus on optimization of maintenance activities in multicomponent systems where each maintenance occasion generates a fixed cost. An integer linear programming model for opportunistic maintenance planning taking into account the uncertainty of component lives is presented, along with complexity and polyhedral analyses and preliminary numerical results.

## ■ WA-06

Wednesday 08:00-09:20

Koch

### Cluster-Optimization

Stream: Clustering

Invited session

Chair: *Aysegul Ozturk*, Koc University, Rumeli Feneri Yolu, Sariyer, 34450, Istanbul, Turkey, agozturk@ku.edu.tr

#### 1 - Constrained minimum-k-star clustering and its application to the consolidation of farmland

*Steffen Borgwardt*, Fakultät für Mathematik, Technische Universität München, Boltzmannstr. 3, 85747, Garching, borgward@ma.tum.de, *Andreas Brieden*, *Peter Gritzmann*

We introduce and study a new clustering model for the consolidation of farmland based on a combinatorial reassignment of the lots in an agricultural region. While the general problem turns out to be NP-hard even in quite restricted cases, the Size-restricted Minimum-k-Star Group Partition problem is solvable in polynomial time. Based on this tractability result, we derive a general approximation algorithm which, as the mathematical analysis and economic evaluation shows, performs well in theory and practice.

#### 2 - On the relationship between constrained clustering and voronoi diagrams

*Andreas Brieden*, Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, 85579, Neubiberg, Germany, andreas.brieden@unibw.de, *Peter Gritzmann*

Starting with the problem of optimally clustering points in space into clusters with prescribed sizes we end up with new insight into the geometry of classical Voronoi diagrams. In particular the latter can be viewed as trivial solutions of a subclass of a family of optimization problems. The nontrivial cases lead straightforward to a generalization of the classical Voronoi diagrams.

#### 3 - A multiobjective support vector machine based on the one-against-all method maximizing geometric margins for multiclass classification

*Keiji Tatsumi*, Division of Electrical, Electronic and Information Engineering, Osaka University, Yamada-Oka 2-1, 565-0871, Suita, Osaka, Japan, tatsumi@eei.eng.osaka-u.ac.jp, *Tetsuzo Tanino*

In this paper, we focus on the one-against-all support vector machine (SVM) for multiclass classification. The method trains binary SVMs which discriminant each class from other classes, and combine them to construct a discriminant function. However, it does not maximize the geometric margins, which can guarantee the generalization ability. Thus, we propose a multiobjective SVM model maximizing the margins. Moreover, we derive a single-objective second order cone programming problem to solve the proposed model, and verify the ability of the proposed model through numerical experiments.

#### 4 - Classification of imbalanced datasets with 1-norm svms

*Aysegul Ozturk*, Koc University, Rumeli Feneri Yolu, Sariyer, 34450, Istanbul, Turkey, agozturk@ku.edu.tr, *Serpil Sayin*

Classification of imbalanced datasets in which negative instances outnumber positive instances is a common situation in real life problems. The objective of this study is to improve the performance of SVMs for imbalanced datasets. The method is based on modifying 1-norm SVM formulation to create a three objective optimization problem so as to incorporate into the formulation the error sums for the two classes independently. To solve it, we reduce the original formulation into two criteria variations and investigate the efficient frontier. The results of computational experiments are discussed.

## ■ WA-07

Wednesday 08:00-09:20

GSI - S 29

### Vehicle and Crew Scheduling

Stream: Optimization in Public Transport

Invited session

Chair: *Natalia Kliewer*, Information Systems and Operations Research, University of Paderborn, Warburger Str. 100, 33100, Paderborn, Germany, kliewer@upb.de

#### 1 - A decomposition approach for the integrated vehicle-crew-rostering problem

*Ana Paias*, DEIO/CIO, University of Lisbon, Portugal, ampaiais@fc.ul.pt, *Marta Mesquita*, *Margarida Moz*, *Margarida Pato*

The integrated vehicle-crew-rostering problem (VCRP) aims to assign, during a given time horizon, the drivers of a public transit company to the vehicle blocks built according to the daily demand of passengers in a specific area. We propose a Benders decomposition approach that iterates between the solution of an integrated vehicle-crew scheduling problem and a solution of a rostering problem, to obtain feasible solutions for the VCRP. Computational experience has shown that this approach leads to a pool of diverse feasible solutions where a large number of efficient solutions may be found.

#### 2 - Aspects of real-world vehicle scheduling problems and their solution

*Stefan Bunte*, Warburger Straße 100, 33100, Paderborn, Germany, bunte@dsor.de, *Natalia Kliewer*

We consider the vehicle scheduling problem arising in public transportation companies and its practical extensions as the well known multiple depot multiple vehicle type vehicle scheduling problem. We would like to give a short overview on proposed solution approaches and will discuss different real-world and artificially generated problem instances and how their different characteristics affect state-of-the-art solution methods. We will present a new solution approach which is based on an aggregated time-space network model and show how it supports planners in public transport.

#### 3 - Vehicle and crew scheduling with irregular timetables

*Boris Amberg*, DS&OR Lab, Faculty of Business Administration and Economics, University of Paderborn, Warburger Str. 100, 33098, Paderborn, Germany, boris.amberg@dsor.de, *Natalia Kliewer*

In public bus transport, many approaches have been developed to get vehicle and crew schedules with minimum cost. However, there are still needs concerning the quality of vehicle and crew schedules. Usually timetables consist of many trips serviced every day. But there are also trips that do not repeat daily. Scheduling vehicles and crews day after day produces schedules which have minimum cost but differ from each other, whereas similar/regular schedules are desired in practice. We discuss different approaches to improve the regularity of crew and vehicle schedules.

#### 4 - A network flow optimization model for integrated capacity-based crew scheduling

*Taieb Mellouli*, Business Information Systems and Operations Research, University of Halle, Universitätsring 3, 06108, Halle Saale, mellouli@wiwi.uni-halle.de

Charter carriers such as TUIfly operate their flight schedules by crew stationed unevenly in multiple domiciles in order to cope with seasonal changes and changing touristic departure airports, hubs and destinations. In order to generate flyable pairing lines under these circumstances, an integrated approach for pairing (chain) optimization is realized incorporating time-dependent crew availability and exact crew transfers. The underlying network flow optimization model is superior to known set-partitioning approaches and is flexible enough to be applied for long-term crew stationing analyses.

## ■ WA-08

Wednesday 08:00-09:20

GSI - S 30

### Supply Chain Coordination

Stream: Supply Chain Management

*Invited session*

Chair: *Serra Caner*, Industrial Engineering, Koc University, Koc University Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey, scaner@ku.edu.tr

#### 1 - Comparative performance of practical "channel coordinating" contract formats under market-par uncertainties

*Hon-Shiang Lau*, Management Sciences, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong, MSHSLAU@cityu.edu.hk, *Jian-Cai Wang*, *Amy Hing-Ling Lau*

It is well-known that in a simple supply chain with deterministic market parameters, such contract formats as two-part tariffs (TPT), maximum-resale-price maintenance (RPM), revenue sharing (RS) and volume discount (VD) are equally perfect in empowering the dominant manufacturer to simultaneously coordinate the channel and arbitrarily divide the channel's profit. In contrast, we show that stochasticity (i.e., uncertainty) of market parameters affects the powers of these contracts very differently. Briefly, RS and RPM are robust against parameter stochasticity, while TPT and VD are not.

#### 2 - A contract for coordinating medium term production capacities of a buyer-supplier dyad of manufacturers

*Cristina Arandeda-Fuentes*, Department of Engineering, Arturo Prat University, Av. Arturo Prat 2120, 1110939, Iquique, I Region, Chile, caraneda@daad-alumni.de, *Leonardo Lustosa*, *Stefan Minner*

Coordinating-contracts in a supply network are formal agreements capable of inducing the parties to act so as to maximize their joint profitability. We propose, and analyze, a contract designed for coordinating the decisions of a buyer-supplier dyad of manufacturers. In the medium term, they have to set their production capacities for facing stochastic market demands known with certainty only in the short term. The contract is novel in the sense that it considers capacity decisions of both parties, and allows the supplier to use her residual capacity for producing to serve the market.

#### 3 - Capacity investment under information asymmetry

*Serra Caner*, Industrial Engineering, Koc University, Koc University Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey, scaner@ku.edu.tr, *Onur Kaya*

This paper studies the capacity investment problem under information asymmetry in a supply chain composed of a supplier(she) who has a random production yield, and a manufacturer (he) who faces random demand. In this system first the supplier invests on her capacity, then the demand is realized and then the manufacturer orders based on the realized demand. In our first model the supplier's capacity investment cost is private information and in our second model she is more informed about her yield. We try to coordinate channels with linear and bonus contracts proposed by the manufacturer.

## ■ WA-09

Wednesday 08:00-09:20

GSI - S 5

### Transport Workforce Scheduling I

Stream: Timetabling and Rostering

*Invited session*

Chair: *Dilay Çelebi*, Management Engineering, Istanbul Technical University, ITU İletme Fakültesi Macka, 34367, Istanbul, Turkey, celebid@itu.edu.tr

#### 1 - Pilot crew rostering at brussels airlines: feasibility study and policy decisions

*Broos Maenhout*, Tweeckerkenstraat 2, 9000, Gent, Belgium, Broos.Maenhout@Ugent.be, *Mario Vanhoucke*

The adoption of EU/OPS 2008 regulations raised many questions for the management of Brussels Airlines involving the construction of feasible rosters wrt the needed number of pilots and the required productivity ratio per crew member. At the same time, the pilot union had some major concerns about the pilot workload and working conditions. We developed a flexible optimization tool that is used as a simulation tool in the negotiation process between Brussels Airlines and the labour union. A wide range of scenarios was tested in order to determine the appropriate mix of pilot rostering rules.

#### 2 - Personnel scheduling problem with high diversity of shifts

*Zdenek Baumelt*, Technicka 2, 16627, Prague, Czech Republic, baumez1@fel.cvut.cz, *Premysl Sucha*, *Zdenek Hanzalek*

We introduce a problem of personnel scheduling (staff timetabling) motivated by a real problem at The Air Navigation Service of the Czech Republic. The problem is similar to classical Nurse Rostering Problem (NRP), but there are more shift types (about 60), which leads to bigger state-space. There are some specific constraints like 'block sequence of shifts' constraint which is a more restrictive version of 'consecutive working days' constraint from NRP. We formalize the problem and we propose several heuristics solutions that are evaluated on a set of benchmarks.

### 3 - An introduction to the personnel planning problem of the Belgian railways

*Burak Bilgin*, Gebroeders Desmetstraat 1, 9000, Gent, burak.bilgin@kahosl.be

The personnel planning problem of the Belgian Railways is a complex problem with different layers and dimensions. A huge set of tasks are supposed to be assigned to the railway personnel with respect to location constraints, work regulations, and employee preferences. The problem is being tackled with various metaheuristics, including Variable Neighbourhood Search and Simulated Annealing. The preliminary results are promising. The problem and the solution methods will be reported in greater detail at the conference, and benchmark data on the problem will be made public on the internet.

## ■ WA-10

Wednesday 08:00-09:20

GSI - S 6

### Vector and Set-Valued Optimization I

Stream: Vector and Set-Valued Optimization

*Invited session*

Chair: *Bienvenido Jiménez*, Departamento de Matemática Aplicada, UNED, Calle Juan del Rosal, 12, 28040, Madrid, Spain, bjimenez@ind.uned.es

#### 1 - Efficiency under pseudoinvexity and duality in nonsmooth multiobjective problems. a characterization

*Manuel Arana Jimenez*, Estadística e Investigación Operativa, University of Cadiz, C/Chile, 1, 11002, Jerez de la Frontera, Cadiz, Spain, manuel.arana@uca.es, *Gabriel Ruiz-Garzón*, *Rafaela Osuna-Gómez*, *Antonio Rufián-Lizana*

We establish characterizations for efficient solutions in nonsmooth multiobjective programming problems, which generalize recent characterization results for differentiable multiobjective programming problems. We prove that in order for Kuhn-Tucker or Fritz John points to be efficient solutions it is necessary and sufficient that the nonsmooth multiobjective problem functions belong to new classes of functions, which are introduced by us, and illustrated by an example. We study the dual problem and establish weak, strong and converse duality results.

#### 2 - Characterization of efficient solutions in non-regular vectorial optimization programming problems

*Beatriz Hernández*, Economics, University Pablo de Olavide, Edificio N<sup>o</sup> 3, José Moñino - 2<sup>a</sup> planta-despacho26, Ctra. de Utrera, Km. 1- 41013 Sevilla, 41013, SEVILLA, Spain, mbherjim@upo.es, *Manuel Arana Jimenez*, *Rafaela Osuna-Gómez*, *Antonio Rufián-Lizana*

We give necessary optimality conditions for a multiobjective problem whose constraints don't verify any constraint qualification, basing on Izmailov's description of the tangent cone in the 2-regular case. To ensure that the optimality conditions obtained are sufficient too in order to characterize the complete efficient solutions set we define a new generalized convexity notion. Besides, we prove the concept of generalized convexity gave here is the weakest to ensure the sufficiency of the optimality conditions presented.

### 3 - Necessary and sufficient conditions for strict local minima of order m in multiobjective optimization

*Marcin Studniarski*, Faculty of Mathematics and Computer Science, University of Lodz, ul. S. Banacha 22, 90-238, Lodz, marstud@math.uni.lodz.pl

We introduce lower and upper limits of vector-valued functions with respect to the usual positive cone in a finite-dimensional space. Using these concepts, we extend the definitions of m-th order lower and upper directional derivatives introduced in [M. Studniarski, SIAM J. Control Optim. 24 (1986) 1044-1049] to vector-valued functions, and prove some necessary and sufficient conditions for strict local Pareto minimizers of order m. A comparison with the recent results of [B. Jiménez, V. Novo, M. Sama, J. Math. Anal. Appl. 352 (2009) 788-798] is also given.

#### 4 - Some remarks on strong convexity and optimality conditions in multiobjective programming problems

*Bienvenido Jiménez*, Departamento de Matemática Aplicada, UNED, Calle Juan del Rosal, 12, 28040, Madrid, Spain, bjimenez@ind.uned.es, *César Gutiérrez*, *Vicente Novo*

An important problem in vector optimization is to characterize different classes of solutions, such as efficient or strict solutions. In this work, we extend the concept of strong convexity from a scalar function, due to Lin and Fukushima (J. Optim. Theory Appl. 118, 67-80, 2003) to a vector-valued function, by considering a partial order given by a convex cone. We establish some optimality conditions for strict minimizers of higher order, in the sense given by the first author (J. Math. Anal. Appl. 265, 264-284, 2002), for a nonsmooth multiobjective optimization problem under strong convexity

## ■ WA-11

Wednesday 08:00-09:20

GSI - S 17

### Environmental Management and MCDA

Stream: Multiple Criteria Decision Analysis

*Invited session*

Chair: *Antonio Boggia*, DSEEA, University of Perugia, Borgo XX giugno, 74, 06121, Perugia, boggia@unipg.it

#### 1 - Implementation of multicriteria modules in a geographic information system: a case study

*Antonio Boggia*, DSEEA, University of Perugia, Borgo XX giugno, 74, 06121, Perugia, boggia@unipg.it, *Gianluca Massei*

This paper presents the implementation of multicriteria modules in an open source GIS system. Features, possible use and output of the following implemented modules are presented: r.mcda.electre; r.mcda.fuzzy; r.mcda.regime; r.roughset. To implement the algorithms GRASS 6.3 has been used, adding a specific module written in C language. In addition, the new module has been included in the GRASS toolbox, in QGIS 0.10. We present the application of one of the implemented modules to a case study on the choice of suitable areas for land application of wastewater from agricultural activities.

#### 2 - Water use scenarios assessment using multicriteria analysis

*Lucia Rocchi*, DSEEA, University of Perugia, Borgo XX giugno 74, 06121, Perugia, lucia.rocchi@unipg.it, *Antonio Boggia*

Increasing in water demand for off-stream uses in multipurpose water basins is in conflict with environmental and recreational uses. New scenarios in environmental policies and new requests from local communities involve the use of decision support systems to find an equilibrium between different uses. In this study a multicriteria decision analysis is applied to decision making in the choice of the best development scenario. Multicriteria approach is capable to integrate quality judgement and preference index to find the best solution for a sustainable local development

### 3 - Measuring sustainability of poultry production systems: a multicriteria approach

Luisa Paolotti, DSEEA, University of Perugia, Borgo XX Giugno 74, 06121, Perugia, Italy,  
luisa.paolotti@gmail.com, Antonio Boggia, Carla Cortina, Emanuele Novelli

We present a comparison among three different systems of poultry production, from an economic, social and environmental perspective. For economic and social evaluations traditional indicators are used, while for environmental evaluation indicators from the application of Life Cycle Assessment, Ecological Footprint and Emergy Analysis methods are involved. Farmers and decision makers need to be supported in their decisions concerning sustainable production. Sustainability is a multidimensional concept: the comparative evaluation among the systems is implemented using a multicriteria approach.

## ■ WA-12

Wednesday 08:00-09:20

GSI - S 18

### Structuring and integrated methodologies for MCDA I.

Stream: Multiple Criteria Decision Analysis

*Invited session*

Chair: *Theodor Stewart*, Statistical Sciences, University of Cape Town, Upper Campus, 7701, Rondebosch, South Africa, theodor.stewart@uct.ac.za

#### 1 - Adapting and refining in a structured MCDM method

Brendan O'Brien, University College Dublin, Sheheree, Loreto Road, 1111, Killarney, Co Kerry, Ireland, brendan.obrien@ucd.ie, *Cathal Brugha*

The Structured Methodology for Direct-Interactive Structured-Criteria (DISC) Multi-Criteria Decision-Making (MCDM) is implemented in a major IT investment case. This method provides a robust model that supported multi-criteria decisions by a group of decision-makers over a long period. The paper introduces and verifies modifications to the Structured Methodology (Brugha, 2004) to include (1) broader 'refinement' of the 'alternatives & scores', 'criteria & weights' and 'set of alternatives', and (2) adapting both the type of measurement and the criteria tree using a 'magnifying glass' approach.

#### 2 - Geometrical approach to characterization optimality in multiobjective optimization

Yury Nikulin, Department of Mathematics, University of Turku, Matematiikan laitos, Turun yliopisto, Vesilinnantie 5, Luonnontieteiden talo, 20014, Turku, yurnik@utu.fi, *Marko M. Mäkelä*

We report the new results concerning some structural properties of strongly efficient and lexicographically optimal solutions which are obtained using the geometrical cone characterization approach. These results are combined with the results previously known for the sets of efficient, weakly and proper efficient solutions to derive the global view on geometrical properties of different optimality principles in multiobjective optimization. The results are specified for both convex and non-convex cases.

### 3 - Structuring risk in multi-criteria terms

*Theodor Stewart*, Statistical Sciences, University of Cape Town, Upper Campus, 7701, Rondebosch, South Africa, theodor.stewart@uct.ac.za

Decision making with single or multiple objectives typically also involve various risk components. Simple expectation or mean-variance models do not adequately represent decision maker preferences in many contexts. We discuss a number of structures for representation of risk components in multicriteria modelling terms. These structures are compared on the basis of implicit biases each may introduce into the decision process, and recommendations are made concerning the use of scenarios and/or different values at risk.

## ■ WA-13

Wednesday 08:00-09:20

GSI - S 31

### Planar location models

Stream: Location Analysis

*Invited session*

Chair: *Yoshiaki Ohsawa*, Institute of Policy and Planning Sciences, University of Tsukuba, 305-8573, Tsukuba, Ibaraki Prefecture, Japan, osawa@sk.tsukuba.ac.jp

#### 1 - Order distance in regular point patterns

Masashi Miyagawa, Ecosocial System Engineering, University of Yamanashi, 4-3-11 Takeda, Kofu, 400-8511, Yamanashi, Japan, mmiyagawa@yamanashi.ac.jp

This paper derives the  $k$ th nearest distance distributions and the average  $k$ th nearest distances for three regular point patterns: square, triangular, and hexagonal lattices. As an application of the  $k$ th nearest distance, a facility location problem with closing of facilities is considered. The problem aims to find the optimal regular pattern that minimizes the average distance to the nearest open facility. Assuming that facilities are closed independently and at random, we show that the triangular lattice is optimal if at least 68% of facilities are open.

#### 2 - Lagrangean relaxation approaches for the multi-commodity capacitated multi-facility Weber problem

Temel Öncan, Industrial Engineering, Galatasaray University, Ciragan Cad., Ortaköy, 34357, ISTANBUL, Turkey, ytoncan@gsu.edu.tr, *I. Kuban Altinel, Mehmet Hakan Akyüz*

The Capacitated Multi-facility Weber Problem is concerned with locating  $I$  capacitated facilities in the plane to satisfy the demand of  $J$  customers with the minimum total transportation cost of a single commodity. In this study, we focus on a multi-commodity extension and consider the situation where  $K$  distinct commodities are shipped to the customers subject to capacity and demand constraints. We present efficient Lagrangean relaxation schemes and report computational experiments on randomly generated test instances.

#### 3 - Equity-efficiency bicriteria facility location model with squared Euclidean distances

*Yoshiaki Ohsawa*, Institute of Policy and Planning Sciences, University of Tsukuba, 305-8573, Tsukuba, Ibaraki Prefecture, Japan, osawa@sk.tsukuba.ac.jp, *Frank Plastria*

This study formulates equity location models using the sum of absolute deviations, one of the simplest measures discussed. That is, it seeks facility locations where the sum of absolute differences between all pairs of facility-inhabitant squared distances is minimized. As efficiency measure we consider two cases, depending on the type of facility. For locating an attractive facility we use a Weber problem, for an obnoxious facility an anti-Weber problem. Combining the equity measure with each efficiency measure, two bicriteria models are obtained and studied here.

#### 4 - Fuzzy approach to planar multi facility location-allocation

*Amirhossein Sadoghi*, Department of Management and Engineering, Linköping University, Björnkarrsgatan 1  
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amisa242@student.liu.se

In this paper we propose fuzzy approach to solve the Location-allocation problem. Passing of the restriction of zero and one to assign customers, is highlighted in this research which is main assumption in formal location allocation problem. With using fuzzy c-means clustering algorithm measures the quality of configuration is used to locate the facility and how much it can serve its customers. We using planar topological structure, and unconstrained facilities. This research is an axiomatic research and try to prove validity and also reliability for using in empirical research

### ■ WA-14

Wednesday 08:00-09:20  
GSI - S 32

#### Inventory Management I

Stream: Inventory Management  
Invited session

Chair: *Armagan Bayram*, Industrial Engineering, Istanbul Kultur University, IKU Atakoy Campus Room 216  
Bakirkoy, 34156, Istanbul, armagannbayram@yahoo.com

#### 1 - Competition and collaboration in a service parts management system

*Mericcan Usta*, Industrial Engineering, Middle East Technical University, 06531, Ankara, Turkey,  
mericcanusta@gmail.com, *Secil Savasaneril*, *Yasemin Serin*

We study the inventory management policies of two dealers in a service parts system. Dealers operate independently but collaborate by requesting service parts from each other. Dealers also get engaged in competition, since if a dealer requests a part from the other, the revenue has to be shared. Using Markov Decision Process we determine each dealer's optimal policy. Due to complexity of the optimal policy, we suggest a simpler operating policy using notions of policy iteration. A game theoretical approach is taken to determine each dealer's best response policy and the possible equilibria.

#### 2 - A better synchronization in the single-vendor multi-buyer integrated inventory supply chain

*Md Abdul Hoque*, Department of Mathematics, University Brunei Darussalam, Faculty of Science, Brunei Darussalam, BE1410, Bandar Seri Begawan, Brunei - Muara, Brunei Darussalam,  
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Researchers have synchronized the single-vendor single-buyer integrated inventory supply chain by partial lots (equal and/or unequal) transfer and obtained optimal solution to the system. However, such synchronization in the single-vendor multi-buyer case for a generalized optimal solution is unavailable. Here we develop a generalized single-vendor multi-buyer supply chain model by extending an idea of synchronization of the single-vendor single-buyer case, and then present its optimal solution technique. The solution technique has been validated with the solutions of some numerical problems.

#### 3 - A state space representation of generalised order up to policies

*Anthony White*, Engineering and Information Sciences, Middlesex University, The Burroughs, Hendon, NW4 4BT, London, a.white@mdx.ac.uk,  
*Michael Censlive*

Lalwani et al (2006) devised a controllable state space model for a general APVIOBPCS production and inventory system. However this procedure did not cater for production delays of other than one time unit. We have devised a model that allows for any value of production delay. This model allows a conversion from a discrete time input-output model using an exponential production delay with no loss of generality and is fully controllable and observable. Stability of these models can be obtained from the system eigenvalues and agree with previously published stability boundaries by us.

### ■ WA-15

Wednesday 08:00-09:20  
Einstein

#### Complexity and Optimization I

Stream: Complexity and Optimization  
Invited session

Chair: *Klaus Meer*, Computer Science Institute, Technical University Cottbus, Konrad-Wachsmann-Allee 1, 03046, Cottbus, Germany, meer@informatik.tu-cottbus.de

#### 1 - Packing cycles in graphs

*Dieter Rautenbach*, Mathematics, TU Ilmenau, 98684, Ilmenau, Germany, dieter.rautenbach@tu-ilmenau.de

For a graph  $G$  let  $\mu(G)$  denote its cyclomatic number and  $\nu(G) / \nu'(G)$  the maximum number of pairwise vertex-disjoint / edge-disjoint cycles of  $G$ , then  $\nu(G) / \nu'(G)$  is at most  $\mu(G)$ . We prove that for every fixed  $k$  there is a finite set  $P(k) / P'(k)$  such that every 2-connected graph  $G$  with  $\mu(G) - \nu(G) = k / \mu(G) - \nu'(G) = k$  arises by applying a simple extension rule to a graph in  $P(k) / P'(k)$ . We give linear time algorithms for fixed  $k$  which decide for an input graph whether  $\mu(G) - \nu(G) / \mu(G) - \nu'(G)$  is at most  $k$  and also construct optimal cycle packings in this case.

#### 2 - Modelling and solving university timetabling problems

*Marco Chiarandini*, Dept. of Mathematics & Computer Science, University of Southern Denmark, Campusvej 55, 5230, Odense, Denmark, marco@imada.sdu.dk

Timetabling at universities may require solving a series of complex problems rather than a single one. This includes creating balanced curricula, scheduling mandatory and elective courses and assigning exams. We focus on balanced curriculum timetabling and post-enrollment course timetabling, and point out similarities and differences in the models. We present some recent results in solving these problems by IP and effective heuristics. Further, we use a multivariate experimental methodology for studying the effects of solver and problem's features.

#### 3 - Approximability of traveling salesman problems

*Markus Bläser*, Informatik, Universität des Saarlandes, 66041, Saarbrücken, Germany, mblaeser@cs.uni-sb.de

Many variants of the Traveling Salesman Problem are NP-hard and among them, many are even hard to approximate. For symmetric TSP with triangle inequality, the well-known Christofides algorithm still achieves the best approximation ratio. For the asymmetric case, the algorithm by Frieze, Galbati & Maffioli was the best one for many years. In the recent years, some progress has been made here. We will give an overview over these algorithms, the underlying techniques, and present some open questions. In this talk, we will outline the development of the last few years.

#### 4 - An analysis of urban landscapes based on computational geometry algorithms

Yudai Honma, Faculty of System Design, Tokyo Metropolitan University, Asahigaoka 6-6, 191-0065, Hino-shi, Tokyo, Japan, yudai@sd.tmu.ac.jp, Osamu Kurita

The solid angle, which is closely related to the sky amount and sky factor, has been commonly used to assess urban landscapes. In this study, we propose a new algorithm to calculate the solid angles of urban landscapes based on computational geometry. This algorithm enables us to incorporate the complicated landscapes which consist of multiple nonconvex polygons. Furthermore, we assess the public space of Tokyo metropolitan area in terms of solid angles. We also develop the algorithm to calculate the sky amount and the sky factor, and evaluate the characteristics of both indexes.

#### ■ WA-16

Wednesday 08:00-09:20

Koenig

#### Scheduling in Sports

Stream: OR in Sports

Invited session

Chair: Michael Trick, Tepper School of Business, Carnegie Mellon University, Tepper Room 338, 15213, Pittsburgh, PA, United States, trick@cmu.edu

##### 1 - Scheduling the topmost football leagues of Norway

Truls Flatberg, SINTEF ICT, PB 124 Blindern, N-0314, Oslo, Truls.Flatberg@sintef.no, Eivind Nilssen, Martin Stølevik

The Norwegian Football Association is responsible for creating the schedules for the topmost football divisions. Before the 2007 season SINTEF ICT was asked to help in the planning process. This talk will summarize our work on the problem, highlighting the motivation for creating new patterns and discussing the modeling of the problem as an integer programming problem. We will share some of our experiences with practical planning and present some constraints that may provide inspiration for future work in the field.

##### 2 - Scheduling the Brazilian soccer tournament by integer programming maximizing audience shares under fairness constraints

Celso Ribeiro, Department of Computer Science, Universidade Federal Fluminense, Rua Bogari 70, 22471-340, Rio de Janeiro, RJ, Brazil, celso@inf.puc-rio.br, Sebastián Urrutia

The Brazilian soccer tournament is a compact mirrored double round robin tournament played by 20 teams. Its fixture should satisfy more than 40 different types of constraints, ranging from fairness to security issues and from technical to broadcasting criteria. We seek to maximize the number of attractive games between elite teams that can be broadcast by open channels. Soft constraints are handled through penalties. A decomposition strategy is used to solve the associated integer programming formulation.

##### 3 - An AHP analysis to schedule the fixtures of the Malaysian super league

Graham Kendall, School of Computer Science It., University of Nottingham, Jubilee Campus, Wallaton Road, NG8 1BB, Nottingham, United Kingdom, gxx@cs.nott.ac.uk, Nor Hayati Abdul Hamid, Mujgan Sagir Ozdemir

Malaysian football is witnessing a decrease in the number of stadium supporters. Therefore, scheduling matches in timeslots that maximise the number of supporters is becoming a priority for the league administrators. We hypothesise that spectators would prefer to watch matches at stadiums if they are more important. Therefore, we propose to define a level of importance for each fixture. The Analytic Hierarchy Process (AHP), a theory of relative measurement with absolute scales, will be applied to obtain these importance levels. The outcome will be used as input to an optimisation model.

#### ■ WA-17

Wednesday 08:00-09:20

Rheinaue

#### Discrete-continuous scheduling

Stream: Scheduling under Resource Constraints

Invited session

Chair: Jan Weglarz, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, jan.weglarz@cs.put.poznan.pl

##### 1 - Maximization of the net present value in some discrete-continuous project scheduling problems

Grzegorz Waligora, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, gwaligora@cs.put.poznan.pl, Jan Weglarz

Some discrete-continuous project scheduling problems with discounted cash inflows are considered, in which number of discrete resources is arbitrary, and there is one continuous, limited, renewable resource. The processing rate of each non-preemptable activity is a continuous, increasing, and convex function of the amount of the continuous resource allotted to the activity at a time. The objective is to maximize the net present value. It is shown that sequential schedules are optimal for the considered problems. Some rules of optimal activity sequencing are proved for a few payment models.

##### 2 - The problem of allocating resources of a grid to workflow applications.

Marek Mika, Institute of Computing Science, Poznań University of Technology, ul Piotrowo 2, 60-965, Poznań, Poland, Marek.Mika@cs.put.poznan.pl, Grzegorz Waligora, Jan Weglarz

The problem of allocating resources of a Grid to workflow applications is considered. This kind of jobs consist of several precedence related tasks. Each task can be executed in one of several modes. Grid resources are divided into computational and network resources. Two types of tasks are considered: computational tasks, which require computational resources, and transmission tasks, which require network resources. Some assumptions necessary to construct a model of the problem, the proposed model, and an exact approach to find all feasible solutions are presented.

##### 3 - A deterministic scheduling problem in green computing

Rafal Rozycki, Institute of Computing Science, Poznan University of Technology, ul.Piotrowo 2, 60-965, Poznan, Poland, rafal.rozycki@cs.put.poznan.pl

We consider a machine scheduling problem where energy is treated as a doubly-constrained resource required to perform a set of jobs in a computer system. The performance enhancement of a system and energy savings are possible because the relation: processor speed vs. power, is nonlinear. This relation is modelled by a continuous speed function. The objective is to find a time-optimal schedule for an instance of the problem where an amount of energy and a constant limit of power are known and given. We show properties of optimal solutions and propose a heuristic algorithm to solve the problem.

#### 4 - Centralized and decentralized management of limited resources shared among multiple users

*Yahya Saleh*, Industrial Engineering, Bilkent University, Rektörlük Binasi, 3cu kat, ofis323, Merkez Kampus, lojman 79/21, 06800, Ankara, Turkey, saleh@bilkent.edu.tr, *Ulku Gurler, Emre Berk*

Our work aims to investigate two groundwater inventory management schemes with multiple users in a dynamic game-theoretic structure. In the centralized scheme, users are allowed to pump water from a common groundwater aquifer with the supervision of a social planner, and in the decentralized scheme, each user is allowed to pump water independently from other users. We consider  $n$ -nonidentical users distributed in two different layouts for the groundwater transmission: the strip transmission and the ring transmission. In each layout, we analyze the groundwater inventory system centrally and decentrally.

#### ■ WA-18

Wednesday 08:00-09:20

*Lenné*

#### Semidefinite Programming and Approximate Algorithms

Stream: Mathematical Programming

*Invited session*

Chair: *Michel Baes*, IFOR, ETH, HG.G.22.1, Ramistrasse 101., 8092, Zurich, Switzerland, michel.baes@ifor.math.ethz.ch

##### 1 - Reduction techniques for sdp relaxations of polynomial optimization problems

*Martin Mevissen*, Tokyo Institute of Technology, Ookayama 2-12-1-W8-29, Meguro-ku, 152-8552, Tokyo, martime6@is.titech.ac.jp, *Masakazu Kojima*

SDP relaxations for a polynomial optimization problem (POP) have been constructed by Lasserre and Waki et al. Still, the size of the sparse SDP relaxation remains the major obstacle to solve POPs of higher degree. An approach to transform general POPs to quadratic optimization problems (QOPs) is proposed, that reduces the size of the SDP relaxation substantially. We introduce different heuristics resulting in equivalent QOPs and show how sparsity of a POP is maintained under the transformation. As the most important issue we discuss how to increase the quality of the SDP relaxation for an QOP.

##### 2 - A fresh view on the multiplicative weights update method

*Michael Bürgisser*, IFOR, ETH, HG G 22.4, Rämistrasse 101, 8092, Zürich, Switzerland, michael.buergisser@ifor.math.ethz.ch, *Michel Baes*

Multiplicative weights update (MWU) method was studied among others by Arora, Hazan, and Kale. It generalizes Littlestone and Warmuth's weighted majority algorithm from learning theory. We show that MWU method is an instance of Nesterov's primal-dual subgradient method. As a direct consequence of the results presented by Nesterov, we derive a new update rule for the MWU method. Vice versa, the setting of the MWU method gives an intuitive description of Nesterov's algorithm.

##### 3 - Approximate estimate sequence schemes

*Michel Baes*, IFOR, ETH, HG.G.22.1, Ramistrasse 101., 8092, Zurich, Switzerland, michel.baes@ifor.math.ethz.ch

In 1983, Nesterov proposed a class of schemes to minimize a convex function with a Lipschitz continuous gradient. These schemes, based on the concept of estimate sequences, are provably the fastest possible for such very large scale convex problems, if only first-order information is available. At each iteration, we must evaluate the gradient of the objective function and solve two auxiliary optimization problems. We determine how precisely we need to compute the gradient and the solution of these subproblems in order to get a reasonably accurate output of the algorithm.

#### ■ WA-19

Wednesday 08:00-09:20

*Haber*

#### Multiobjective metaheuristics

Stream: Metaheuristics

*Invited session*

Chair: *Sebnem Demirkol*, Industrial Engineering, Dokuz Eylul University, Dokuz Eylul University Department of Industrial Engineering, Tinaztepe Campus Buca, 35160, Izmir, Turkey, sebnem.demirkol@deu.edu.tr

##### 1 - Use of multiobjective algorithms for scheduling jobs in large scale grid applications

*Juan Arturo Perez Cebreros*, Grid Computing, CIC-IPN, Col. Nueva Industrial Vallejo, C.P. 07738 Mexico, D.F. Mexico, 75476, D.F., DF, Mexico, perezcebreros@hotmail.com

Scheduling is a key problem in emergent computational systems, such as Grid and P2P, in order to benefit from the large computing capacity of such systems. In this paper we present a Multi-Objective Particle Swarm (MOPSO) based schedulers for efficiently allocating jobs to resources in a Grid system. The extensive experimental study showed that our MOPSO-based schedulers outperform existing GA implementations in the literature for the problem and also revealed their efficiency when makespan and flowtime are minimized.

##### 2 - Multi-objective evolutionary meta-heuristic optimization

*Sebnem Demirkol*, Industrial Engineering, Dokuz Eylul University, Dokuz Eylul University Department of Industrial Engineering, Tinaztepe Campus Buca, 35160, Izmir, Turkey, sebnem.demirkol@deu.edu.tr, *G. Mirac Bayhan*

Single-objective optimization problem has attracted the scientists' interest for a few decades. In single-objective optimization methods, the problem is described by only one objective function. However, in today's highly competitive global business environment there are many objectives for companies. Also there may be some conflicting objectives in such a real life model. As a result, this kind of problems should have more than one objective function. In this study, we are going to make comparisons between our meta-heuristic approaches.

## ■ WA-20

Wednesday 08:00-09:20

Mann

### DEA Applications IV

Stream: DEA and Performance Measurement

*Invited session*

Chair: *Carlos Ramón García Alonso*, Management, ETEA, Business Administration Faculty, University of Córdoba, Spain, Escritor Castilla Aguayo 4, 14004, CORDOBA, CORDOBA, Spain, cgarcia@etea.com

#### 1 - Analysing the socio-economic potential of rural areas: a dea-based approach for the valencian region (spain)

*Ernest Reig*, Applied Economics II, University of Valencia, Facultat d'Economia, Avda.dels Tarongers s/n, 46022, Valencia, ernest.reig@uv.es

Rural areas are considerably heterogeneous with regard to their socio-economic characteristics, a fact not always recognized in rural development planning. This paper shows how a Multi-Criteria DEA Model (MCDEA) can be used for the construction of a composite index of local socio-economic potential. This model offers a higher discrimination power than conventional DEA, in order to assess the diversity of potential displayed by rural municipalities. MCDEA, and a conventional DEA model are applied to data from 48 municipalities belonging to the Leader+ Program Zone of the Valencian Region.

#### 2 - Travel agency productivity change: a case study in alicante, spain.

*Ramon Fuentes*, Applied Economic Analysis, University of Alicante, Fac. de Economicas, Ap. 99, E-03080. Alicante. Spain., E-03080, Alicante, Spain, rfuentes@ua.es

This study analyses the development of productivity growth of 22 travel agencies based in Alicante (Spain) over the period 2004-2007. This analysis is carried out by using Malmquist productivity Indices that can be broken down into three different components (Pure, Scale and Technological Efficiency Change) and a sensibility analysis of the results relative to sampling variations of the frontier (bootstrap). Finally, using the Mann Whitney-U Test, the relationship between the levels of productivity of these agencies and their ownership type, location and level of experience are examined.

#### 3 - A DEA based clustering approach as a classification tool for multiple criteria decision analysis: an application to world university rankings

*Kazim Baris Atici*, Dep.of Business Administration, Hacettepe University, Beytepe Campus/Cankaya, 06532, Ankara, kba@hacettepe.edu.tr, *Aydin Ulucan*

A widely applied sorting methodology, UTADIS (Utilities Additives Discriminates) requires a predefined classification of a set of alternatives. This classification is obtained through a single classification criterion. However, some real world problems may require consideration of more than one classification criteria. In this study, we aim to propose the use of a DEA based clustering approach with these varying classification criteria and to take the classification obtained through this analysis as predefined classes of UTADIS in the evaluation of world universities' performance.

#### 4 - Expert-oriented monte-carlo dea: technical efficiency assessment of the agrarian sector

*Carlos Ramón García Alonso*, Management, ETEA, Business Administration Faculty, University of Córdoba, Spain, Escritor Castilla Aguayo 4, 14004,

CORDOBA, CORDOBA, Spain, cgarcia@etea.com, Mercedes Torres, César Hervás-Martínez

The interpretation of non-standard inputs and/or outputs (I/O) in Data Envelopment Analysis (DEA) is a problem to deal with when Monte-Carlo DEA is used to evaluate relative technical efficiency in complex environments. In this paper, a dynamic model to interpret I/O automatically in complex models generated by a Monte-Carlo engine is presented and evaluated. The relative technical efficiency of agrarian sub-sectors and sizes has been assessed.

## ■ WA-21

Wednesday 08:00-09:20

Hauptmann

### Recent developments in optimization for computer vision

Stream: Boolean Programming

*Invited session*

Chair: *Ramin Zabih*, Cornell, Computer Science, 4130 Upson Hall, 14853, Ithaca, New York, United States, rdz@cs.cornell.edu

#### 1 - Exact energy minimization via sequences of approximations and message passing

*Amir Globerson*, Computer Science, Hebrew University, Givat Ram Campus, 91904, Jerusalem, gamir@cs.huji.ac.il

Energy minimization in Markov random fields is a ubiquitous problem in machine vision, but is intractable in the general case. However, one may still devise a sequence of approximations, that are guaranteed to yield tighter and tighter bounds on the minimal energy, albeit at an increased computational cost. I will describe algorithms that efficiently optimize such approximations, and that often provide provably exact solutions to real world problems. These algorithms are obtained via LP duality and have a simple message passing structure. I will describe their use in machine-vision problems.

#### 2 - Discrete optimization in computer vision and pattern recognition based on linear programming

*Nikos Komodakis*, Computer Science, University of Crete, 0000, Heraklion, Crete, Greece, komod@csd.uoc.gr

The problem of discrete MRF optimization (MAP estimation) is known to be of fundamental importance for numerous tasks in computer vision and pattern recognition. The use duality theory and linear programming provides us with one of the best and most efficient ways for dealing with this extremely challenging task. I will show that LP-based approaches to MRF optimization are able to deliver state of the art performance, can enjoy very nice and strong theoretical properties, while they can also lead to very efficient algorithms that are much faster compared to prior art.

#### 3 - Boolean optimization methods for linear inverse systems with edge-preserving priors

*Ramin Zabih*, Cornell, Computer Science, 4130 Upson Hall, 14853, Ithaca, New York, United States, rdz@cs.cornell.edu

Linear inverse systems are commonly solved with convex optimization techniques, which are inherently biased towards globally smooth solutions. Yet for many imaging problems the desired solution are naturally piecewise smooth rather than globally smooth. I will describe a number of methods that we are investigating to solve these problems by drawing on recent work by Boros, Hammer and their collaborators. Preliminary results for an important MRI image reconstruction problem will be shown. This is joint work with Endre Boros and Ashish Raj.

## ■ WA-22

Wednesday 08:00-09:20

Arndt

### AHP III

Stream: Analytic Hierarchy Processes, Analytic Network Processes

*Invited session*

Chair: *Demet Bayraktar*, ITU Faculty of Management Maçka, 34367, Istanbul, demet.bayraktar@itu.edu.tr

#### 1 - An application of AHP for inventory classification

*Demet Bayraktar*, ITU Faculty of Management Maçka, 34367, Istanbul, demet.bayraktar@itu.edu.tr, *Dilay Çelebi*

Maintenance operations play a crucial role in railway services for providing uninterrupted and high quality service to passengers. Fast and secure management of the spare parts inventory is an important factor for successful execution of the maintenance process. The purpose of this research is to extend the classical ABC analysis by developing a multi-criteria inventory classification approach for supporting the planning and designing of Istanbul Metropolitan Municipality Light rail system.

#### 2 - Performance management in healthcare industry: an analytic hierarchy process model for assessing physician performance

*Murat Albayrakoglu*, Business Informatics Program, Istanbul Bilgi University, Kurtulus Deresi Cd. 47, Dolapdere, 34440, Beyoglu, Istanbul, Turkey, albayrak@bilgi.edu.tr, *Tuba Cullazoglu*, *Isik Gonenc*

In this study, an Analytic Hierarchy Process (AHP) model to assess physician performance is presented. To develop the model, assessment criteria were discussed with physicians, clinical directors, and hospital administrators through a series of interviews. Based on the interviews, criteria were specified, organized, and used to design a questionnaire and conduct a field research. Upon the field research, an AHP model for the assessment of physician performance is suggested. An application of the model is presented, and, implications, advantages, and limitations of the model are discussed.

#### 3 - A quantitative method for administrative audit

*Yuji Sato*, Mie Chukyo University, Graduate School of Policy Science, 1846, Kubo, 515-8511, Matsusaka, Mie, Japan, ysatoh@mie-chukyo-u.ac.jp

In an administrative audit, enhancing accountabilities and improving transparencies would be crucial issues for auditing organizations. In this study, we focused on the contribution ratio of projects to a measure in the audit, and formulated the quantifying scheme of the ratio in the auditing process by applying the analytic hierarchy process. Then we showed that the quantification of the ratio rounded the refinements of the administrative audit through actual cases of a local government in Japan.

## ■ WA-23

Wednesday 08:00-09:20

Planck

### Knowledge Management and DSS

Stream: Decision Support Systems

*Invited session*

Chair: *Fatima Dargam*, SimTech Simulation Technology, Ries Strasse 120, 8010, Graz, Austria, F.Dargam@SimTechnology.com

#### 1 - Knowledge extraction in e-cognocracy

*José María Moreno-jimenez*, Grupo Decisión Multicriterio Zaragoza, Universidad de Zaragoza, Facultad de Económicas, Gran Vía, 2, 50005, Zaragoza, Spain, moreno@unizar.es, *Jesús Cardeñoso*, *Carolina Gallardo*, *Juan Aguarón*, *María Teresa Escobar*, *Adrian Toncovich*, *Alberto Turón*

E-cognocracy is a cognitive democracy oriented to the extraction and democratization of the knowledge related with the scientific governance of society. This paper deals with the conjoint use of quantitative (data mining) and qualitative (text mining) approaches to identify, from the e-discussion stage of its methodology, the arguments that support the decisions of the political parties and the citizens. The proposed methodology has been applied to a case study related with the potential location of the greatest leisure project in Europe (Gran Scala) at Aragón.

#### 2 - Group memory support to collaborative decision making

*AbdelKader Adla*, IRIT - Université Paul SABATIER de Toulouse, 118 Route de Narbonne, 31062, Toulouse, Cedex 09, France, adla@irit.fr

The decision making processes involve groups performing periodic and repetitive activities. At each session, new sets of information may be generated. The composition of the decision-makers' group, however, may change. New members need to learn how previous decisions were made and are likely to spend significant time in learning the decision context. This paper describes the integration of a group memory within our proposed Group Decision Support System where is stored the work of prior groups to provide additional information processing and collaborative decision making support.

#### 3 - Applicability of simple additive weighting method with grey relations and comparison with other grey theory techniques

*Edmundas Zavadskas*, Research Institute of Internet and Intelligent Technologies, Vilnius Gediminas Technical University, Sauletekio al. 11, 2054, Vilnius, Lithuania, edmundas.zavadskas@adm.vtu.lt, *Arturas Kaklauskas*, *Tatjana Vilutiene*

Multi-attribute analysis is useful in many economical, managerial or constructional problems. The accuracy of performance measures in COPRAS method is usually assumed to be accurate. However, there is usually an uncertainty involved in all multi-attribute model inputs. We demonstrate how simulation can be used to reflect fuzzy inputs, allowing more complete interpretation. A case study is used to illustrate the concept of general contractor choice based on multiple attributes of efficiency with fuzzy inputs applying COPRAS-G. We conclude that this method is appropriate to use.

#### 4 - An evidence-adaptive belief rule-based decision support system for clinical risk assessment in emergency care

*Guilan Kong*, Manchester Business School, m16 6pb, Manchester, guilan.kong@postgrad.mbs.ac.uk, *Dong-Ling Xu*, *Jian-Bo Yang*

In this paper, a clinical decision support system based on a recently developed new belief rule inference methodology using the evidential reasoning approach is described. The system is specific for clinical risk assessment, and it can handle different uncertainties in clinical practice. Moreover, the system keeps its knowledge base evidence-adaptive by providing a machine learning functionality. Validation of the system is conducted by a case study using a data set of patients with cardiac chest pain. The study results show that the system can provide accurate clinical decisions.

## ■ WA-24

Wednesday 08:00-09:20

GSI - S 20

### Extremal problems and applications II

Stream: Nonlinear Programming

*Invited session*

Chair: *Joao Lauro D. Facó*, Dept. of Computer Science, Universidade Federal do Rio de Janeiro, Rua Lasar Segall, 100 / 109- A, 22611-100, Rio de Janeiro, RJ, Brazil, jldfacó@ufrj.br

#### 1 - Improved navier-stokes solutions, for global aerodynamical shape's optimization

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NAOPTBONI.pdf

#### 2 - Time-cost trade off problem in pert networks and sdp relaxation

*Mohammad Reza Peyghami*, Math Department, K.N. Toosi University of Technology, Math. Department, K.N. Toosi University of Technology, P.O.Box 16315-1618, Tehran, Iran, 1513944717, Tehran, Iran, Islamic Republic Of, peyghami@optlab.mcmaster.ca

In this paper, we propose a new approach based on Semidefinite Programming (SDP) relaxation and Monte Carlo (MC) simulation technique to solve the Time-Cost Trade off Problem (TCTP) in PERT networks in which all activities are subjected to linear cost function and assumed to be exponentially distributed. In order to maximize the project completion probability in a predefined deadline based on a prespecified probability, we construct the TCTP as a nonlinear optimization problem with decision variables of activity mean durations.

#### 3 - Derivative optimization and design

*Hans-Jörg von Mettenheim*, Leibniz Universität Hannover, Institut für Wirtschaftsinformatik, Königsworther Platz 1, 30167, Hannover, Germany, mettenheim@iwi.uni-hannover.de, *Michael H. Breitmner*

Derivative instruments like options allow market participants to manage risks. The creation of customer tailored derivatives is often manual. We propose a software-based approach. Our software optimizes boundary conditions of an option according to an error function. It uses a Crank-Nicolson scheme and non-linear optimization to solve and optimize the Black-Scholes partial differential equation. We present an option with constant Delta. Such options are easy to hedge for issuers and exhibit a behavior like a future for buyers. We conclude with an example showing how to hedge the oil-price.

#### 4 - Optimal control approach to crude oil scheduling

*Joao Lauro D. Facó*, Dept. of Computer Science, Universidade Federal do Rio de Janeiro, Rua Lasar Segall, 100 / 109- A, 22611-100, Rio de Janeiro, RJ, Brazil, jldfacó@ufrj.br, *Fabio Fagundes*

We present an optimal control model for scheduling crude oil transportation from tankers to the crude distillation unit. Transfer operations are carried out by flows from a source equipment (e.g. tank, tanker, pipeline or process unit) to a destination equipment; discrete yes/no decisions are modeled as bilinear constraints and the control variables are the flows from one equipment to another. This continuous model is applied to an example from the literature based on a real refinery, reaching a local optimal solution by an efficient Nonlinear Programming method.

## ■ WA-25

Wednesday 08:00-09:20

GSI - S 25

### Cooperative games: Solutions

Stream: Cooperative Game Theory

*Invited session*

Chair: *Irinel Dragan*, Mathematics, University of Texas, 411 S.Nedderman Dr., Pickard Hall, 76019-0408, Arlington, Texas, United States, dragan@uta.edu

#### 1 - Variants of the core which emphasize fairness and non-monotonicity

*Alf Kimms*, Mercator School of Management, University of Duisburg-Essen, Lotharstr. 65, LB 125, 47057, Duisburg, Germany, alf.kimms@uni-due.de, *Julia Drechsel*

The core is a popular solution concept for cooperative games. Arbitrary core solutions, however, may not be considered as equally fair. We discuss some variants of the core which take fairness more into account. Also, we look at situations where the characteristic function is not monotone. Arbitrary core elements may not be appropriate here and so we discuss a core variant which fits better to such cases.

#### 2 - Lexicographic optimization in cooperative game theory

*Stef Tijs*, Center and Department of Econometrics and Operations Research, Tilburg University, Tilburg University, 5000LE, Tilburg, Netherlands, s.h.tijs@uvt.nl

We focus first on some solution concepts where lexicographic optimization plays a role such as: (1) the lexicographic IIA-solutions for bargaining problems, (2) the nucleolus and variants for cooperative TU-games, (3) the average lexicographic value for balanced TU-games. Then running procedures to other share sets than the core are discussed.

#### 3 - Characterization of augmenting systems by greedy algorithms

*Encarnación Algaba*, Applied Mathematics II, Seville University, C/Camino de los Descubrimientos s/n, Isla de la Cartuja., 41092, Sevilla, Spain, ealgaba@us.es, *Jesus-Mario Bilbao*, *Manuel Ordoñez*

We propose study cooperative games where the cooperation restriction is given by a combinatorial structure called augmenting system which is a generalization of the antimatroid structure and the system of connected subgraphs of a graph. Our purpose in this paper is to provide an algorithmic characterization of the augmenting systems. Moreover, taking into account that in monotone convex games on augmenting systems the Weber set is in the core, we solve the problem of maximizing a linear function over the core in this framework.

#### 4 - A maschler type algorithm for computing multi-weighted Shapley values of tu games

*Irinel Dragan*, Mathematics, University of Texas, 411 S.Nedderman Dr., Pickard Hall, 76019-0408, Arlington, Texas, United States, dragan@uta.edu

In an earlier paper (Dragan,1994), the Multiweighted Shapley Values have been introduced as linear operators on the space of TU games, which satisfy the efficiency and the dummy player axioms. This is a family of values which for different systems of weights includes the Shapley Value, the Weighted Shapley Value, the Harsanyi payoff vectors, etc. An early algorithm for computing the Shapley Value is due to late M.Maschler (1982). In the present work, we show a similar algorithm for computing the Multiweighted Shapley Values. Previous results and an illustration of the algorithm are included.

## ■ WA-26

Wednesday 08:00-09:20

GSI - S 35

### Graph Algorithms II

Stream: Discrete Optimization

Contributed session

Chair: *Bibiana Obregón*, Posgrado de Ingeniería, UNAM, Loma del Convento No. 61, 01620, México, Distrito Federal, Mexico, b.obregon.q@gmail.com

#### 1 - Optimizing quasi-locally quasi-adjoin graphs

*Hacene Ait Haddadene*, Faculty of Mathematics, Dept of Operations research, USTHB University, BP32 Bab ezzouar 16111, 16111, Algiers, Algeria, aithaddadenehacene@yahoo.fr

In this paper we introduce a Quasi-Locally Quasi-Adjoin graphs (QLQA graphs, graphs such that each induced subgraph has a vertex whose neighbourhood can be partitioned into at most two maximal cliques). First, we give polynomial combinatorial algorithms of recognizing and also of determining the maximum clique in QLQA graphs. Then, we give a polynomial combinatorial algorithm for w-coloring any perfect Quasi-Adjoin graph. Finally, we give another polynomial combinatorial algorithm for w-coloring any perfect QLQA graph. These algorithms use the technique of the bichromatic exchange.

#### 2 - Levelwise mesh sparsification for point-to-point shortest path queries

*Yuichiro Miyamoto*, Dept. of Information & Communication Sciences, Sophia University, Kioicho 7-1, Chiyoda-ku, 102-8554, Tokyo, Japan, miyamoto@sophia.ac.jp, *Takeaki Uno, Mikio Kubo*

We propose the levelwise mesh sparsification method for fast point-to-point shortest path queries in networks using preprocessed data. In our method, several sparse networks are obtained by preprocessing the original network, and the shortest path is found quickly by searching the shortest path in these sparse networks. The advantage of our method is that it can deal with negative costs and time-dependent costs, and uses only a small amount of memory. Computational experiments on real world data show the efficiency of our method in terms of computational time and memory usage.

#### 3 - Mixed integer linear formulations for the minimum label spanning tree problem

*Maria Eugénia Captivo*, Universidade de Lisboa, Faculdade de Ciências and Centro de Investigação Operacional, Campo Grande, Bloco C6, Piso 4, 1749-016, Lisboa, Portugal, mecaptive@fc.ul.pt, *João Clímaco, Marta Pascoal*

In the minimum label spanning tree problem each edge of the network is assigned with a label (such as a color) and it is intended to determine a spanning tree with the minimum number of different labels. This problem has applications in telecommunication or transportation networks. We introduce mixed integer formulations and prove that one of their linear relaxations always gives the optimal value. Computational experiments are presented and discussed. In order to compare the computational times, we also ran a C language implementation of an existent exact procedure for the same problem.

#### 4 - Transport properties of complex networks for different assortativity levels: electric and max-flow

*Bibiana Obregón*, Posgrado de Ingeniería, UNAM, Loma del Convento No. 61, 01620, México, Distrito

Federal, Mexico, b.obregon.q@gmail.com, *Lev Guzmán*

We present a study of transport in complex networks. In particular, in transport properties of scale-free and Erdos-Renyi networks and compare electric and max-flow cases. We construct scale-free networks with a given degree sequence, to estimate the distribution of conductances for different values of assortativity parameter. For the electric case and for one source/sink node, the distribution of conductances is related to the assortativity level. The max-flow case, multiple sources/sinks, changes in the local connectivity lead to a different flow value as a function of the number of sources

## ■ WA-27

Wednesday 08:00-09:20

GSI - S 21

### Warehouse design and performance

Stream: Facility Logistics

Invited session

Chair: *René de Koster*, Rotterdam School of Management, Erasmus University Rotterdam, Room T10-56, PO Box 1738, 3000 DR, Rotterdam, Netherlands, rkoster@rsm.nl

Chair: *Kees Jan Roodbergen*, Rotterdam School of Management, Erasmus University, P.O. Box 1738, 3000 DR, Rotterdam, Netherlands, kroodbergen@rsm.nl

#### 1 - Queueing network analysis of a distribution center

*Liqiang Liu*, EURANDOM, Eindhoven Univ. of Technology, 1.03 Laplace Gebouw, Den Dolech 2, 5612 AZ, Eindhoven, liu@eurandom.tue.nl, *Ivo Adan*

In this paper we focus on queueing network modeling and performance evaluation of a distribution center (DC). The DC is equipped with automated storage and retrieval systems (AS/RS), which are modeled as bulk servers. The resulting model is a closed, multi-chain queueing network which does not possess a product form solution in general. We develop an efficient aggregation/disaggregation type approximation to compute major performance measures accurately. We conduct extensive numerical experiments to test the goodness of the method.

#### 2 - The order-picking problem in a rectangular warehouse with turn costs

*Melih Çelik*, Industrial Engineering Department, METU, ODTU Endüstri Mühendisliği, Bolumu Oda: 326 ODTU, 06531, Ankara, Turkey, celik@ie.metu.edu.tr, *Haldun Sural*

The order-picking problem in a rectangular warehouse aims to pick all the items corresponding to an order while minimizing the distance travelled by the picker. In this study, we treat the number of turns as the objective function instead of distance travelled and provide polynomial-time algorithms for the warehouses without and with middle aisles respectively. We also consider the case where both the distance travelled and the number of turns are to be minimized in warehouses both without and with middle aisles. Computational results on this problem are also provided.

#### 3 - Modeling goals and deadlines for enhancing worker performance

*José Antonio Larco*, Rotterdam School of Management, Erasmus University Rotterdam, Burgemeester Oudlaan 50 Room T10-34, 3062 PA, Rotterdam, jlarco@rsm.nl, *Kees Jan Roodbergen, René de Koster, Jan Dul*

We present the potential use of setting goals for enhancing production efficiency and flexibility. We build a behavioral decision making model that is consistent with the current empirical results of goal-setting behavioral theory. Our model is capable of making testable predictions of the workers' workplace under the influence of goals. The operational model shows the value of information of the workplace over time in providing insights as to how to set goals for enhanced performance. We test our model in a laboratory experiment and present initial results.

## ■ WA-28

Wednesday 08:00-09:20

GSI - S 1

### Financial Optimization 6

Stream: Financial Optimization

Invited session

Chair: *Griselda Deelstra*, Mathematics, Actuarial Sciences, Université Libre de Bruxelles (U.L.B.), Boulevard du Triomphe, CP 210, 1050, Brussels, Belgium, [griselda.deelstra@ulb.ac.be](mailto:griselda.deelstra@ulb.ac.be)

#### 1 - A regime-switching regression model for hedge funds

*Christina Erlwein*, Department of Financial Mathematics, Fraunhofer ITWM, Fraunhofer Platz 1, 67663, Kaiserslautern, Germany, [christina.erlwein@itwm.fraunhofer.de](mailto:christina.erlwein@itwm.fraunhofer.de), *Marlene Mueller*

We develop a regime-switching regression model for hedge funds, which accounts for possible shifts in trading strategies. The factors in this model are governed by a Markov chain in discrete time and are able to switch between different regimes representing different states of the economy. Hedge fund indices are chosen as independent variables. A filtering technique for hidden Markov models is applied, recursive parameter estimates are calculated through a filter-based EM-algorithm. The switching regression model is implemented on hedge fund series and their trading strategies are analyzed.

#### 2 - Optimal portfolio selection with stochastic exponential utility functions

*Turan Bulmus*, Industrial Engineering, Koc University, Rumelifeneri yolu Koc Universitesi, sariyer, 34450, Istanbul, Turkey, [tbulmus@ku.edu.tr](mailto:tbulmus@ku.edu.tr), *Suleyman Ozekici*

We analyze a single-period portfolio selection problem where the investor maximizes the expected utility of the terminal wealth. The utility function is exponential, but the Pratt-Arrow measure of absolute risk aversion is random. It is known that the investor is memoryless in wealth for exponential utility functions with a constant parameter meaning the investment portfolio consisting of risky stocks does not depend on initial wealth. However, we show that this is not true if this parameter is random. We obtain a number of interesting characterizations on the structure of the optimal policy.

#### 3 - Some optimisation problems in stochastic pension plans

*Griselda Deelstra*, Mathematics, Actuarial Sciences, Université Libre de Bruxelles (U.L.B.), Boulevard du Triomphe, CP 210, 1050, Brussels, Belgium, [griselda.deelstra@ulb.ac.be](mailto:griselda.deelstra@ulb.ac.be)

As an example, we determine the optimal contribution rate of a stochastic defined benefit pension fund. The affiliate's mortality is modelled by a jump process and the benefits paid in at retirement are function of the evolution of stochastic salaries. Assets of the fund are invested in cash, stocks and a rolling bond. Interest rates are driven by a Vasicek model. The objective is to minimize both the quadratic spread between the contribution rate and the normal cost, and the quadratic spread between the terminal asset and the mathematical reserve required to cover benefits.

#### 4 - Real options pricing by numerical methods: an R & D project application

*Jorge González*, Industrial Engineering Department, University of Concepción, Edmundo Larenas 215, Fourth floor, \*, Concepción, Bio Bio, Chile, [jorgonza@udec.cl](mailto:jorgonza@udec.cl), *Alejandro Andalaft*

Options pricing in project valuation have been solved by application of methods based in simulation, lattice methods and finite differences, delaying the application of finite elements method, widely used in others fields of science. The finite elements methods is studied and introduced like a numerical method that allows the resolution of real options pricing models, being an alternative that presents advantages in terms of convergence in relation to the finite differences methods. Finally, the abandonment and the expansion real option presents in a R & D investment project are valued.

## ■ WA-29

Wednesday 08:00-09:20

GSI - S 2

### Energy and Environmental Market Modeling

Stream: Energy and Emission Markets

Invited session

Chair: *Steven Gabriel*, Civil & Env. Engin./ Applied Math and Scientific Computation Program, University of Maryland, 1143 Martin Hall, 20742, College Park, MD, United States, [sgabriel@umd.edu](mailto:sgabriel@umd.edu)

#### 1 - Gasmod-dynamic - a dynamic model of the European natural gas market and network

*Franziska Holz*, International Economics, DIW Berlin, Mohrenstr. 58, 10117, Berlin, Germany, [fholz@diw.de](mailto:fholz@diw.de)

We develop a dynamic model of the European natural gas market and network. It is based on the GASMOD-Net model in which the natural gas flows are constrained by a network graph. We focus on endogeneous investments in the transport infrastructure (pipelines, LNG facilities) in an open-loop approach. Applying the GASMOD-Dynamic model to a small, stylized data set of the European natural gas market shows the importance of the transit infrastructure between European countries, in particular in an imperfect market.

#### 2 - A model for the global crude oil market using a multi-pool mcp approach

*Daniel Huppmann*, DIW Berlin, Mohrenstraße 58, 10117, Berlin, Germany, [dhuppmann@diw.de](mailto:dhuppmann@diw.de)

This paper proposes a partial equilibrium model to describe the global crude oil market. Pricing on the global crude oil market is strongly influenced by price indices such as WTI (USA) and Brent (Northwest Europe). We adapt a modeling approach for pool-based electricity markets, in order to capture the particularities of these benchmark price indices and their influence on the market of physical oil. We use this approach to investigate market power of OPEC and compare this modeling approach to bilateral trade relations as is traditionally used in models of energy markets.

### 3 - Cooperation among liquefied natural gas suppliers: is rationalization the sole objective?

*Olivier Massol*, Center for Economics and Management, IFP - IFP School, 228-232 Avenue Napoléon Bonaparte, 92852, Rueil-Malmaison, olivier.massol@ifp.fr, *Stéphane Tchong-Ming*

This paper studies the possible emergence of a logistic rationalization among LNG exporters. Thanks to a transportation model, the gains that may result from this policy were assessed. Results suggest that cooperation is not a rational move for some exporters unless a redistribution policy is implemented. Several gain sharing methods have thus been studied, but out of them, only the per capita nucleolus satisfies two requirements: core belonging and monotonicity. Given the complex nature of the sharing problem at hand, the credibility of this cooperation scenario should be reappraised.

### 4 - Natural gas grid investment decisions under competitive operations

*Marte Fodstad*, Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred Getz veg 3, 7491, Trondheim, Norway, martefo@iot.ntnu.no, *Asgeir Tomasgard*, *Yohan Shim*, *Steven Gabriel*

We present a model to analyze how the introduction of third party access should affect the long term investment decisions in a natural gas infrastructure. The investment decisions are analyzed from the perspective of a centralized planner maximizing social surplus. Operational production and sales decisions are taken by several independent producers while the routing of gas is taken care of by an independent system operator. The producers compete for capacity in a transportation market. The model is a discrete stochastic mathematical program with equilibrium constraints.

## ■ WA-30

Wednesday 08:00-09:20

GSI - S 26

### Solution Methods in Nonsmooth Optimization

Stream: Nonsmooth Optimization and its Applications  
*Invited session*

Chair: *Refail Kasimbeyli*, Industrial Systems Engineering Department, Izmir University of Economics, Sakarya Caddesi 156, Balcova 35330, Izmir, TURKEY, 35330, Izmir, refail.kasimbeyli@ieu.edu.tr

#### 1 - A derivative free solution algorithm in nonconvex optimization

*Refail Kasimbeyli*, Industrial Systems Engineering Department, Izmir University of Economics, Sakarya Caddesi 156, Balcova 35330, Izmir, TURKEY, 35330, Izmir, refail.kasimbeyli@ieu.edu.tr

In this paper we continue to study the Modified Subgradient (MSG) algorithm previously suggested by R. Gasimov for solving the nonconvex optimization problems. This algorithm is based on primal-dual relations and uses the sharp augmented Lagrangian dual scheme. The new algorithm does not require finding global minimum of the augmented Lagrangian at each iteration for updating step size parameters. A collection of test problems and applications are presented to demonstrate the performance of the new algorithm.

#### 2 - An efficient algorithm for solving d.c. programs based on the cutting angle method

*Albert Ferrer*, Dpt. of Applied Mathematics I, Technological University of Catalonia, Av. Doctor

Marañon, 44-50, 08028, Barcelona, Catalunya, Spain, alberto.ferrer@upc.edu, *Gleb Beliakov*

By adapting the Cutting Angle method in such a way that only values of the objective function are used we describe a new global optimization algorithm for solving d.c. programs, in which the objective function is a difference of convex functions. Applications of such an algorithm to mathematical programming problems are described and computational results are presented. Solutions obtained with another d.c. optimization package that uses subgradients are also included and their results compared.

### 3 - Generalized subgradient algorithm for nonsmooth, nonconvex optimization

*Adil Bagirov*, School of Information Technology & Mathematical Sciences, University of Ballarat, University Drive, Mount Helen, P.O. Box 663, 3353, Ballarat, Victoria, Australia, a.bagirov@ballarat.edu.au, *Julien Ugon*, *Ali Hakan Tor*

In this paper a new algorithm for minimizing locally Lipschitz continuous functions is developed. Descent directions in this algorithm are computed by solving a system of linear inequalities. The convergence of the algorithm is proved for quasidifferentiable semismooth functions. We present the results of numerical experiments. We also compare the proposed algorithm with two different versions of the subgradient method using the results of numerical experiments.

### 4 - Conjugate duality in nonconvex vector optimization

*Yalcin Kucuk*, Department of Mathematics, Anadolu University, anadolu Universitesi Fen Fakultesi Matematik Bolumu, 26470, Eskisehir, ykucuk@anadolu.edu.tr, *Ilknur Atasever*, *Mahide Kucuk*

In this work, by using a special vectorial norm, we defined conjugate and biconjugate maps of a set valued map. In addition, a new subdifferential of nonconvex setvalued map is defined and existence theorems for subdifferentiability of a nonconvex set valued map are given. Relations between conjugate map, biconjugate map and subdifferential are examined. Conjugate dual problem of the vector optimization problem is defined, weak duality and strong duality theorems are given.

## ■ WA-31

Wednesday 08:00-09:20

GSI - S 34

### Data Mining and Decision Making 1

Stream: Data Mining and Decision Making

*Invited session*

Chair: *Lai-Soon Lee*, Laboratory of Applied and Computational Statistics, Universiti Putra Malaysia, Institute for Mathematical Research, Universiti Putra Malaysia, 43400, UPM Serdang, Selangor, Malaysia, lee@math.upm.edu.my

#### 1 - An experimental comparison of classification algorithms for imbalanced credit scoring data sets

*Iain Brown*, School of Management, University of Southampton, University of Southampton, University Road, SO17 1BJ, Southampton, I.Brown@soton.ac.uk, *Christophe Mues*

This paper sets out several techniques that can be used in the analysis of imbalanced data sets from a credit scoring perspective. Imbalanced data sets occur when the number of defaulting observations are significantly lower than those which do not default. As well as using traditional classification techniques, such as logistic regression, linear and quadratic discriminant analysis, neural networks and decision trees this paper will also explore the suitability of gradient boosting, least square support vector machines and random forests.

## 2 - Price forecasting in the used car market

*Mariana Listiani*, Information and Media Technology, TU Hamburg Harburg, Handweg 17a, 21077, Hamburg, Germany, mariana.listiani@gmail.com,  
*Stefan Lessmann*

The paper develops a data-driven approach to support decision making in the car leasing industry. In order to determine a profitable yet competitive leasing rate, an accurate prediction of a car's residual value after the leasing period is required. To achieve this, a forecasting methodology based on support vector regression and evolutionary strategies is proposed. The model's potential is examined by means of empirical experimentation using real-world data from a leading German car manufacturer.

## 3 - Loss given default modelling for mortgage loans

*Mindy Leow*, School of Management, University of Southampton, University of Southampton, University Road, SO17 1BJ, Southampton, m.leow@soton.ac.uk,  
*Christophe Mues*, *Lyn Thomas*

We propose the combination of a Probability of Repossession (given default) Model and a Haircut (given repossession) Model, where probabilities of repossession and non-repossession are weighted against respective predicted loss values to get an estimate for Loss Given Default (LGD). We find the Probability of Repossession Model should comprise of more than just the commonly used loan-to-value ratio, and that estimation of LGD benefits from the Haircut Model which predicts the discount the sale price of a repossessed property consistently undergoes.

## 4 - Comparison of single and mixture distribution models for modelling lgd

*Jie Zhang*, School of Management, University of Southampton, Quantitative financial risk management centre, Building 2, Highfield Campus, Southampton, SO17 1BJ, Southampton, jz3g08@soton.ac.uk

Estimating Recovery Rate and Recovery Amount has taken a more importance in consumer credit because of both the new Basel Accord regulation and the increase in number of defaulters due to the recession. We examine whether it is better to estimate Recovery Rate or Recovery amounts. We look at the advantages and disadvantages of using single distribution model or mixture distribution models for default. We also investigate the 'cash flow' in recoveries and see how such a model aids decisions about when it is optimal to write off loans.

## ■ WA-32

Wednesday 08:00-09:20

GSI - S 4

## Financial Modelling

Stream: Financial Modelling

Contributed session

Chair: *Stefan Hirth*, Aarhus School of Business, Aarhus University, Fuglesangs Alle 4, 8210, Aarhus, Denmark, stefanh@asb.dk

## 1 - The stable distributions, their parameter estimation, and financial application

*Vadym Omelchenko*, Faculty of Mathematics and Physics, The Charles University in Prague and UTIA, Ke Karlovu 3, 121 16 Praha 2, The Czech Republic, UTIA: Pod Vodarenskou vezi 4 CZ-182 08, Praha 8, The Czech Republic, 121 16, Prague, vadim224@yahoo.com

Stable distributions can be used as a generalization of the Gaussian law and the Wiener process. In financial practice the asset prices exhibit behavior that cannot happen under assumption that they are ruled by the standard Wiener process. But the stable laws in many relations copy the normal one therefore, it is reasonable to replace the Gaussian model by its stable counterpart. The stable laws have 4 parameters and their estimation is very important task and there will be used the modified version of the maximum likelihood method and the methods based on characteristic function.

## 2 - Asymptotic expansions for the first four moments of the sparre anderson surplus process

*Rovshen Aliyev*, Department of Statistics and Computer Sciences, Karadeniz Technical University, a Karadeniz Technical University, Faculty of Arts and Sciences, Trabzon, Turkey, 61080, Trabzon, aliyevrt@mail.ru, *Vafa Jafarova*

In this study the surplus process is considered, where the number of events occurred until time  $t, N(t)$  an ordinary renewal process. The asymptotic expansions for large number of  $t$  for the first four moments of the surplus process are obtained. Furthermore, the asymptotic expansions for large  $t$  for the skewness and kurtosis of the process are established.

## 3 - Premium bounds for the cedent's (reinsurer's) total risk under reinsurance with dependent random retention levels

*Eva-Maria Ortega*, Centro de Investigacion Operativa, University Miguel Hernandez, Campus Orihuela., Ctra. de Beniel, km. 3,2, 03312 Orihuela, Alicante, Spain, evamaria@umh.es, *Laureano Fernando Escudero*

We analyze how dependencies influence the variability of retained and reinsured total claim amount, under reinsurance with random retention levels. Premium bounds are derived for several principles that are preserved by the variability and Laplace order. We consider an extension of the LCR model, with arbitrary random retention, obtaining comparisons of Laplace transforms of retained risk and Exponential premiums bounds. We extend this to the excess-loss, stop-loss reinsurance, for the variability ordering and the reinsured total risk. Criteria on the valuation of financial assets are derived

## 4 - The non-monotonic effect of financing constraints on investment

*Stefan Hirth*, Aarhus School of Business, Aarhus University, Fuglesangs Alle 4, 8210, Aarhus, Denmark, stefanh@asb.dk, *Marc Viswanatha*

We analyze investment timing in a discrete-time framework with two possible investment dates, which is an extension of the model by Lyandres (2007). While Lyandres could only show non-monotonicity of investment in market frictions, we derive an investment threshold that is U-shaped in the firm's liquid funds, a result similar to the infinite-horizon model by Boyle and Guthrie (2003). However, due to the tractability of our model, we can more clearly explain the relevant trade-offs leading to the U-shape.

## ■ WA-33

Wednesday 08:00-09:20

GSI - S 7

### Interval B&B Algorithms: Theory to Applications

Stream: Global Optimization

*Invited session*

Chair: *Frederic Messine*, ENSEEIHT-IRIT, 2 rue Camichel, 31000, TOULOUSE, France, Frederic.Messine@n7.fr

#### 1 - On estimating workload in parallel branch-and-bound global optimization algorithms

*Jose Luis Berenguel*, Computer Architecture and Electronics, Universidad de Almería, Ctra. Sacramento s/n, La Cañada de San Urbano, 04120, Almeria, Spain, jlberenguel@gmail.com, *L.g. Casado, I. Garcia, Eligius M.T. Hendrix*

In general, solving Branch-and Bound Global Optimization problems requires a huge computational capacity. These type of algorithms are examples of dynamic workload problems because the number of nodes we have to evaluate in the B&B tree isn't known a priori. We are interested in load balancing strategies for Tree-based multiple pool algorithms. We present a new way of estimating the remaining running time of B&B algorithms dynamically. This will allow us to manage the load balancing in a multiprocessing environment. Illustrations are based on interval global optimization algorithms.

#### 2 - Metaheuristic methodology based on interval branch and bound algorithms with a limitation of the memory

*Jordan Ninin*, Computer Science, IRIT-ENSEEIHT, 2 rue Camichel, 31000, Toulouse, France, Jordan.Ninin@n7.fr, *Frederic Messine*

The exponential complexity in time, and also in memory, of an Interval Branch and Bound Algorithm does not make it possible to solve some quite large problems. In this work, we propose a metaheuristic methodology based on an interval branch and bound algorithm which consists in fixing an upper bound on the available memory. During the computations, when this bound is reached, a heuristic is then used to limit the size of the data structure. With this metaheuristic frame, some heuristics are proposed and their efficiencies are compared and discussed by considering some numerical tests.

#### 3 - Interval branch and bound algorithms for inverse problems of electromagnetic devices design

*Julien Fontchastagner*, GREEN, Nancy Université - INPL, ENSEM, 2 avenue de la Forêt de Haye, 54516, Vandoeuvre lès Nancy, France, Julien.Fontchastagner@ensem.inpl-nancy.fr, *Frederic Messine, Yvan Lefevre*

Two extensions of an interval Branch and Bound algorithm (IBBA) for solving particular types of mixed constrained global optimization problems are presented. Indeed, this kind of methods needs analytical expressions of objective functions and constraints which must be relatively simple. Our work deals with two ways for solving our design problems: by adapting IBBA in order to deal with a more elaborate analytical model than those used usually; by extending IBBA to deal with the main equality constraint of type black-box which is issued from the computations of a finite element code.

#### 4 - Global optimization via interval equations

*Ioannis A. Nikas*, Department of Mathematics, University of Patras, Univeristy Campus, 26 504, Rio,

Greece, nikas@math.upatras.gr, *Theodoula N. Grapsa, George S. Androulakis*

In this paper, the problem of finding reliably and with certainty all minima of an interval optimization problem within a given search interval for continuously differentiable functions over real numbers is examined. A new formality of interval arithmetic is described in a theoretical manner to develop and prove a new method. Theoretical aspects of the proposed methodology are stated and proved. Finally, the method is tested on a set of test functions and promising theoretical results are verified.

## ■ WA-34

Wednesday 08:00-09:20

GSI - S 8

### Model Selection and Optimization Techniques in Machine Learning

Stream: Machine Learning and Its Applications

*Invited session*

Chair: *Sureyya Ozogur-Akyuz*, Faculty of Engineering and Natural Sciences, Department of Electronics, Sabanci University, Sabanci University, Faculty of Engineering and Natural Sciences, Orhanli Tuzla, 34956, Istanbul, Turkey, sozogur@sabanciuniv.edu

#### 1 - Support vector machine model selection using strangeness

*Zakria Hussain*, Computer Science, Unvertsity College London, Gower Street, WC1E 6BT, London, United Kingdom, Z.Hussain@cs.ucl.ac.uk, *David Hardoon, John Shawe-Taylor*

We investigate the issue of model selection and the use of the non-conformity (strangeness) measure in batch learning. Using the non-conformity measure we propose a new training algorithm that helps avoid the need for Cross-Validation or Leave-One-Out model selection strategies. We provide a new generalisation error bound using the notion of nonconformity to upper bound the loss of each test sample and show that our proposed approach is comparable to standard model selection methods, but with theoretical guarantees of success & faster convergence. We demonstrate our novel technique using the SVM

#### 2 - Multi-task learning via matrix regularization

*Andreas Argyriou*, Computer Science, University College London, Malet Place, WC1E 6BT, London, United Kingdom, argyriou@cs.ucl.ac.uk

We present a method for learning representations shared across multiple tasks. The method consists in learning a low-dimensional subspace on which task regression vectors lie. Our formulation is a convex optimization problem, which we solve with an alternating minimization algorithm. This algorithm can be shown to always converge to an optimal solution. Moreover, the method can easily be extended to use nonlinear kernels. To this end, we completely characterize optimality conditions ("representer theorems") for a general class of matrix learning problems that includes the one above.

#### 3 - Hashing for approximate nonparametric inference

*Alex Smola*, Statistical Machine Learning, NICTA, Northbourne Avenue 218, 2600, Canberra, ACT, alex.smola@gmail.com

Empirical evidence suggests that hashing is an effective strategy for dimensionality reduction and practical nonparametric estimation. We provide canonical distortion bounds for feature hashing and show that the interaction between random subspaces is negligible with high probability. We demonstrate the feasibility of this approach with experimental results for a new use case — multitask learning with hundreds of thousands of tasks.

#### 4 - Association mining analysis of automobile spare parts sales: a case study

*Gurdal Ertek*, Faculty of Engineering and Natural Sciences, Sabanci University, Orhanli, Tuzla, 34956, Istanbul, Turkey, ertekg@sabanciuniv.edu, *Mehmet Can Arslan*

We describe a project that we carried out at a major automobile distributor in Turkey. Spare parts sales for a particular model have been analyzed using association mining and graph visualization, and recommendation rules have been incorporated into the information system. We analyze the association patterns for the 5 months on which the recommendations are based, and compare them to the patterns encountered 1,5 months after the recommender system was put into practice. Numerous theoretical and practical challenges that have been encountered throughout the project will be presented.

### ■ WA-35

Wednesday 08:00-09:20

GSI - S 9

#### Cops and Robbers

Stream: Graph Searching

*Invited session*

Chair: *Boting Yang*, Dept. of Computer Science, University of Regina, 3737 Wascana Parkway, S4S 0A2, Regina, Saskatchewan, Canada, boting@cs.uregina.ca

##### 1 - Guarding games on graphs

*Petr Golovach*, Department of informatics, University of Bergen, PB. 7803, 5020, Bergen, Norway, Petr.Golovach@ii.uib.no, *Fedor Fomin*, *Alex Hall*, *Deniel Lokshantov*, *Matus Mihalak*, *Elias Vicari*, *Peter Widmayer*

We consider a problem of keeping a moving intruder out of an given area in a graph by blocking the ways of possible attacks by a team of mobile agents (guards). The intruder and the guards are placed on vertices of the graph; they take turns in moving to adjacent vertices (or staying). The goal of the intruder is to enter the guarded region at a vertex without guards. The problem is to find the minimum number of guards needed to prevent this event. We consider two variants of the problem which differs by the order of players moves and establish a number of complexity and algorithmic results.

##### 2 - Cops-and-robbers on infinite graphs

*Gena Hahn*, Informatique et recherche operationnelle, Universite de Montreal, 2920 Chemin de la tour, H3T1J8, Montreal, Quebec, Canada, hahn@iro.umontreal.ca

While the game of cops-and-robbers has been studied, sometimes intensely, over the past two decades for finite graphs, not much has been done for infinite ones. This talk will be a quick survey of some finite graph results leading to considerations of infinite ones where we mention some perhaps surprising results, some old, some new. Some of this work is in collaboration with Anthony Bonato, Francois Laviolette, Norbert Sauer, Claude Tardif and Robert Woodrow.

##### 3 - Cops and robbers from a distance

*Anthony Bonato*, Mathematics, Ryerson University, 350 Victoria St, M5B2K3, Toronto, ON, Canada, abonato@ryerson.ca

In vertex pursuit games played on graphs such as Cops and Robbers, the cops must occupy the node of the robber to win. We present results on scenarios where the cops win if they are some prescribed distance from the robber. We study this new game—distance  $k$  Cops and Robber—from algorithmic, structural, and probabilistic perspectives.

#### 4 - A witness version of the cops and robber game

*Nancy Clarke*, Mathematics and Statistics, Acadia University, 12 University Avenue, B4P2R6, Wolfville, Nova Scotia, Canada, nancy.clarke@acadiau.ca

The games considered are mixtures of Searching and Cops and Robber. The cops have partial information provided via witnesses who report sightings of the robber. The witnesses are able to provide information about the robber's position but not the direction in which he is moving. The robber has perfect information. In the case when sightings occur at regular intervals, we present a recognition theorem for graphs on which a single cop suffices to guarantee a win. In a special case, this recognition theorem provides a characterization.

### ■ WA-36

Wednesday 08:00-09:20

GSI - S 11

#### Stochastic Modelling and Simulation I

Stream: Stochastic Modelling and Simulation

*Invited session*

Chair: *Andreas Rößler*, Fachbereich Mathematik, TU Darmstadt, Schlossgartenstrasse 7, 64289, Darmstadt, Germany, roessler@mathematik.tu-darmstadt.de

Chair: *Erik Kropat*, Department of Mathematics, Friedrich-Alexander University Erlangen-Nuremberg, Martensstraße 3, 91058, Erlangen, Germany, kropat@am2.am.uni-erlangen.de

##### 1 - Financial valuation of guaranteed minimum withdrawal benefit in variable annuities under correlated lévy processes

*Kwai-sun Leung*, Systems Engineering and Engineering Management, The Chinese University of Hong Kong, Shatin, New Territories,, Hong Kong, N.A., Hong Kong, Hong Kong, ksleung@se.cuhk.edu.hk

In annuity policy with guaranteed minimum withdrawal benefit (GMWB), the policyholder pays a single lump sum premium to the insurance company in return for a guaranteed stream of periodic withdrawals on a set of preset dates over the life of the contract. The received premium is then invested in a reference portfolio of assets which is usually a mutual fund. Periodic fees are charged for providing this guarantee.

In this paper, the price of this insurance policy when the underlying fund value and the interest rate process are driven by two-dimensional correlated Lévy processes is derived.

##### 2 - Probabilistic approach of serial multi-level production/inventory systems with finite capacities

*Fouzia Baghery*, LAMAV, Valenciennes University, Mont Houy, Valenciennes, F59304, valenciennes, France, fbaghery@univ-valenciennes.fr

Let us consider for a single product, a serial system with finite capacities installations. Stochastic external demand arises at the lowest installation. At any time each level  $i$  places orders to level  $i+1$  and the exterior supplies the highest installation. The excess demand at level  $i$  is transmitted to level  $i+1$ , with some cost depending on  $i$ . We characterize the optimal cost as a maximum solution of quasi-variational inequalities. The existence and properties of optimal policy are given.

**3 - Make-to-order systems with correlated demands**

*Michael Zazanis*, Statistics, Athens University of Economics and Business, 76 Patission str., 10434, Athens, Greece, zazanis@aub.gr

We examine markovian models of make-to-order systems when the demand stream is correlated. Explicit results are obtained for demand streams with exponential interarrival times and markovian dependence based on the bivariate exponential distribution. Exact and asymptotic results are also derived for multistage make-to-order systems and for assemble-to-order systems when the demand stream and the processing times are correlated.

**4 - Estimating some effects of prioritizing aircraft landings at over-congested airports**

*Milan Janic*, OTB Research Institute, Delft University of Technology, Jaffalaan 9, 2628BX, Delft, M.Janic@tudelft.nl

This paper investigates effects of prioritizing the aircraft landings at the over-congested runways as a short-term demand management measure similar to the congestion charging measure. The deterministic queuing model for estimating queues, delays, and related costs of particular prioritized aircraft categories (classes) is developed. The assignment of priorities to particular aircraft is based on the dynamic priority function designed to minimize the total cost of delays for all aircraft. The model is applied to a congested European airport using "what-if" reasoning.

**WA-37**

Wednesday 08:00-09:20

GSI - S 12

**Decision Theory and Analysis - 1**

Stream: Decision Analysis

*Contributed session*

Chair: *Hermann Jahnke*, Fakultät für Wirtschaftswissenschaften, Universität Bielefeld, Universitätsstraße 25, 33615, Bielefeld, Germany, hjahnke@wiwi.uni-bielefeld.de

**1 - Uta — nm: searching for non-monotonic utility functions**

*Tomas Kliegr*, Department of Information and Knowledge Engineering, University of Economics, Prague, Faculty of Informatics and Statistics, Winston Churchill Sq.4, 13067, Prague, Czech Republic, tomas.kliegr@vse.cz, *Lucia Nemethyova*

UTA methods use linear programming for finding a model consisting of piecewise-linear additive partial utility functions assuming that stated preferences are monotonic. UTA-NM (Non-Monotonic) is inspired by UTA Star algorithm but allows non-monotonic partial utility functions if they decrease total model error. The shape of the functions is determined automatically while linearization techniques ensure balance between the error and simplicity of the model. The resulting program is still linear and convex. UTA-NM was applied on the analysis of preferences in the domain of transportation choice.

**2 - Analyzing the effects of decision maker's characteristics on the violations of expected utility theory**

*Amilcar Serrao*, Management Department, Evora University, Largo dos Colegiais, 7000, Evora, Alentejo, Portugal, aserrao@uevora.pt

Expected utility theory has been tested by experimental studies which have been violating their axioms. This research work uses a structural equation modeling approach to evaluate the effects of biological, demographical and emotional characteristics of decision makers on the violations of expected utility theory. Model results show that there exist choice patterns which are inconsistent with EUT and this inconsistency may be explained by the differences of decision makers' characteristics. Emotions might have the greatest influence how decision makers violate expected utility axioms.

**3 - Lower price limits for full-service contracts based on almost stochastic dominance**

*Hermann Jahnke*, Fakultät für Wirtschaftswissenschaften, Universität Bielefeld, Universitätsstraße 25, 33615, Bielefeld, Germany, hjahnke@wiwi.uni-bielefeld.de, *Jan Thomas Martini*

Capital equipment requires services like installation, maintenance, and repair. In a competitive environment it is a crucial part of the equipment manufacturer's strategy to offer such industrial services. In this context, full-service contracts (FSCs) are increasingly important. We focus on risk issues when analyzing lower price limits of FSCs. The approach is based on the concept of almost stochastic dominance (ASD). It allows to model the choice of a lower price limit as a multi-person decision. Application issues discussed are, e.g. the implementation of ASD and a variable number of FSCs.

**WA-38**

Wednesday 08:00-09:20

GSI - S 13

**Simulation Optimization**

Stream: Simulation, Metamodeling and Optimization

*Invited session*

Chair: *Gulser Koksak*, Industrial Engineering, Middle East Technical University, 6531, Ankara, Turkey, koksak@ie.metu.edu.tr

**1 - Robust simulation-optimization through taguchi's approach and metamodels**

*Gabriella Dellino*, Information Engineering Dept., University of Siena, Via Roma 56, Edificio S. Niccolò, 53100, Siena, Italy, dellino@dii.unisi.it, *Jack Kleijnen*, *Carlo Meloni*

Simulation-optimization aims to identify a combination of input parameters that gives optimal performance of a simulated system. This optimization usually ignores the uncertainty in the input factors, leading to suboptimal or infeasible solutions. We therefore propose a novel methodology for robust simulation-optimization, based on Taguchi's worldview: it approximates the simulation input-output behavior through either linear regression or Kriging metamodels. Next, these metamodels are solved through Mathematical Programming. The methodology has already been applied to some inventory models.

**2 - Multicriteria optimization for the performance of solid rocket motor**

*Elcin Kartal*, Statistics, Middle East Technical University, 06531, Ankara, Turkey, kartalelcin@gmail.com, *Inci Batmaz*, *Gulser Koksak*

Simulation optimization can be defined as the process of finding the best input variable values which optimize the output variable. The output of a simulation model is used by an optimization strategy to provide feedback on progress of the search for the optimal solution. In many real life optimization problems, however, multiple and/or conflicting objectives have to be taken into account. This paper examines some multicriteria optimization methods for optimising the performance of solid rocket motor.

### 3 - Constrained optimization in simulation using kriging metamodeling

*Inneke Van Nieuwenhuyse*, Research Centre for Operations Management, K.U.Leuven, Naamsestraat 69, Office 04.112, 3000, Leuven, inneke.vannieuwenhuyse@econ.kuleuven.be, *Jack Kleijnen*, *Wim van Beers*

This paper presents a novel heuristic for constrained optimization of random simulation models. One output is selected as objective to be minimized, while other outputs must satisfy given target values. The heuristic uses Kriging metamodels to guide the search for the optimal parameter settings. The heuristic is applied to a call center simulation model, aiming to determine optimal capacity sizes (for operators and trunk lines) in order to balance resource costs and customer waiting costs.

## ■ WA-39

Wednesday 08:00-09:20

GSI - S 14

### Process Scheduling

Stream: Scheduling

Contributed session

Chair: *Deniz Türsel Eliiyi*, Department of Business Administration, Izmir University of Economics, Sakarya Cad. No:156, Balçova, 35330, Izmir, Turkey, deniz.eliiyi@ieu.edu.tr

#### 1 - Multi-stage continuous production systems: planning and optimization issues

*Krystina Bakhrankova*, Faculty of Economics, Informatics and Social Sciences, Molde University College, Britvegen 2, 6411, Molde, Norway, krystina.bakhrankova@himolde.no

Despite their prevalence, continuous production systems are less researched in the literature. This paper explores relevant planning and optimization issues on a concrete industrial example of a multi-product continuous plant with non-discrete units and intermediate tanks. Thus, two multi-stage optimization models focused on, respectively, energy costs minimization and capacity maximization are developed, tested and analyzed. The models reflect the actual system: up- and downstream capacity restrictions, return flows and multiple processing alternatives, and provide substantial cost savings.

#### 2 - Optimisation in food-processing industry: a case study

*Veronika Skocdoplova*, Dept. of Econometrics, University of Economics Prague, Winston Churchill sq. 4, 130 67, Prague 3, Czech Republic, veronika.skocdoplova@vse.cz, *Josef Jablonsky*

The paper presents the model for optimisation of production of white masses (WMs) in the food-processing company. The problem is formulated as a blending problem with several special features. The optimisation criterion is minimisation of total costs. The most important constraints are requirements on composition of WMs, composition of raw materials and limits for surplus sales of materials. The results of the model offer recommendation for purchase, production and surplus sales of raw materials. DSS for company management based on the cooperation of MS Excel with LINGO solver is presented.

#### 3 - A closed-loop approach to continuous process scheduling problems

*Christoph Schwindt*, Institute of Management and Economics, Clausthal University of Technology,

Julius-Albert-Str. 2, 38678, Clausthal-Zellerfeld, Germany, christoph.schwindt@tu-clausthal.de, *Hanno Sagebiel*

We consider the scheduling of multistage continuous production plants. Starting from the decomposition into a planning and a scheduling problem, we present a closed-loop approach. Having computed a feasible production schedule, we return to the planning phase, where we re-optimize the operating conditions subject to the constraints of the scheduling problem. We then schedule the operations again and iterate the planning and scheduling phases until a fixed point is reached. The method is able to find good feasible schedules for complex benchmark instances within few minutes on a standard PC.

#### 4 - Operational fixed job scheduling problems with time limitations

*Deniz Türsel Eliiyi*, Department of Business Administration, Izmir University of Economics, Sakarya Cad. No:156, Balçova, 35330, Izmir, Turkey, deniz.eliiyi@ieu.edu.tr, *Meral Azizođlu*

We present heuristics for the Operational Fixed Job Scheduling problem. Jobs should start processing as soon as they arrive. Working/Spread time constraints limit operation times of machines. We propose greedy constructive algorithms and filtered beam search for the working time problem. For the spread time problem, Minimum Cost Network Flow (MCNF) and longest path solutions, decomposition by time, and a two-phase enumeration tree are used in three algorithms. Improvement algorithms apply to both problems. Computational experiment reveals that solutions to both problems are quite satisfactory.

## ■ WA-40

Wednesday 08:00-09:20

GSI - S 27

### Governance and Development

Stream: OR for Development and Developing Countries

Invited session

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

Chair: *Honora Smith*, School of Mathematics, University of Southampton, Highfield, SO17 1BJ, Southampton, Hampshire, United Kingdom, honora.smith@soton.ac.uk

#### 1 - Citizen adoption of e-government systems: a structural equation modelling application

*Irfan Emrah Kanat*, Informatics Institute, Middle East Technical University, 06531, Ankara, Turkey, iekanat@gmail.com, *Sevgi Ozkan*

E-Government initiatives are increasing the convenience and accessibility of government services worldwide. Unfortunately not all e-government initiatives end up as being successful. A deeper understanding the factors influencing citizens' adoption behavior is required for the effectiveness of e-government implementations. The aim of this study is to develop a model for predicting and explaining citizen behavior regarding the acceptance of e-government systems in Turkey and validate it through the use of Structural Equation Modelling.

#### 2 - Russian market of refuse collection: problems and perspectives

*Mikhail Belousov*, Microeconomics, SU-HSE, 20, Myasnitskaya, State —University Higher School of

Economics, Department of Microeconomics, 101000,  
Moscow, belousov\_mikhail@mail.ru

Current problems in Russian refuse collection market: The municipalities perform both functions of service providers and functions of customers who assess service quality received. The current situation with the monopoly of municipal companies has largely resulted from the existing determination of a service provider based upon nonselection procedure. Reorganization of the refuse collection municipal companies is often only a change of ownership, not a change of its established links and controls. High administrative entry barriers play a crucial role for small companies in the market.

### 3 - The drivers of citations in management science journals

Fang Xu, 21, sancroft avenue, ct2 8jw, canterbury,  
fx7@kent.ac.uk, John Mingers

This study explores the factors that affect the number of citations a paper receives. We have a sample of 670 papers published in six management science journals in 1990 including Management Science, EJOR and JORS. We have applied generalized linear modelling and found that the most significant were: the journal, the number of references and length of the paper; the institution of the author, and whether the paper was a review paper. The major factor that we could not include was the intrinsic quality of the paper. The complex interactions between these factors are discussed.

## ■ WA-41

Wednesday 08:00-09:20

GSI - S 28

### Long Term Financing and Investment 2

Stream: Long Term Financial Decisions

Invited session

Chair: *Thomas Burkhardt*, Campus Koblenz, IfM,  
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#### 1 - Product liability as a subject of financial valuation

*Peter Kurz*, Ernst-Moritz-Arndt-Universität  
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Eckart Klingelhoefner*

Product liability can have significant, long-term impact on a company through the cost of litigation, damages and market reactions. We present a model for the financial valuation of actions to reduce a manufacturer's liability exposure. Investments in product safety, disinvestments, insurance and indemnification clauses can be considered. Interdependencies between production, sales, investment and finance are taken into account as well as uncertainty concerning batch failures, market reactions and possible product recalls. Sensitivity analysis is used to assess the impact of changed settings.

#### 2 - The impact of macroeconomic announcements on stocks: why are some firms more sensitive than others?

*Georg Bestelmeyer*, Seminar für ABWL und  
Unternehmensfinanzen, Universität zu Köln, 50923,  
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*Dieter Hess*

Theory suggests that the stock market's reaction to macroeconomic news depends on the news' impact on growth expectations, risk free interest rates and risk premiums. On the index level, Boyd et al. (2005) suggest that the impact of unemployment news depends on the stage of the business cycle. We analyze individual stocks, hypothesizing that companies whose earnings are more closely linked to the overall economy, react stronger to news about overall economic activity. Analyzing unemployment rates as well as nonfarm payrolls, we document strong stock price reactions on the individual level.

#### 3 - Long term profitability assessment of open pit mining in intransparent markets: perspectives and case study

*Thomas Burkhardt*, Campus Koblenz, IfM, Universität  
Koblenz-Landau, Universitätsstr. 1, 56070, Koblenz,  
Germany, tburkha@uni-koblenz.de, *Alexander Hennig*

Mining is a risky business, and the proper assessment of profitability is particularly difficult if we have to deal with commodities for which markets are highly localized and intransparent. We discuss, based on an actual case study of a gravel surface mining project, the essential issues involved in the evaluation. Our analysis highlights that in practical applications the limitations on available data are serious, so that a detailed modeling of the production process in connection with rather robust valuation techniques seem most appropriate.

## ■ WA-42

Wednesday 08:00-09:20

GSI - S 3

### Novel opportunities of Nonconvex Programming for Industry and Finance

Stream: Nonconvex Programming: Local and Global Approaches - Theory, Algorithms and Applications

Invited session

Chair: *Ba Chu*, Economics, Carleton University, 1125  
Colonel By Drive, Ottawa, K1S 5B6, Ottawa, Ontario,  
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#### 1 - A deterministic optimization approach for planning a multisensor multizone search for a moving target.

*Manh Nguyen Duc*, LMI, INSA de Roen, BP 08 Place  
Emile Blonde, 76131, Mont Saint Aignan, Rouen,  
France, nguyenducmanh1982@yahoo.com, *Hoai An  
Le Thi, Tao Pham Dinh*

In this paper, we consider a well-known problem in the general area of search theory: optimize the search resources sharing of multisensor in multizone so as to maximize the probability of detection of a target. We first introduce a new optimization model that is linear constrained mixed 0-1 nonconvex minimization. The problem is then reformulated as a DC (Difference of Convex functions) program via a penalty technique. DC programming and DCA (DC algorithm) have been investigated for solving the resulting DC program.

#### 2 - Optimisation of flexibility and predictability of the air traffic flow management system

*Tao Pham Dinh*, INSA Rouen, 76131, Rouen, France,  
pham@insa-rouen.fr, *Trung-Tuyen Hoang*

In the Air Traffic Flow Management, the predictability is essential information in building schedules. Therefore a high value is attached to predictability as it enables airlines and airports to improve the punctuality/financial performance trade-off. We propose a modeling for the predictability and flexibility of the Air Traffic Flow Management system. This modeling leads to a trade-off between the arrival rate of flights and the time window. We show one method to transform this trade-off to 0-1 optimization problem. The real data results are also presented.

### 3 - A dc programming approach for feature selection in support vector machines

*Mamadou Thiao*, Laboratory of Modelling, Optimization and Operations Research, LMI., National Institute for Applied Sciences of Rouen France, BP 08, Place Emile Blondel, 76131, Mont Saint Aignan, thiaoma@insa-rouen.fr, *Tao Pham Dinh*, *Hoai An Le Thi*

Feature selection consists of choosing a subset of available features that capture the relevant properties of the data. This paper presents a novel feature selection approach minimizing directly the classifier error while controlling the number of features selected. The main idea of our approach is the addition of a constraint for the number of features. The resultant problem is formulated as a DC program and handled by the DCA algorithm in DC programming. Experiments with various real-world data sets show that our method accomplishes the desired feature selection and classifier performance.

### 4 - Approximating risk in a large portfolio and empirical applications

*Ba Chu*, Economics, Carleton University, 1125 Colonel By Drive, Ottawa, K1S 5B6, Ottawa, Ontario, ba\_chu@carleton.ca

This paper provides an asymptotic approach for the portfolio selection problem of an investor who desires to ensure himself from losing more than a specified amount, which is also called as the shortfall probability approach. We shed some light on the relationship between the shortfall probability of a well-diversified portfolio and an investment decision based on the expected utility maximization. As a result, an optimal portfolio is determined by either minimization of the Value-at-Risk or maximization of an expected utility.

## WA-43

Wednesday 08:00-09:20

GSI - S 10

### Forecasting and Risk Management

Stream: Long Term Financial Decisions

Invited session

Chair: *Ralph Grothmann*, Corporate Technology, Learning Systems (CT IC 4), Siemens AG, Otto-Hahn-Ring 6, 81735, München, Germany, ralph.grothmann@siemens.com

### 1 - Design of cost efficient foreign exchange risk management in exporting companies

*Tanya Mishchenko*, Insitut für Management, Universität Koblenz-Landau, 56070, Koblenz, Germany, mishchenko@uni-koblenz.de, *Thomas Burkhardt*

We base the analysis of foreign exchange risk management for exporting companies on a unified theoretical concept, which considers risk management strategies as probability transformations of the underlying FX rate. The conceptual approach is detailed for general derivative based strategies. We show how our approach can be utilized to find a cost efficient strategy under appropriate risk constraints and more general considerations based on stochastic dominance.

### 2 - Forecasting financial market volatility using high frequency data

*Panagiotis Ballis-Papanastasiou*, Faculty of Economics, University of Bremen, Hochschulring 4, WiWI Gebäude, Raum 3.20, 28359, Bremen, Germany, p.papanastasiou@uni-bremen.de

We investigate whether realized volatility, realized range and implied volatility from option data have any predictive power in forecasting daily index volatility calculated by using high frequency intra day data. We examine the forecasting ability of autoregressive fractionally integrated moving average models (ARFIMA) models and Generalized AutoRegressive Conditional Heteroscedastic (GARCH) family of models on four major indexes (CAC, SP500, DAX and Dow Jones) against the random walk model, which serves as our benchmark.

### 3 - Forecasting commodity prices with large recurrent neural networks

*Ralph Grothmann*, Corporate Technology, Learning Systems (CT IC 4), Siemens AG, Otto-Hahn-Ring 6, 81735, München, Germany, ralph.grothmann@siemens.com

In the age of globalization, financial markets are highly interrelated. Usual segregated market analyses are therefore questionable. What is required is a joint modeling of all interrelated markets. To this end, we have developed large time-delay recurrent neural networks that model coherent markets as interacting dynamical systems, which has been applied successfully to forecasts in the commodity markets. Our integrated market model integrates major international stock, bond and foreign exchange markets as well as major primary energy markets.

## WA-44

Wednesday 08:00-09:20

GSI - S 16

### Health Care Applications of Simulation

Stream: Simulation Applications in Private and Public Organizations

Invited session

Chair: *Murat Caner Testik*, Industrial Engineering, Hacettepe University, Hacettepe Universitesi, Muhendislik Fak. Endustri Muh. Bolumu, 06800, Beytepe- Ankara, Turkey, mtestik@hacettepe.edu.tr

Chair: *Banu Yuksel Ozkaya*, Department of Industrial Engineering, Hacettepe University, Hacettepe University, Department of Industrial Engineering, 06800, Ankara, Turkey, byuksel@hacettepe.edu.tr

### 1 - Inventory management of hospital blood banks

*Banu Yuksel Ozkaya*, Department of Industrial Engineering, Hacettepe University, Hacettepe University, Department of Industrial Engineering, 06800, Ankara, Turkey, byuksel@hacettepe.edu.tr, *Murat Caner Testik*

The major responsibility of a hospital blood bank is to ensure that demand for blood and blood components are satisfied on time while minimizing outdates and reducing shortages that might require emergency shipments from other blood banks. In order to achieve these goals, it is important for blood banks to set appropriate inventory levels and rationing policies that will capture the trade-off between shortage versus outdate rates. In this study, we analyze the blood inventory management of Hacettepe University Hospitals' Blood Center using simulation and discuss improvement recommendations.

## 2 - Simulation of hospital blood banks for service quality improvement

*Volkan Sonmez*, Department of Industrial Engineering, Hacettepe University, Hacettepe University  
Department of Industrial Engineering, Beytepe  
Ankara, 06800, Ankara, Turkey,  
volkansz@hacettepe.edu.tr, *Murat Caner Testik*, *Banu Yuksel Ozkaya*

Immense demand for blood products increases the importance of blood banks' service quality. Due to the complexity of analytical models for blood donation processes, simulation modeling is an effective tool. In this study, we use simulation approach to analyze and improve Hacettepe University Hospital's blood donation process. Our model takes into account waiting lines at various stages and capacity constraints such as the number of beds and staff. Model is used first to analyze the current system and then alternative systems are proposed to minimize waiting times and increase utilization

## ■ WA-45

Wednesday 08:00-09:20

GSI - S 33

## Structural Equation Modeling Studies in OR

Stream: OR Applications in Education

*Invited session*

Chair: *Seren Basaran*, Secondary Science and Mathematics Education, Middle East Technical University, Informatics Institute - METU, 06531 Ankara Turkey, Turkey,  
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Chair: *Meltem Sari*, Secondary Science and Mathematics Education, Hacettepe University, Hacettepe Universitesi Egitim Fakultesi OFMA Egitimi Bölümü Beytepe/Ankara, 06800, ANKARA, Turkey, meltem-s@hacettepe.edu.tr

### 1 - A structural equation modeling study: modeling the relationship between factors affecting students' views about proof and their performance in proof

*Meltem Sari*, Secondary Science and Mathematics Education, Hacettepe University, Hacettepe Universitesi Egitim Fakultesi OFMA Egitimi Bölümü Beytepe/Ankara, 06800, ANKARA, Turkey,  
meltem-s@hacettepe.edu.tr, *Seren Basaran*

The aim of this study is three-fold; to determine effective factors in students' views about proof; to confirm proposed structural model including the interrelationships between these factors and proof performance, and to serve as a prototype for modeling social/behavioral related problems in OR. Consequently, this study not only gives clues to mathematics instructors on how to improve students' proof performance by considering identified factors in their teaching, but also provides OR researchers an example on how to implement structural equation models to formulate behavioral OR problems.

### 2 - E-learning systems evaluation: structural equation modeling approach

*Sevgi Ozkan*, Informatics Institute, Middle East Technical University, Ismet Inonu Bulvari, 06531, Ankara, Turkey, sozkan@ii.metu.edu.tr, *Refika Koseler*

This study aims to propose an e-learning effectiveness model including six dimensions: (1) system quality, (2) service quality, (3) content quality, (4) learner perspective, (5) instructor attitudes, and (6) supportive issues. A structural equation model based on these six dimensions has been developed. The proposed structural equation model depicts the interrelationships between the six dimensions. Findings of this research will be valuable for both academics and practitioners of e-learning systems, providing a prototype for modeling technical and social issues in distance education.

### 3 - Empirical investigation of factors moderating it—performance relationship in developed and developing countries

*Ali Asghar Anvary Rostamy*, Management, Tarbiat Modares University (TMU), Department of Management, Tarbiat Modares University, Chamran Expressway-Nasr Street, Tehran, Iran, 19546, Tehran, Tehran, Iran, Islamic Republic Of,  
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This paper provides a new conceptual model that offering an empirically based insight into the effects of IT-Performance moderators in developed and developing countries. Using data from 34 developed and 211 developing countries and applying Pearson Correlation Method and Structured Equation Model, we found some interesting results determine moderator variables significantly moderate the IT-performance relationship in developing and developed countries, respectively. Results of this research confirm fitness of the data with our proposed new Structured Equation model.

## Wednesday 09:35-11:05

### ■ WB-01

Wednesday 09:35-11:05

Beethoven

#### Keynote WM1

Stream: Keynote Talks

Keynote session

Chair: *Endre Boros*, RUTCOR, Rutgers University, 08854, Piscataway, New Jersey, United States, [Endre.Boros@rutcor.rutgers.edu](mailto:Endre.Boros@rutcor.rutgers.edu)

Chair: *Roman Slowinski*, Institute of Computing Science, Poznan University of Technology, Laboratory of Intelligent Decision Support Systems, Street Piotrowo 2, 60-965, Poznan, Poland, [roman.slowinski@cs.put.poznan.pl](mailto:roman.slowinski@cs.put.poznan.pl)

#### 1 - Problem solving by general purpose solvers

*Toshihide Ibaraki*, Informatics, Kwansai Gakuin University, 2-1 Gakuen, Sanda, Hyogo, Japan, 669-1337, Sanda, Hyogo, Japan, [ibaraki@kwansai.ac.jp](mailto:ibaraki@kwansai.ac.jp)

To solve problems abundant in real world applications, we have been proposing an approach of using general purpose solvers, since we cannot afford to prepare special purpose algorithms for all individual problems. For this, we developed general purpose solvers for several standard problems such as CSP (constraint satisfaction problem), RCPSP (resource constrained project scheduling problem) and VRP (vehicle routing problem), among others. Their algorithms are all based on metaheuristics which utilize local search as their cores. The solvers have been successfully applied to many applications. In this talk, we report some of our recent experiences, including those for ITC2007 (International Timetabling Competition) and other industrial applications.

#### 2 - The dominance-based rough set approach for decision analysis and operations research

*Salvatore Greco*, Department of Economics and Quantitative Methods, University of Catania, Corso Italia 55, 95129, Catania, Italy, [salgreco@unict.it](mailto:salgreco@unict.it)

Rough set approach proposed by Pawlak at the beginning of eighties can be considered as a mathematical basis for reasoning about data. It has been applied in a large spectrum of domains, ranging from medicine to chemistry, and from biology to finance. Standard rough set theory is not able, however, to deal with ordinal data which are so important for decision problems where they represent preferences. On the basis of this remark, Dominance-based Rough Set Approach (DRSA) has been proposed and developed since mid-nineties. It accepts preference information in the easy form of examples of decisions, and gives as output well understandable "if ..., then ..." decision rules, such as "if objective<sub>1</sub> reaches at least value alpha<sub>1</sub> and objective<sub>2</sub> reaches at least value alpha<sub>2</sub>, then the considered solution is good". The simple input of decision examples and the comprehensible output in terms of decision rules makes of DRSA a decision support "glass box", which contrasts with many existing "black boxes". DRSA has also been successfully applied to decision under uncertainty and time preference. Moreover, DRSA has been integrated with interactive multiobjective optimization procedures, in particular, evolutionary procedures, that can be used to deal with hard operations research problems, like production planning, portfolio selection, scheduling, inventory management, and so on. We present basic ideas of DRSA with an emphasis on its applications in operations research.

### ■ WB-02

Wednesday 09:35-11:05

Schumann

#### Keynote WM2

Stream: Keynote Talks

Keynote session

Chair: *Silvano Martello*, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, [smartello@deis.unibo.it](mailto:smartello@deis.unibo.it)

Chair: *Paolo Toth*, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, [paolo.toth@unibo.it](mailto:paolo.toth@unibo.it)

#### 1 - Routing in graphs with applications to material flow problems

*Rolf Möhring*, Institut für Mathematik, Technische Universität Berlin, Straße des 17 Juni 136, 10623, Berlin, [Rolf.Moehring@TU-Berlin.DE](mailto:Rolf.Moehring@TU-Berlin.DE)

Material flow problems are complex logistic optimization problems. We want to utilize the available logistic network in such a way that the load is minimized or the throughput is maximized. This lecture deals with these optimization problems from the viewpoint of network flow theory and reports on two industrial applications: (1) controlling material flow with automated guided vehicles in a container terminal (cooperation with HHLA), and (2) timetabling in public transport (cooperation with Deutsche Bahn and Berlin Public Transport). The key ingredient for (1) is a very fast real-time algorithm which avoids collisions, deadlocks, and other conflicts already at route computation, while for (2) it is the use of integer programs based on special bases of the cycle space of the routing graph.

References [1] E. Gawrilow, E. Köhler, R. H. Möhring, and B. Stenzel, Dynamic routing of automated guided vehicles in real-time, in Mathematics ? Key Technology for the Future. Joint Projects between Universities and Industry 2004 -2007, W. Jäger and H.-J. Krebs, eds., Springer, 2008, pp. 165—178. [2] C. Liebchen and R. H. Möhring, The modeling power of the periodic event scheduling problem: Railway timetables - and beyond, in Algorithmic Methods for Railway Optimization, F. Geraets, L. Kroon, A. Schöbel, D. Wagner, and C. D. Zaroliagis, eds., vol. 4359 of Lecture Notes in Computer Science, Springer, Berlin/Heidelberg, 2007, pp. 3—40.

#### 2 - 2-dimensional packing problems in telecommunications

*Andrea Lodi*, D.E.I.S., University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, [andrea.lodi@unibo.it](mailto:andrea.lodi@unibo.it)

We consider 2-dimensional packing problems arising from telecommunications applications. In particular, according to WiMAX technology, information is sent to several users within the same frame, and an efficient and fast way to send information and to recover it is required. This leads to interesting 2-dimensional packing problems for which different objective functions can be defined. For a simplified version of the real-world problem we provide an approximation algorithm and different fast heuristics, which turn out to be effective in practice. Finally, computational experiments on a set of real-world instances are presented.

## ■ WB-03

Wednesday 09:35-11:05

Reger

### Keynote WM3

Stream: Keynote Talks

Keynote session

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

#### 1 - Optimal control of manufacturing systems: solution of fluid approximation and tracking by queueing model.

*Gideon Weiss*, Department of Statistics, The University of Haifa, Department of Statistics, The University of Haifa, 31905, Haifa, Israel, gweiss@stat.haifa.ac.il

We consider the optimal control of a large manufacturing system, over a finite time horizon, e.g. a semiconductor wafer fabrication plant.

We model this as a multi-class queueing network. We approximate the queueing network by a fluid network, and obtain an optimal fluid solution by solving a separated continuous linear program (SCLP). To track this fluid solution we model the deviations of the real system from the fluid solution by a multi-class queueing network with infinite virtual queues (IVQ). By keeping these deviations stable we obtain an asymptotically optimal control policy.

We shall explain our motivation and the main features of this approach. We will then introduce the two themes of which it is based: A novel simplex like algorithm for the solution of SCLP, and the modeling device of IVQs.

While this talk combines ideas from Manufacturing, Optimization and Queueing, it will be accessible to a wide audience of EURO members.

#### 2 - Semi-infinite optimization

*Hubertus Th. Jongen*, Dept. Mathematics, RWTH Aachen University, Templergraben 55, 52062, Aachen, Germany, jongen@rwth-aachen.de

Semi-infinite optimization problems (SIP) are problems in finite dimensions with an infinite number of inequality constraints. For example, the index set of inequality constraints might be an interval, a rectangle or a compact manifold with boundary. In case that the latter index set also depends on the state variable, SIP is called a general(ized) semi-infinite optimization problem (GSIP). The structure of GSIP is much more complicated. In this lecture we present a survey on structural results on SIP and GSIP.

## Wednesday 11:20-12:40

### ■ WC-01

Wednesday 11:20-12:40

Beethoven

### Recent advances in combinatorial optimization II

Stream: Combinatorial Optimization

Invited session

Chair: *Andrea Lodi*, D.E.I.S., University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, andrea.lodi@unibo.it

Chair: *Michele Monaci*, D.E.I., University of Padova, Via Gradenigo 6/A, 35131, Padova, Italy, monaci@dei.unipd.it

#### 1 - Intersection cuts revisited

*Egon Balas*, Tepper School of Business, Carnegie Mellon University, 15213, Pittsburgh, PA, United States, eb17@andrew.cmu.edu

Intersection cuts from maximal lattice-free convex sets have recently been investigated to derive cutting planes simultaneously from multiple rows of a simplex tableau. We examine the relationship of these cuts to disjunctive cuts and lift-and-project cuts from multiple-term disjunctions. In the case of 0-1 mixed-integer programs (MIPs), cuts from maximal  $q$ -dimensional lattice-free convex sets are dominated by cuts from  $q$ -term disjunctions, which in turn are rank  $q$  split cuts. For a general MIP, we examine the relation between disjunctive hulls, corner polyhedra and the integer hull.

#### 2 - A polyhedral approach to the single-row facility layout problem

*Adam Letchford*, Department of Management Science, Lancaster University, Management School, LA1 4YX, Lancaster, United Kingdom, A.N.Letchford@lancaster.ac.uk, *Andre Amaral*

The Single Row Facility Layout Problem is the NP-hard problem of arranging facilities of given lengths on a line, while minimizing a weighted sum of the distances between all pairs of facilities. We perform the first ever polyhedral study of this problem. We derive several classes of facet-inducing inequalities, and also point out a connection to the so-called cut cone. We also describe a cutting plane algorithm and present computational results. Finally, we discuss how to adapt the approach to other layout problems.

#### 3 - A branch-and-bound algorithm for the multi-type capacitated facility location problem

*Andreas Kloze*, Department of Mathematical Sciences, University of Aarhus, Ny Munkegade, Building 1530, 8000, Aarhus, Denmark, akloze@imf.au.dk

The multi-type capacitated facility location problem (MCFLP) is to locate a set of facilities and to allocate capacity and customer demands to them, so as to minimize fixed facility, capacity acquisition as well as variable supply costs. We present a branch-and-bound algorithm that is based on Lagrangean relaxation of demand constraints and subgradient optimization. Lagrangean solutions are averaged for primal solution recovery and branching decisions are based on the estimated primal solution to the Lagrangean dual. First computational experiences are reported.

## ■ WC-02

Wednesday 11:20-12:40

Schumann

### Rich Vehicle Routing Problems

Stream: Transportation Planning

*Invited session*

Chair: *Geir Hasle*, Applied Mathematics, SINTEF ICT, P.O. Box 124 Blindern, NO-0314, Oslo, Norway, Geir.Hasle@sintef.no

#### 1 - The cost of regularity in liner shipping

*Jose Fernando Alvarez*, Research & Innovation – Maritime Transport, Det Norske Veritas, Veritasveien 1, BRINO911, 1322, Høvik, Baerum, Norway, jose.fernando.alvarez@dnv.com

In the maritime liner business, several vessels are deployed on a route in order to meet calling frequency expectations. First, the combination of vessels and transshipment points used by the carrier is of no concern to the customer. Second, there exist multiple fleet configurations that could provide a given level of service, but a regularity requirement likely increases fleet operating expenses. We present a model for fleet configuration with and without calling regularity. We use simulation to assess the level of service and robustness of the two alternative designs.

#### 2 - A heuristic for maritime inventory routing

*Oddvar Kloster*, SINTEF ICT, Postboks 124 Blindern, 0314, OSLO, Norway, okl@sintef.no, *Truls Flatberg*

In maritime inventory routing, a fleet of vessels is employed to transport products that are produced and consumed in different ports, in order to keep stock levels in each port legal. In addition, regular bookings/orders may be transported. We describe construction and optimization heuristics that can solve a wide range of problem variants, including pure inventory, pure tramp, mixed, single/multiple products, tank stowage, tank cleaning, boil-off. The results are competitive in cases where a MIP solver is available for comparison.

#### 3 - The node edge arc routing problem - applications and heuristics

*Geir Hasle*, Applied Mathematics, SINTEF ICT, P.O. Box 124 Blindern, NO-0314, Oslo, Norway, Geir.Hasle@sintef.no, *Truls Flatberg*, *Oddvar Kloster*, *Eivind Nilssen*, *Morten Smedsrud*

In the VRP literature, the Arc Routing Problem is often advocated as an adequate model for routing applications such as newspaper delivery and garbage collection. We argue that a better model is the Node Edge Arc Routing Problem (NEARP), combining demand on nodes, edges, and arcs in a transportation network. We describe how we have extended a node based VRP solver to enable modeling and resolution of the NEARP, and network based heuristics for aggregating node-based demand into demands on arcs and edges. Experimental results on standard benchmarks and industrial cases are presented.

## ■ WC-03

Wednesday 11:20-12:40

Reger

### TRAFFIC MANAGEMENT

Stream: Transportation

*Invited session*

Chair: *Tobias Pohlmann*, Institut fuer Verkehr und Stadtbauwesen, Technische Universitaet Braunschweig, Pockelsstr. 3, 38106, Braunschweig, Germany, t.pohlmann@tu-braunschweig.de

#### 1 - Multivariate stochastic time series model for short-term freeway traffic flow forecasting

*Ming-Tsung Lee*, Institut für Verkehrswirtschaft, Straßenwesen und Städtebau, Leibniz Universität Hannover, Appelstr. 9A, 30167, Hannover, Germany, lee@ivh.uni-hannover.de, *Bernhard Friedrich*

Real-time short-term traffic flow forecasting contributes a crucial element to the dynamic traffic management systems. The univariate time series model provides a reasonable predictor and shows accurate performance. However, it performs not well when traffic flow deviates significantly from normal weekly patterns. A multivariate time series model incorporating the neighbor traffic flow is expected to improve this weakness. An empirical study shows that the upstream flow can express the downstream flow. The multivariate model exhibits the ability to trace the traffic flow profile.

#### 2 - A soft computing based model for the simulation of pedestrian roadways crossing decision

*Leonardo Caggiani*, Technical University of Bari, 74100, Bari, Italy, l.caggiani@poliba.it, *Michele Ottomanelli*, *Giuseppe Iannucci*, *Domenico Sassanelli*

The study of pedestrians' gap acceptance at unsignalized road crossings is very attractive for the design of safer urban road network. The interaction between pedestrians and vehicles drivers have a strong non-deterministic components and the representation of such a problem is not immediate. This paper presents a Fuzzy logic based model for simulating of pedestrian crossing behaviour by explicitly considering the imprecision and uncertainty in human perception relevant to the elements that affect the crossing decision. The model has been calibrated through an Adaptive Neural Network

#### 3 - Short term traffic demand estimation for online control strategies

*Tobias Pohlmann*, Institut fuer Verkehr und Stadtbauwesen, Technische Universitaet Braunschweig, Pockelsstr. 3, 38106, Braunschweig, Germany, t.pohlmann@tu-braunschweig.de, *Bernhard Friedrich*

An algorithm for predicting traffic demand in a network for adaptive traffic control strategies will be described. Based on space-time-patterns, link volumes of the next optimization interval are forecasted and checked for redundancies before being used as constraints for the information minimization model to estimate OD matrices. A matrix is repeatedly estimated and assigned to the network until it converges. The assignment assumes stochastic user equilibrium and uses a macroscopic model to get realistic travel times. The method performs well and is sufficiently fast for online applications.

## ■ WC-04

Wednesday 11:20-12:40

Liszt

### Job-Shop Scheduling

Stream: Scheduling

*Invited session*

Chair: *Kun Yuan*, LGIPM / COSTEAM, Universite Paul Verlaine - Metz/INRIA Nancy grand est, Ile du Saulcy, UFR MIM, 57045, Metz, France, [yuankun\\_hust@hotmail.fr](mailto:yuankun_hust@hotmail.fr)

#### 1 - The flexible blocking job shop with transfer and set-up times

*Heinz Gröflin*, Dept. of Informatics, University of Fribourg, Bd de Pérolles 90, 1700, Fribourg, Switzerland, [heinz.groeflin@unifr.ch](mailto:heinz.groeflin@unifr.ch), *Reinhard Bürgy*

We consider a job shop (FBJS) with flexible machines and blocking (a job, after completing an operation, waits on the machine until its next operation starts). Transfer times, passing a job from a machine to the next, and setup times are allowed. The goal is to assign machines and schedule operations, minimizing makespan. A tabu search is proposed based on a disjunctive graph framework of job insertion with local flexibility. Feasible neighbors are generated, moving an operation together with implied moves. Extensive numerical results validate the method and establish benchmarks for the FBJS.

#### 2 - The job-shop scheduling problem with shift-varying production time

*Christian Rathjen*, Economics, University of Wuppertal, Gaußstraße 20, building M, room 12.34, 42119, Wuppertal, Germany, [crathjen@winfor.de](mailto:crathjen@winfor.de), *Stefan Bock*, *Simon Goertz*

In Industries there shift working often takes place and within different working shifts setup times and production times can vary because of shift-based resource capacities. A mathematical formulation of the job-shop scheduling problem with different production and setup times will be presented. A starting heuristic and an improvement method for this problem will be introduced and it will be demonstrated how these heuristics can be adopted to objective functions with practical relevance, such as makespan minimization and the weighted tardiness objective.

#### 3 - A multi-agent learning approach for the job shop scheduling problem

*Yailen Martinez*, VUB, Pleinlaan 2, 1050, Brussels, [yailenm@gmail.com](mailto:yailenm@gmail.com), *Ann Nowe*

In this paper, a Multi-Agent learning approach for the JSSP is proposed, a Q-Learning algorithm is implemented assigning an agent per machine, which will decide which job will be processed next out of a set of currently waiting jobs at the corresponding resource. The behavior of the algorithm is studied using three different cost functions, and on different benchmarks problems from the OR-Library. The approach is compared with other heuristic approaches such as ACO. The results show that our approach yields solutions as good as better than the ACO approach.

#### 4 - A mixed-integer linear programming model and a lower bound for hybrid flow shop scheduling problems with a special blocking

*Kun Yuan*, LGIPM / COSTEAM, Universite Paul Verlaine - Metz/INRIA Nancy grand est, Ile du Saulcy, UFR MIM, 57045, Metz, France,

[yuankun\\_hust@hotmail.fr](mailto:yuankun_hust@hotmail.fr), *Nathalie Sauer*, *Christophe Sauvey*

In this work, we consider scheduling problem of hybrid flowshops composed of identical parallel machines at each stage. The objective is the minimisation of the makespan. Contrarily to classical blocking, where the machine remains blocked until the job starts on the next machine in the routing, we consider special blocking which exists in certain industrial situations like waste treatment plants or aeronautics parts fabrications. In this case, the machine stays blocked until one job has finished its operation on the next machine. We present an MILP and a lower bound to solve this problem.

## ■ WC-05

Wednesday 11:20-12:40

Haydn

### Scheduling Heuristics

Stream: Scheduling

*Invited session*

Chair: *Prabha Sharma*, Mathematics and Statistics, Indian Institute of Technology, Kanpur, Deptt. of Mathematics and Statistics, I. I. T. Kanpur, 208016, Kanpur, U. P., [prabha@iitk.ac.in](mailto:prabha@iitk.ac.in)

#### 1 - Comparison of meta-heuristics for the single machine scheduling problem

*Veronique Sels*, Faculty of Economics and Business Administration, Ghent University, Faculteit Economie en Bedrijfskunde, Tweeackerstraat 2, 9000, Gent, Oost Vlaanderen, Belgium, [veronique.sels@ugent.be](mailto:veronique.sels@ugent.be), *Mario Vanhoucke*

We consider the problem of scheduling  $n$  jobs with release times and due dates, on a single machine with the objective of minimizing the maximum lateness. This problem often occurs as a subproblem in solving more complex scheduling environments such as flow shops or job shops. We developed various meta-heuristics and compared their performance on diverse datasets. Computational results revealed that there exist problem instances where some heuristics are dominated by others. We extended our study to other similar single machine-scheduling problems with promising results.

#### 2 - A flexible multi-objective scheduling system based on configurable heuristics

*Jorge Pinho de Sousa*, INESC Porto / FEUP, Campus da FEUP, Rua Dr. Roberto Frias, 4200-465, Porto, Portugal, [jsousa@inescporto.pt](mailto:jsousa@inescporto.pt), *Luis Guardao*

In this work we present a flexible, multi-objective scheduling system to tackle extensions of the classic job-shop problem. For this purpose, a simple general framework has been developed. First jobs are sequenced by hybrid constructive heuristics. Then a scheduling algorithm creates a plan for the operations. A kind of randomized local search procedure is then used to improve the job sequences. The algorithm was embedded in a DSS constructed around a powerful, interactive Gantt chart. Computational results obtained for real complex applications are very promising.

#### 3 - A hybrid metaheuristic for machine scheduling in cell formation problems

*Grammatoula Papaioannou*, The Business School, Loughborough University, Ashby Road, LE11 3TU, Loughborough, United Kingdom, [g.papaioannou@lboro.ac.uk](mailto:g.papaioannou@lboro.ac.uk), *John Wilson*

The paper describes an IP model for the cell formation problem with part-machine assignment and cell formation addressed simultaneously and part machine operation sequence taken into account. Due to the NP-hard nature of the problem a three stage heuristic approach is first proposed to generate an initial solution which is fed into a hybrid metaheuristic. The hybrid metaheuristic involves a tabu search approach and a greedy heuristic algorithm. Simulations verified the robustness of the proposed algorithm, and its effectiveness for large scale data sets.

## ■ WC-06

Wednesday 11:20-12:40

Koch

### GOR Dissertation Awards

Stream: GOR-Awards

*Invited session*

Chair: *Stefan Nickel*, Institut fuer Operations Research, Universitaet Karlsruhe, Geb 11.40, 76128, Karlsruhe, Baden-Wuerttemberg, Germany, [Stefan.Nickel@kit.edu](mailto:Stefan.Nickel@kit.edu)

Chair: *Uwe T. Zimmermann*, Institute of Mathematical Optimization, TU Braunschweig, Pockelsstrasse 14, 38106, Braunschweig, Germany, [u.zimmermann@tu-bs.de](mailto:u.zimmermann@tu-bs.de)

#### 1 - Extending concepts of reliability

*Sebastian Stiller*, Institut für Mathematik, Technische Universität Berlin, 10623, Berlin, Berlin, Germany, [stiller@math.tu-berlin.de](mailto:stiller@math.tu-berlin.de)

Recoverable robustness combines the virtues of classical robust optimization and stochastic programming. A solution is recovery robust, if it can be recovered by a limited effort in every likely scenario. We develop the theory and efficient algorithms for the case of linear recovery. We devise the first, best possible, constant factor approximate feasibility test for arbitrary multiprocessor sporadic real-time scheduling instances. We give the first non-trivial analysis of a network creation game with exponential payoff function. We determine its Price of Anarchy exactly.

#### 2 - Waiting time and product age distribution of a (r,s)-inventory policy.

*Lars Fischer*, Department of Supply Chain Management and Production, University of Cologne, Albertus-Magnus-Platz, 50859, Cologne, Germany, [euro-online.uni@larsfischer.de](mailto:euro-online.uni@larsfischer.de)

We analyse a (r,S)-inventory policy under stochastic demand. Two customer oriented service criteria are considered: First the probability distribution of the waiting time which is important from the perspective of the customer since his contentment depends on the time until his order is filled. Second the probability distribution of the product age which is relevant for perishable goods, e.g. food or medicine, where product age dependent costs affect the optimal inventory policy. We consider both periodic and sporadic demand with arbitrarily distributed times between orders (compound demand).

#### 3 - Neural networks for simultaneous forecasting and inventory level estimation - an experimental evaluation on synthetic and empirical retail time series

*Sven F. Crone*, Department of Management Science, Lancaster University Management School, Bailrigg Campus, LA1 4YX, Lancaster, United Kingdom, [s.crone@lancaster.ac.uk](mailto:s.crone@lancaster.ac.uk)

In forecasting for inventory management, neural networks (NN) are conventionally parameterised using squared error loss criteria. This thesis extends NNs to the use of arbitrary objective functions of decision costs. Using asymmetric costs of over- and under-forecasting, NNs are expanded beyond conventional point predictions towards a direct estimation of cost minimal inventory levels. The accuracy of NN in forecasting and inventory performance is evaluated in a representative evaluation across multiple synthetic and empirical retail time series in comparison to statistical benchmark methods.

#### 4 - Advanced planning concepts for mixed-model assembly systems

*Malte Fliedner*, Wirtschaftswissenschaftliche Fakultät, Friedrich-Schiller-Universität Jena, Carl-Zeiss-Strasse 3, 07743, Jena, Thüringen, Germany, [malte.fliedner@uni-jena.de](mailto:malte.fliedner@uni-jena.de)

Manufacturing companies in several fields of business have adopted mass customization strategies in order to tailor their products according to customer needs. This typically requires the implementation of cost-efficient, flexible production systems, such as mixed-model assembly lines, which are extremely popular in the production of automobiles and electronic consumer goods. Based on comprehensive classification of prior research, we develop innovative planning concepts and solution algorithms for the core problems of strategic assembly line balancing and short-term mixed-model sequencing.

## ■ WC-07

Wednesday 11:20-12:40

GSI - S 29

### Transit network design problems with elastic demand

Stream: Optimization in Public Transport

*Invited session*

Chair: *Mariano Gallo*, Dipartimento di Ingegneria, Università degli Studi del Sannio, Piazza Roma 21, 82100, Benevento, Italy, [gallo@unisannio.it](mailto:gallo@unisannio.it)

#### 1 - The transit network design problem with elastic demand and internalisation of external costs

*Mariano Gallo*, Dipartimento di Ingegneria, Università degli Studi del Sannio, Piazza Roma 21, 82100, Benevento, Italy, [gallo@unisannio.it](mailto:gallo@unisannio.it), *Bruno Montella*, *Luca D'Acerno*

In this paper we study the transit network design problem with elastic demand. We propose a multimodal optimisation model that considers an objective function equal to the sum of (car and transit) user costs, firm costs, external costs (air pollution, noise, etc.) and other social costs. In the proposed model external costs are considered in the objective function and optimised taking into account the effects of improving the LOS of transit system on modal share and, therefore, on the external costs. The proposed model is tested for optimising the services on a Regional Metro System.

#### 2 - A bus network design procedure with elastic demand

*Ernesto Cipriani*, Dept. Civil Engineering, University of Roma TRE, Via Vito Volterra 62, 00146, Roma, Italy, [ecipriani@uniroma3.it](mailto:ecipriani@uniroma3.it), *Stefano Gori*, *Marco Petrelli*

The paper deals with the transit network design problem that is formulated as an optimization problem consisting in the minimization of all resources and costs related to the transport system, subject to bus capacity constraints and a set of feasibility constraints on route length and line frequency. The new procedure solves the transit network design problem in a multimodal, demand elastic urban context, explicitly taking into consideration the relationships among modal split, level of transit services and externalities.

### 3 - A heuristic algorithm for optimizing frequencies in a transit network

*Eusebio Angulo Sánchez-Herrera*, Mathematics, Escuela Superior de Informática, Universidad de Castilla La Mancha, Paseo de la Universidad, 4, 13071, Ciudad Real, Castilla La Mancha, Spain, Eusebio.Angulo@uclm.es, *Ricardo Garcia*

This paper dealt with the problem of optimizing frequencies in a transit network in a context of medium-term planning. It is assumed that the size of the fleet can be a variable and requires to be decided. The model is formulated as a bi-level optimization problem. An heuristic algorithm for the integer bilevel model has been proposed. It is based on the optimality conditions of Karush-Kuhn-Tucker (KKT). A computational experience on the rapid transit network of Seville has been carried out. The convergence of the algorithm is shown in the numerical tests.

### 4 - The route deviation bus model compared to a real low transit demand service management

*Antonio Pratelli*, Dept. of Civil Engineering, University of Pisa, Largo Lazzarino 1 (ex Via Diotalalvi 2), 56126, Pisa, Italy, antonio.pratelli@ing.unipi.it

We present the design analysis performed on a real network through a new model for the bus deviation route problem, or RDBP, which is based on mixed integer linear programming. The study network is placed in Campi Bisenzio, a small town close to Florence. This urban area is characterized by a low level of the transit demand during the major part of a day. First, the RDB problem is briefly summarized. Second, the results drawn from the model application to the Campi Bisenzio instance are shown in comparison with the existing on-demand service managed as a mixed operations dial-a-ride system.

## ■ WC-08

Wednesday 11:20-12:40

GSI - S 30

### Capacity Planning

Stream: Supply Chain Management

*Invited session*

Chair: *Youssef Boulaksil*, School of Industrial Engineering, Eindhoven University of Technology, PAV E16, P.O. Box 513, 5600MB, Eindhoven, Netherlands, Y.Boulaksil@tue.nl

### 1 - Permanent and contingent workforce budgeting under stochastic demand

*Nico Dellaert*, IE&IS, Technische Universiteit Eindhoven, Postbus 513, 5600MB, Eindhoven, n.p.dellaert@tue.nl, *Jully Jeunet*

We model budgeted services with permanent and contingent capacity costs. We consider a stochastic demand of tasks to be performed. No backordering of tasks is allowed, capacity shortages are penalized in each week. We optimize the permanent capacity at the start of the year and the contingent capacity based on the weekly demand, several models are developed, with hard and soft budget constraints, and different capacity shortage penalty cost functions. We provide analytical results and perform numerical experiments, showing among others the optimal budget spending patterns.

### 2 - On the optimal product assortment

*Simme Douwe Flapper*, Technische Universiteit Eindhoven, Netherlands, s.d.p.flapper@tm.tue.nl

Which products should be in the product assortment/portfolio of a company if part or all of the (potential) customers only order if the company can deliver timely all desired quantities for all products the customer is interested in (one-stop-shopping concept)? Mathematical models to calculate the consequences of using two of the most often used strategies (product based vs. customer based) are given for a producer confronted with limited capacity, setup times and setup cost. The results for a case study in practice are presented, as well as suggestions for further research.

### 3 - The contract manufacturer's portfolio management - optimal allocation of production flexibility

*Youssef Boulaksil*, School of Industrial Engineering, Eindhoven University of Technology, PAV E16, P.O. Box 513, 5600MB, Eindhoven, Netherlands, Y.Boulaksil@tue.nl, *Martin Grunow*, *Jan C. Fransoo*

We consider a contract manufacturer who serves a number of out-sourcers (customers) on the same capacitated production line. The out-sourcers have different risk profiles and the contract manufacturer faces the question of how to optimize its portfolio, i.e. how to allocate the production flexibility in an optimal way. We develop a mathematical programming model and perform a simulation study by solving the model in a rolling horizon setting. The simulation results reveal interesting managerial insights, which are helpful for managers when having negotiations with the out-sourcers.

## ■ WC-09

Wednesday 11:20-12:40

GSI - S 5

### Rostering in the Services Industry

Stream: Timetabling and Rostering

*Invited session*

Chair: *Jonas Bæklund*, Department of Mathematical Sciences, Aarhus University, Ny Munkegade 118, 8000, Aarhus, Denmark, baeklund@imf.au.dk

### 1 - A solution for workforce supply chain management in an outsourcing environment

*Changrui Ren*, IBM China Research Lab, Building 19 Zhongguancun Software Park, 8 Dongbeiwang WestRoad, Haidian District, 100193, Beijing, rencr@cn.ibm.com

Workforce is crucial to the success of service industry, especially for those software and consulting firms, where much of their revenue comes from the assignment of highly-skilled professionals. This is even more critical in the outsourcing environment, under which some of the professionals are outsourced from external vendors. This paper studies on how to hire/assign right people at the right time for the right project with the right cost in the outsourcing environment. Based on the concept of "workforce supply chain", the demand and supply matching problem is mainly discussed.

## 2 - Automatic generation of optimized working time models in personnel planning

Maik Günther, TU Ilmenau, Baumkirchner Straße 29a, 81673, München, Germany, maik.guenther@gmx.de,  
Volker Nissen

The practical problem concerns a department store with different sales positions where 16 employees are assigned, each with different contract terms. The personnel requirement per position is defined in one-hour increments. There are no set working time models, rather a min. and max. length of time. Working time models are automatically generated during planning, which should cover demand and also consider the availability of employees, their weekly time target and flextime status. Sub-daily position changes are allowed. Planning is done for an entire year using different meta-heuristics.

## 3 - Heuristic approach with branch and bound to solving nursing scheduling problem

Lakhdar Djeflal, Universit Hadj-lakhdar, 05000, Batna, Algeria, lakdar\_djeflal@yahoo.fr

Properly scheduling the nursing staffs has a great impact on the development of nursing budgets. The goal in prospect is to balance the trade-off between staffing coverage and schedule preferences of individual nurses. In order to address this problem, we use a PCSP model which consist of a constraint satisfaction problem and objective function, and we describes a technique that combined heuristic approach with branch and bound to solving scheduling problem. The search of solution can be guided by a value ordering heuristic that attempts to minimize the number of violations after each step.

## 4 - Nurse rostering - an overview.

Jonas Bæklund, Department of Mathematical Sciences, Aarhus University, Ny Munkegade 118, 8000, Aarhus, Denmark, baeklund@imf.au.dk

Nurse rostering is a complex scheduling problem, occurring every month in every hospital around the world. Efficient solution methods, that create good solutions are required, since schedules impact the quality of health care, the requirement of nurses, and the hospitals' budgets. Solutions methods range from ILP models, constraint satisfaction, Lagrangean relaxation and column generation to manual scheduling as well as heuristics of all kinds. This paper presents an overview of different recent solutions methods suggested for this problem.

## WC-10

Wednesday 11:20-12:40

GSI - S 6

### Vector and Set-Valued Optimization II

Stream: Vector and Set-Valued Optimization

Invited session

Chair: César Gutiérrez, Departamento de Matemática Aplicada, Universidad de Valladolid, E.T.S.I. Informática, C<sup>o</sup>. Cementerio s/n, Campus Miguel Delibes, 47011, Valladolid, Spain, cesargv@mat.uva.es

## 1 - Box constrained multi-objective optimization: a gradient-like method without "a priori" scalarization

Elena Molho, Dipartimento di Economia Politica e Metodi Quantitativi, Università di Pavia, Via San Felice 5, 27100, Pavia, Italy, molhoe@eco.unipv.it,  
Enrico Miglierina, Maria Cristina Recchioni

We formulate an interior point algorithm without "apriori" scalarization based on gradient-like directions to solve a box-constrained multiobjective optimization problem. We prove the convergence of the algorithm to the critical points of the considered problem, where the classical Kuhn-Tucker first order optimality conditions for the multi-objective box-constrained problem are satisfied. A numerical validation of the algorithm is carried out through direct calculations on test functions proposed in the literature.

## 2 - The geometry of strict maximality

Enrico Miglierina, Dipartimento di Economia, Università dell'Insubria, via Monte Generoso 71, 21100, Varese, Italy, enrico.miglierina@uninsubria.it,  
Emanuele Casini

The notion of strictly maximal point is a solution concept that plays an important role in the study of the stability and well-posedness of vector optimization problems. We study some geometrical aspects of this notion. More precisely we individuate some relationships between strict maximality and the properties of the bases of the ordering cone. In order to prove this result a new characterization of the existence of a bounded base for a closed convex cone is given. Moreover we link strict maximality to the geometrical notion of strongly exposed points of a given set.

## 3 - On continuity properties in vector optimization

Ruben Lopez, Departamento de Matematica y Fisica Aplicadas (DMFA), Universidad Catolica de la Santisima Concepcion, Alonso Ribera 2850, 409-0541, Concepcion, VIII Region, Chile, rlopez@ucsc.cl,  
César Gutiérrez, Vicente Novo

In this work, we study continuity properties of various mappings that appear when dealing with vector optimization problems. To do this end we employ a new type of convergence for vector valued-mappings.

\* This work has been supported by Proyecto FONDECYT de Iniciación en Investigación 11060015 through CONICYT-Chile.

## 4 - On the characterization of approximate efficiency in vector optimization via approximate solutions of some scalarized problems

César Gutiérrez, Departamento de Matemática Aplicada, Universidad de Valladolid, E.T.S.I. Informática, C<sup>o</sup>. Cementerio s/n, Campus Miguel Delibes, 47011, Valladolid, Spain, cesargv@mat.uva.es, Bienvenido Jiménez, Vicente Novo

This talk concerns with the characterization of approximate solutions of vector optimization problems via scalarization processes. Two properties on the sublevel sets at zero of the scalarization mapping are introduced, from which necessary and sufficient optimality conditions for approximate efficient solutions are deduced through approximate solutions of the scalarized problem. By these properties one can easily propose scalarization processes to solve approximately a vector optimization problem through scalar optimization problems. Some examples are showed that illustrate this approach.

## WC-11

Wednesday 11:20-12:40

GSI - S 17

### Robust ordinal regression

Stream: Multiple Criteria Decision Analysis

Invited session

Chair: Salvatore Greco, Department of Economics and Quantitative Methods, University of Catania, Corso Italia 55, 95129, Catania, Italy, salgreco@unict.it

### 1 - The most representative value function in robust multiple criteria sorting

Salvatore Greco, Department of Economics and Quantitative Methods, University of Catania, Corso Italia 55, 95129, Catania, Italy, [salgreco@unict.it](mailto:salgreco@unict.it),  
 Milosz Kadzinski, Roman Slowinski

Recently a method based on robust ordinal regression, UTADIS-GMS, has been proposed to deal with multiple criteria sorting. It considers the whole set of value functions coupled with a set of thresholds representing exemplary assignments given by the DM. Application of UTADISGMS results in a necessary and a possible sorting. In order to ease interpretation of these results, we propose a methodology permitting to build the most representative value function taking into account the necessary and possible sortings.

### 2 - Non-additive robust ordinal regression with choquet integral

Benedetto Matarazzo, Department of Economics and Quantitative Methods, Faculty of Economics - University of Catania, Corso Italia, 55, 95129, Catania, Italy, [matarazz@unict.it](mailto:matarazz@unict.it), Silvia Angilella, Salvatore Greco

In this presentation, we want to give the basis of a general methodology for non-additive robust ordinal regression, for Choquet integral and its generalizations (therefore also the bipolar Choquet integral) in the whole spectrum of decision problems, i.e. not only ranking and choice, but also multicriteria classification. The proposed non-additive robust ordinal regression takes inspiration from the robust ordinal regression, recently proposed in the multicriteria methodologies UTAGMS, GRIP and UTADISGMS.

### 3 - The possible and necessary approach for robustness analysis in decision aid and operations research

Vincent Mousseau, LGI, Ecole Centrale Paris, Grande voie des vignes, 92 295, Chatenay Malabry, France, [vincent.mousseau@ecp.fr](mailto:vincent.mousseau@ecp.fr), Salvatore Greco, Roman Slowinski

To deal with robustness concerns, we consider decision problems in terms of a set of possible worlds (scenarios). Each possible world is characterized by a specific instantiation of data used for problem formulation and by a preference relation on the space of the objective values. An alternative is necessarily preferred to another if it is preferred in all possible worlds, and it is possibly preferred if it is preferred in at least one possible world. Credibility degree of possible worlds can be considered in this context. We illustrate these concepts on a multiobjective knapsack problem.

## ■ WC-12

Wednesday 11:20-12:40

GSI - S 18

### MCDA: Theory, Computations, and Applications II

Stream: Multiple Criteria Decision Analysis

Invited session

Chair: José Rui Figueira, Instituto Superior Tecnico, Technical University of Lisbon, Av. Cavaco Silva, Tagus Park, 2780 - 990 Porto Salvo, 2780 - 990, Lisbon, Portugal, [figueira@ist.utl.pt](mailto:figueira@ist.utl.pt)

#### 1 - Some decomposition-coordination methods for multi-objective optimization

Otu Vaarmann, Dep. of Mathematics, Tallinn University of Technology, 19086, Tallinn, Estonia, [vaarmann@staff.ttu.ee](mailto:vaarmann@staff.ttu.ee), Alar Leibak

In this talk we present some results concerning the study of two most widely used decomposition-coordination approaches based on either the generation of feasible or non-feasible points respectively. For finding proper values of coordination parameters some rapidly convergent iterative methods are developed if the feasible approach is used. For the non-feasible approach a few gradient-type methods are studied.

#### 2 - Multiobjective decomposition of positive integer matrix: application to radiotherapy

Thibaut Lust, Laboratory of Mathematics and Operational Research, Faculté Polytechnique de Mons, 9, rue de Houdain, 7000, Mons, Belgium, [thibaut.lust@fpms.ac.be](mailto:thibaut.lust@fpms.ac.be), Jacques Teghem

We consider the following problem: to decompose a positive integer matrix into a linear combination of binary matrices that respect the consecutive ones property. This problem occurs in intensity-modulated radiotherapy treatment. The aim is to find a decomposition that minimizes the irradiation time, and the setup-time to configure a multi-leaf collimator at each step of the decomposition. We propose for this NP-hard multiobjective problem a heuristic method, based on the Pareto local search method. Experimentations are carried out on different size instances and the results are reported.

#### 3 - Modifying roc curve for diagnostic systems with more than two classes

Kasirga Yildirak, IAM, METU, 06531, Ankara, Turkey, [kasirga@metu.edu.tr](mailto:kasirga@metu.edu.tr), Efsun Kürüm, Gerhard-Wilhelm Weber

In diagnostic tests, to classify a population into more than two classes is also very important. As ROC curve analysis is weak in validation of the systems with more than two classes, it needs improvement. We optimize the ROC curve as an objective on discrimination power and introduce constraints preventing the length for each class from becoming too small. We combine both aims in a multiobjective program, and treat a resulting regression problem by Levenberg-Marquardt method and special techniques. Various applications in medicine and finance are discussed, and a conclusion is given.

## ■ WC-13

Wednesday 11:20-12:40

GSI - S 31

### Competitive location 1

Stream: Location Analysis

Invited session

Chair: Blas Pelegrin, Statistics and Operations Research, University of Murcia, Spain, [pelegrin@um.es](mailto:pelegrin@um.es)

#### 1 - A discrete competitive facility location model with variable attractiveness

Hande Kucukaydin, Industrial Engineering, Bogazici University, Bogazici University Industrial Engineering Department, Bebek-Istanbul-Turkey, 34342, Istanbul, Turkey, [hande.kucukaydin@boun.edu.tr](mailto:hande.kucukaydin@boun.edu.tr), Necati Aras, I. Kuban Altinel

We consider the discrete version of the competitive facility location problem in which new facilities have to be located by a new market entrant firm to compete against already existing ones that may belong to one or more competitors. The objective of the firm is to determine the locations of the new facilities and their attractiveness levels to maximize the profit. We formulate a mixed-integer nonlinear programming model for this problem and propose three methods for its solution: a Lagrangean heuristic, two branch-and-bound methods using Lagrangean and nonlinear programming relaxations.

## 2 - Strategic multi-store opening under financial constraint

*Nobuo Matsubayashi*, Faculty of Science and Technology, Keio University, Hiyoshi 3-14-1, Kohoku-ku, 223-8522, Yokohama, Japan, nobuo\_m@ae.keio.ac.jp

This paper analyzes strategic store openings in a situation in which firms can open multiple stores depending on the financial constraints of the firm. Specifically, given any upper limit of the number of store openings that two potentially symmetric firms can open, they sequentially determine the number of store openings, including their locations, to maximize their profits. As a result of our analysis in a microeconomic framework, we show that the equilibrium location strategy can be clearly classified into the two opposite strategies according to the level of their financial constraints.

## 3 - Competitive location modeling for hub-and-spoke transportation systems

*Mihiro Sasaki*, Information Systems and Mathematical Sciences, Nanzan University, 27 Seirei, 489-0863, Seto, Aichi, Japan, mihiro@nanzan-u.ac.jp, *James Campbell*, *Mohan Krishnamoorthy*, *Andreas Ernst*

Hub-and-spoke networks play an important role in many transportation networks. We present a competitive Stackelberg hub arc location model that locates arcs with discounted transport costs connecting pairs of hub facilities. Two mechanisms are presented to allocate passengers between the two firms based on their relative travel costs and travel distances. Results with up to three hub arcs for each competing firm show the role of a competitive environment in designing transportation systems.

## 4 - Avoiding the cannibalization effect caused by firm expansion

*Blas Pelegrin*, Statistics and Operations Research, University of Murcia, Spain, pelegrin@um.es, *Pascual Fernandez*, *María D. García*

We propose a location model for firm expansion in which the cannibalization effect is taken into account. Demand in each market is price-sensitive and given by a known decreasing function of price. As result of the expansion, a pre-existing facility owned by the expanding firm may lose profit. This negative effect can be avoided by side payments to compensate the cannibalized facilities for their losses. We show some discretization results when location candidates are points on a network, and solve some test problems for different configurations of the parameters of the model.

## WC-14

Wednesday 11:20-12:40

GSI - S 32

### Inventory Management III

Stream: Inventory Management

*Invited session*

Chair: *Ying Wei*, Universite catholique de Louvain, CORE, Voie du Roman Pays 34, 1348, Louvain-la-Neuve, Belgium, ying.wei@uclouvain.be

#### 1 - Optimal inventory policy under supply reliability and demand cancellation

*Wee Meng Yeo*, Singapore Institute of Manufacturing Technology, 71 Nanyang Drive, 638075, Singapore, Singapore, yeowm3@singnet.com.sg

We consider a periodic review inventory system with supply reliability and demand cancellation issues. The optimal inventory policy is dependent on the supply reliability and cancellation behavior of the customer. We also investigate the impact of supply uncertainty and demand cancellation on the performance of the supply chain. We develop a model to quantify the importance of encouraging low cancellation behavior and reducing variability supply reliability. The single and multiple periods are studied. Finally, we show that an order-up-to policy is optimal.

#### 2 - Investigating advantages of advanced demand information under heterogeneous demand

*Bisheng Du*, Department of Business Studies, Aarhus School of Business, University of Aarhus, Fuglesangs Alle 4, DK-8210 Aarhus V, 8210, Aarhus V, Aarhus, Denmark, bisd@asb.dk, *Christian Larsen*

We study an inventory system operated by a base stock policy. There are two customer classes that must be served. One customer class, Class 1, does not provide any advanced demand information at all, while the other, Class 2 does. Using the service measures, order fill rate and volume fill rate, we will investigate the magnitude of discrepancy in service between these two customer classes, as well as identifying the cases where customer Class 2 is rewarded by their advanced demand information, by having the best service among the two classes.

#### 3 - Modeling and managing the variability in supply chains with the peakedness

*Ying Wei*, Universite catholique de Louvain, CORE, Voie du Roman Pays 34, 1348, Louvain-la-Neuve, Belgium, ying.wei@uclouvain.be, *Philippe Chevalier*, *Jean-François Macq*, *Jean-Christophe Van den Schrieck*

We introduce a novel way to measure the variability of flows in supply chains, the peakedness. We are able to estimate the peakedness from individual as well as batch arrival data. We can also characterize demand, forecast and inventory variables based on the peakedness functional. Our results hold for single stage inventory system, multistage inventory system, and a tree-structured supply chain with single supplier and multiple retailers. Furthermore, the peakedness can be applied to study traditional inventory models such as quantifying bullwhip effects, and inventory pooling effects.

## WC-15

Wednesday 11:20-12:40

Einstein

### Complexity and Optimization II

Stream: Complexity and Optimization

*Invited session*

Chair: *Marco Chiarandini*, Dept. of Mathematics & Computer Science, University of Southern Denmark, Campusvej 55, 5230, Odense, Denmark, marco@imada.sdu.dk

#### 1 - A new approach to proving the np-hardness of discrete optimization problems

*Yakov Shafransky*, United Institute of Informatics Problems, Surganov str. 6, 220012 Minsk, Belarus, 220012, Minsk, Belarus, shafr-04@yandex.ru, *T.C. Edwin Cheng*, *C.t. Ng*

We present a situation in which the standard approach to proving the NP-hardness of optimization problems fails to work due to the NP-hardness of computing objective function values of a scheduling problem under study. For a special case of this problem, we establish that constructing an optimal schedule takes polynomial time while computing the objective function value is NP-hard. We provide a new approach to proving the NP-hardness of optimization problems without the need to compute the objective function values, and use this approach to prove the NP-hardness of the problem under study.

## 2 - An improved heuristic algorithm for the set covering

*Tsahi Avrahami*, Hativat Alexandroni 7/44, 47307, Ramat-Hasharon, tsahiavr@zahav.net.il, Amnon Gonen

The set covering problem is well known as an NP-complete problem. A common heuristic family of algorithms that solves the problem is the Greedy type algorithms. In this study we have to cover  $N$  sites by allocating minimum number of servers. The study compares the Improved Heuristic Algorithm (IHA) with the Greedy one. The results showed that in most cases, for symmetric servers, the IHA finds a better solution. For big problems of above 600 sites, the probability to find a better solution is above 80%. However, the computing time of the IHA is much higher than the greedy one

## 3 - Testing membership in the 0, 1/2-closure is strongly np-hard, even for polytopes contained in the n-dimensional 0/1-cube

*Sebastian Pokutta*, Department of Mathematics, Technical University of Darmstadt, Alois-Eckert-Str. 4, 60528, Frankfurt, Germany, sebastian.pokutta@mac.com, Adam Letchford, Andreas S. Schulz

Caprara and Fischetti introduced a class of cutting planes, called 0,1/2-cuts, which are valid for arbitrary integer linear programs. They also showed that the associated separation problem is strongly NP-hard. We show that separation remains strongly NP-hard, even when all integer variables are binary, even when the integer linear program is a set packing problem, and even when the matrix of left-hand side coefficients is the clique matrix of a graph containing a small number of maximal cliques. In fact, we show these results for the membership problem, which is weaker than separation.

## WC-16

Wednesday 11:20-12:40

Koenig

### Preference Learning from Data I

Stream: Preference Learning from Data

*Invited session*

Chair: *Roman Slowinski*, Institute of Computing Science, Poznan University of Technology, Laboratory of Intelligent Decision Support Systems, Street Piotrowo 2, 60-965, Poznan, Poland, roman.slowinski@cs.put.poznan.pl

#### 1 - Learning to rank from ordered class information: a new approach based on pairwise classification

*Eyke Hüllermeier*, Philipps-Universität Marburg, 35032, Marburg, Germany, eyke@mathematik.uni-marburg.de, Johannes Fürnkranz

In this presentation, we discuss various approaches for tackling ordinal classification problems via a reduction to multiple binary classifiers. After a review of various approaches that have been proposed in the past, we focus on a theoretical discussion of the relation between ordinal classification and ranking. To that end, we consider extensions of the definition of the well-known area under the ROC curve from to case of binary classification to the case of ordinal (multi-class) classification, and discuss its relation to a well-known extension for the unordered multi-class case.

#### 2 - Learning of label ordering for ordered and non-ordered classification

*Philippe Fortemps*, MathRO, Faculty of Engineering, Mons, Belgium, Rue de Houdain, 9, 7000, Mons, Belgium, philippe.fortemps@fpms.ac.be, Salvatore Greco, Roman Slowinski

Label ordering is a frequently considered classification problem where for each object characterized by multiple attributes, one is looking for an order of class labels according to decreasing credibility of assignment. The order of labels can be partial or total. The core of proposed methodology is based on conversion of ordered or non-ordered classification problems into a formulation which can be handled by the Dominance-based Rough Set Approach (DRSA). Our approach considers also the possibility of monotonicity constraints between attribute values and class labels.

#### 3 - Multi-criteria ranking using dominance-based rough set approach

*Marcin Szelag*, Institute of Computing Science, Poznan University of Technology, ul. Piotrowo 2, 60-965, Poznan, Poland, marcin.szelag@cs.put.poznan.pl, Roman Slowinski, Salvatore Greco

We apply the Dominance-based Rough Set Approach to the multi-criteria ranking problem. First, the decision maker compares pairwise some alternatives. Then, we calculate rough approximations of preference relations. These approximations are the basis for induction of decision rules, which imply a preference graph in the complete set of alternatives. Finally, this graph is exploited using a ranking procedure. As it is known, no procedure satisfies all desirable properties. Therefore, we identify procedures non-dominated with respect to a core of desirable properties.

#### 4 - Preference learning in interactive multiobjective optimization

*Roman Slowinski*, Institute of Computing Science, Poznan University of Technology, Laboratory of Intelligent Decision Support Systems, Street Piotrowo 2, 60-965, Poznan, Poland, roman.slowinski@cs.put.poznan.pl, Salvatore Greco, Benedetto Matarazzo

We present three cases of preference learning in interactive multiobjective optimization (MOO). In all cases, the DM is just asked to indicate relatively good solutions in a current sample. The preference model is a set of decision rules inferred by Dominance-based Rough Set Approach (DRSA). The most complex case involves multiple objectives and uncertainty. Feasible solutions are characterized by some quantiles of distributions of objectives over possible scenarios. DRSA based on first- or second-order stochastic dominance is producing decision rules exploited by an evolutionary MOO.

## ■ WC-17

Wednesday 11:20-12:40

Rheinaue

### Structures and Algorithms on Graphs

Stream: Graphs and Networks

Invited session

Chair: *Marc Demange*, ESSEC Business School, avenue B. Hirsch, BP 50105, 95021, Cergy Pontoise, France, demange@essec.edu

#### 1 - Accelerating $A^*$ : smart search for and usage of seg-lines

*Felix Hahne*, Betriebswirtschaft und Wirtschaftsinformatik, Stiftung Universität Hildesheim, Samelsonplatz 1, 31141, Hildesheim, Germany, hahne@bwl.uni-hildesheim.de, *Curt Nowak*, *Klaus Ambrosi*

For shortest-path problems based on real world road-maps, the number of iterations of  $A^*$  can be decreased by using a tighter estimator for the remaining distance to the target than the Euclidian. Obstacles ignored by the Euclidian can in contrast be taken into account by using segmentation lines (SegLines) modeling their extent and yielding a better estimator. We will both identify obstacles precisely and smartly sketch their shape with SegLines algorithmically. Furthermore different techniques are presented on how to efficiently exploit this information to accelerate  $A^*$ .

#### 2 - Recognising twin-constrained Hamiltonian threshold graphs

*Kai Helge Becker*, Department of Management, London School of Economics, Operational Research Group, Houghton Street, WC2A 2AE, London, United Kingdom, k.h.becker@lse.ac.uk

For an undirected graph  $G$  with an even number of nodes and a bijective function  $b$  on the node set that assigns to each node  $i$  a "twin node"  $b(i)$ , we define a graph  $G'$  by adding to  $G$  the edges  $i, b(i)$ . We call  $G$  "twin-constrained Hamiltonian with respect to  $b$ " if there exists a Hamiltonian cycle on  $G'$  in which every node has its twin node as successor (or predecessor). We analyse the case where  $G$  is a threshold graph (TG) and show how, for a given  $b$ , twin-constrained Hamiltonian TGs can be recognized in polynomial time. The problem has an application in the paper industry.

#### 3 - Some characterization of different classes of $G$ -graphs

*Cerasela Tanasescu*, ESSEC Business School, Bucharest, Romania, tanasescu@essec.edu

There are significant interactions between group theory and graph theory. An example is provided by Cayley Graphs. Their regularity and underlying algebraic offers many applications of these graphs in the frame of communication networks.  $G$ -Graphs constitute another family of graphs constructed from groups. These graphs have also highly-regular properties. The purpose of this presentation is to propose some characterizations of  $G$ -Graphs and to show that well-known infinite families of graphs are  $G$ -Graphs, some of them are not Cayley Graphs.

#### 4 - Some inverse chromatic number problems

*Yerim Chung*, CERMSEM, Université Paris 1, 106-112 boulevard de l'Hôpital, 75013, Paris, yerim.chung@malix.univ-paris1.fr, *Culus*, *Jean-François*, *Marc Demange*

We consider an inverse chromatic number problem in interval graphs: we are given an integer  $K$  and an interval graph associated with a list of intervals. The intervals are to be newly positioned with the least possible discrepancies from the original positions in such a way that the new related interval graph is  $K$ -colorable. We propose a model involving this problem called inverse booking problem. We show that it is hard to approximate in general case with no constraints on lengths of the intervals. We then study the tractability of the sub-problem with a limited number of interval lengths.

## ■ WC-18

Wednesday 11:20-12:40

Lenné

### Application of MP to Spatial Systems

Stream: Mathematical Programming

Invited session

Chair: *Igor Konnov*, University of Kazan, Kazan, Russian Federation, Igor.Konnov@ksu.ru

Chair: *Elisabetta Allevi*, University of Brescia, Brescia, Italy, allevi@eco.unibs.it

Chair: *Adriana Gnudi*, Mathematics, Statistics, Computer science and Applications, University of Bergamo, Via dei Caniana, 2, 24127, Bergamo, Italy, adriana.gnudi@unibg.it

#### 1 - Average power contracts can mitigate carbon leakage

*Giorgia Oggioni*, Department of Mathematics, Statistics, Computer Sciences and Application, University of Bergamo, Bergamo, Italy, giorgia.oggioni@unibg.it, *Yves Smeers*

The relocation of some Energy Intensive Industries (EIIs) out of Europe is a possible consequence of the combination of emission charges and higher electricity prices entailed by the EU-Emission Trading Scheme. In order to mitigate this effect, EIIs have asked for special power contracts whereby they would be supplied from dedicated capacities at average costs. We consider different average cost based models that are formulated as non-monotone complementarity problems. Simulations in GAMS show that the success of these contracts depends on national power policies.

#### 2 - Infinite dimensional duality and applications to complex networks

*Patrizia Daniele*, Mathematics and Computer Science, University of Catania, Viale A. Doria, 6, 95125, Catania, Italy, daniele@dmi.unict.it, *Antonino Maugeri*

We present an infinite dimensional duality theory for optimization problems and evolutionary variational inequalities where the constraint sets are given by inequalities with an ordering cone, and also by equalities. We ensure the strong duality between such convex optimization problem and its Lagrange dual without assumptions on the interior of the ordering cone and apply our results to a wide class of dynamic equilibrium problems. In particular, we consider a supply chain network with three levels of decision-makers and the data evolving on time.

#### 3 - Basic mathematical models for evacuation problems in urban areas

*Sarah Bretschneider*, Mercator School of Management - Fachbereich Betriebswirtschaft, Universität Duisburg-Essen, Lotharstraße 65, Gebäude LB, 47057, Duisburg, Germany, sarah.bretschneider@uni-due.de, *Alf Kimms*

The basic evacuation model is a dynamic network flow problem with additional variables for the number and direction of used lanes and with additional complicating constraints. Because of the size of the time-expanded network due to the detailed modeling of intersections and, of course, to the fact being time-expanded, the computational effort required by standard software is already very high for tiny instances of the basic mixed integer evacuation model. To deal with realistic instances we propose a heuristic approach that can manage this problem.

#### 4 - A variational inequality approach for dynamic spatial auction market problems

*Adriana Gnudi*, Mathematics, Statistics, Computer science and Applications, University of Bergamo, Via dei Caniana, 2, 24127, Bergamo, Italy, [adriana.gnudi@unibg.it](mailto:adriana.gnudi@unibg.it), *Elisabetta Allevi*, *Igor Konnov*

In the talk we consider spatial equilibrium models utilized for description of complex systems taking into account the spatial distribution of interacting elements. For economic systems related to natural monopolies it seems suitable to utilize auction type market mechanisms. We consider systems of auction markets joined by transmission lines subject to joint balance and capacity flows constraints for a certain time period and we propose a primal-dual system of variational inequalities whose solutions yield an equilibrium trajectory. A splitting type method is utilized to find a solution.

### ■ WC-19

Wednesday 11:20-12:40

Haber

#### Traffic Information Systems

Stream: Metaheuristics and Information Systems

Contributed session

Chair: *Xiaohong Chen*, Tongji University, 200092, Shanghai, [chenxh@mail.tongji.edu.cn](mailto:chenxh@mail.tongji.edu.cn)

#### 1 - Applying geostatistical analyst methods in gis-supported procedures to prevent traffic accidents in urban planning

*I.Bulent Gundogdu*, Geodesy and Photogrammetry/Cartography, Selcuk University, Selcuk Universitesi Muh.Mim.Fakultesi, 42031, Konya, Turkey, [bgundogdu@selcuk.edu.tr](mailto:bgundogdu@selcuk.edu.tr)

By applying Geostatistical Analysis(GA), this study differs from previous studies which have determined the hot spots using linear analysis. In this study, the aim is to determine new safe routes and zones with the help of GA. Another aim is to map and determine graduated hot or safe zones using not only traffic accident numbers but also other traffic accident criteria(AC). AC1 is the number of mortalities criterion, AC2 is the number of injured people criterion, AC3 is the number of accidents with damage only criterion, and AC4 is the total number of accidents criterion.

#### 2 - Estimating traffic data in traffic networks by singular value decomposition and maximum-likelihood

*Ina Seydel*, Fraunhofer Institute for Transportation and Infrastructure Systems, Zeunerstraße 38, 01069, Dresden, Germany, [ina.seydel@ivi.fraunhofer.de](mailto:ina.seydel@ivi.fraunhofer.de), *Georg Foerster*, *Matthias Klingner*

Traffic data is often estimated on basis of historical time series for single locations. We propose an adaptive estimator for a whole traffic network on the basis of multivariate statistics. For data analysis Singular Value Decomposition is used. A Maximum-Likelihood-Estimator and current data from selected detectors enable to estimate data from all other detector sites. These methods are applied to data from inductive loops from the City of Nuremberg. Estimation errors are smaller than those of conventional estimation-systems and can be furthermore improved by sensor and data allocation.

#### 3 - A data mining approach on poi based traffic flow estimation - an industrial case study

*Thomas Liebig*, Knowledge Discovery, Fraunhofer IAIS, Schloss Birlinghoven, 53754, Sankt Augustin, Germany, [thomas.liebig@iais.fraunhofer.de](mailto:thomas.liebig@iais.fraunhofer.de)

Estimating traffic flow became business critical for the German outdoor advertisement market, because each transaction depends on the reach estimation: How many people are reached by a campaign? Fraunhofer IAIS develops many data mining algorithms that answer both questions for different scenarios. In this work, we present a method that uses no frequency counts but points of interesting locations (POI) and the total number of pedestrians. We utilise model trees to compute frequency estimates and show and evaluate this approach on a public building scenario taken from an industrial project.

### ■ WC-20

Wednesday 11:20-12:40

Mann

#### DEA Applications V

Stream: DEA and Performance Measurement

Invited session

Chair: *Yannis Smirlis*, University of Piraeus, Karaoli - Dimitriou 80, 18534 Piraeus, 18534, Piraeus, [smirlis@unipi.gr](mailto:smirlis@unipi.gr)

#### 1 - Input-output tables and network dea: efficiency of the 47 prefectures of japan

*Hirofumi Amatatsu*, Information Science of Graduate School of Engineering, Seikei University, 3-3-1 Kichijoji-Kitamachi, 180-8633, Musasino-shi, Tokyo, Japan, [amatatsu@mint.ocn.ne.jp](mailto:amatatsu@mint.ocn.ne.jp), *Tohru Ueda*

In organizations described in input-output tables, each sector produces goods for other sectors, and similarly, each sector receives goods from other sectors. We refer to this type of organization as a matrix-type organization. We propose algorithms of network DEA programs to measure the efficiency of matrix-type organizations and algorithms to measure the super-efficiency of network DEA. Then we apply the proposed algorithms to the input-output tables of the 47 prefectures of Japan and investigate their industrial efficiencies.

#### 2 - An integrated approach of performance management in public parking lot

*Gaea Lin*, Department of transportation, Taipei City Government, 6F, NO. 1, SHI FU ROAD, TAIPEI, TAIWAN, R.O.C., 110, TAIPEI, TAIWAN, R.O.C., Taiwan, [D92520005@ntou.edu.tw](mailto:D92520005@ntou.edu.tw), *Tzay An Shiau*

This paper is to construct the integration model of appraising the operational performance of public parking lot in Taipei. The model differs from previous models in that it is also assessed the policy mission of completion and considering location. Rough set theory and data envelopment analysis are applied in this model which is an integrated approach to highlight a classification for policy mission of completion and evaluated operational performance.

### 3 - Evaluating the productive efficiency of highway maintenance operations: environmental and dynamic considerations

*Saeideh Fallah-Fini*, Industrial and Systems Engineering, Virginia Tech, 307 Hunt Club Rd., #6400G, 24060, Blacksburg, VA, United States, fallah@vt.edu, *Konstantinos Triantis*

Significant attention to the road maintenance operations in the last two decades makes it imperative to implement comprehensive measurement systems that effectively assess the multiple dimensions of road maintenance dynamic performance. In this paper, we augment the dynamic performance efficiency model (DPEM) of Vaneman and Triantis (2003, 2007) and explicitly model the non-linear relationship between uncontrollable drivers such as climate conditions, load, and traffic that cause pavement deterioration, affect required maintenance operations, and drive performance goals over time.

### 4 - Reducing the size of large scale data envelopment analysis problems using interval DEA

*Yannis Smirlis*, University of Piraeus, Karaoli - Dimitriou 80, 18534 Piraeus, 18534, Piraeus, smirlis@unipi.gr, *Lamprini V. Stamati, Dimitris Despotis*

Large scale DEA problems require increased processing effort while an in depth analysis of the efficiency of the units is practically impossible. The reduction of the size can be achieved if some inefficient units are eliminated. This paper presents a technique that uses the initial data set to segment the range of values for inputs/outputs so as to define a new interval data setting. Applying the interval DEA model, reveals interval combinations that contain inefficient units of the initial data set. By eliminating these inefficient units, the size of the initial problem is reduced.

## ■ WC-21

Wednesday 11:20-12:40

Hauptmann

### Nonlinear 0-1 optimization

Stream: Boolean Programming

*Invited session*

Chair: *Bruno Simeone*, Dept. of Statistics, University of Rome La Sapienza, Piazzale Aldo Moro 5, 00185, Rome, Italy, bruno.simeone@uniroma1.it

Chair: *Isabella Lari*, Statistics, La Sapienza University, Piazzale Aldo Moro 5, 00186, Rome, Italy, isabella.lari@uniroma1.it

#### 1 - Nonlinear 0-1 optimization by reduction to max-cut

*Christoph Buchheim*, Computer Science Department, University of Cologne, Pohligstr. 1, 50969, Cologne, Germany, buchheim@informatik.uni-koeln.de, *Giovanni Rinaldi*

Nonlinear 0-1 optimization problems are usually much harder than their linear counterparts. Maximizing a quadratic objective function over binary variables is NP-hard even in the unconstrained case, where it is equivalent to the maximum cut problem. On the other hand, the latter problem has been well-studied. Many results have been obtained for the corresponding cut polytopes, which have led to practically fast algorithms for max-cut and unconstrained quadratic 0-1 optimization. We discuss how to extend these results to general pseudoboolean and constrained quadratic 0-1 optimization.

### 2 - Cones of nonnegative quadratic pseudo-boolean functions and lift-and-project hierarchies

*Endre Boros*, RUTCOR, Rutgers University, 08854, Piscataway, New Jersey, United States, Endre.Boros@rutcor.rutgers.edu, *Miguel Anjos, Michel Minoux, Gabriel Tavares*

We study lift-and-project closures of the standard linearization of max-2-sat problems and conical hierarchies based on posiform representations of the objective function.

### 3 - Some properties of the boolean quadric polytope

*Isabella Lari*, Statistics, La Sapienza University, Piazzale Aldo Moro 5, 00186, Rome, Italy, isabella.lari@uniroma1.it, *Endre Boros*

We study the structure of some facets of the Boolean Quadric Polytope, which is obtained from the standard linearization of unconstrained 0-1 quadratic programming. Padberg (1989) has identified three classes of facets. Boros, Crama and Hammer (1990, 1992) have proved that the facets can be classified in a hierarchy where each level is defined by exactly those facets corresponding to non negative 0-1 functions with at most a given number  $k$  of variables. They have determined all facets for  $k = 3$ . We provide all facets and find some properties for  $k = 4, 5$ .

### 4 - Quadratic -1,0,1 optimization

*Andrea Lodi*, D.E.I.S., University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, andrea.lodi@unibo.it, *Christoph Buchheim, Alberto Caprara*

We present a fast branch-and-bound algorithm for minimizing a convex quadratic objective function over integer variables. In each node of the enumeration tree, a natural lower bound is given by the continuous minimum of the restricted objective function. We improve this bound by considering lattice-free ellipsoids that are determined by a reduced lattice basis. In practice, this approach performs well mainly because all expensive calculations can be done in a preprocessing phase, while the running time for a single node in the enumeration tree is at most quadratic in the problem dimension.

## ■ WC-22

Wednesday 11:20-12:40

Arndt

### AHP IV

Stream: Analytic Hierarchy Processes, Analytic Network Processes

*Invited session*

Chair: *Mirosław Dytczak*, Institute of Spatial Management and Housing ISMH, ul. Targowa 45, 03-728, Warsaw, Poland, mdytczak@rsnot.com.pl

#### 1 - Multi-model MCDA approach application for solution of socio-economic problems

*Mirosław Dytczak*, Institute of Spatial Management and Housing ISMH, ul. Targowa 45, 03-728, Warsaw, Poland, mdytczak@rsnot.com.pl, *Grzegorz Ginda*

Real decision making socio-economic problems are of a complex nature. Therefore, application of appropriate decision support approach is required to recommend reasonable decisions. There are different supporting approaches available. They differ in a level of usefulness and nature of delivered results. Therefore, it seems reasonable to apply them in parallel to obtain more justified outcomes. The approach based on parallel application of AHP/ANP, extended DEMATEL, numerical taxonomy and zero unitarization method is introduced. Usefulness of this combination is illustrated using sample cases.

## 2 - Intangibility-aware assessment of building systems based on small prefabricated structural components

*Andrzej Słodziński*, Faculty of Civil Engng., Opole University of Technology, ul.Katowicka 48, 45-061, Opole, a.slodzinski@gmail.com, *Mirosław Dytczak*

The paper deals with ranking of building systems applied for erection of contemporary single-family dwelling houses. A number of quality criteria related to civil engineering technology issues are included. Choice of considered technology issues, assessment criteria and indicators is based on a detailed analysis of existing building market requirements. Analytic Hierarchy Process approach is utilised for assessment of building systems. Numerous variable and intangible market issues are included during the AHP analysis.

## 3 - System for validation of real estate value estimation

*Mirosław Dytczak*, Institute of Spatial Management and Housing ISMH, ul. Targowa 45, 03-728, Warsaw, Poland, mdytczak@rsnot.com.pl, *Maciej Szpringier*, *Grzegorz Ginda*

Real estate value depends on numerous factors of both tangible and intangible nature. Diverse issues should be included to assess the value adequately. Necessity to include numerous factors and a considerable level of subjectivism with regard to assessment of their influence can result in big difference of outcomes of distinct estimations. Therefore, a need arises to justify obtained results. The need is especially evident in case of real estate sold by government agencies. A validating approach is proposed in the paper. It is based on parallel application of AHP/ANP and other MCDA methods.

## 4 - Intangibility-aware decision-making support for printed works preparation

*Mirosław Dytczak*, Institute of Spatial Management and Housing ISMH, ul. Targowa 45, 03-728, Warsaw, Poland, mdytczak@rsnot.com.pl, *Ewa Kolodziejuk*

The effects of printed works preparation depend on numerous tangible factors e.g. the economical factor. However, the main aim of the works is to transmit particular essence to a target reader. Therefore, issues with regard to effects of the essence transmission ought to be included during the works preparation. The issues can be of intangible nature. The presence of numerous and intangible factors causes a need for application of advanced decision making support approaches to obtain optimal form of the works. Application of such approach for the works layout choice is discussed in the paper.

## WC-23

Wednesday 11:20-12:40

Planck

### Methodologies for DSS

Stream: Decision Support Systems

Invited session

Chair: *Pascale Zaraté*, Institut de Recherche en Informatique de Toulouse, 118 route de Narbonne, 31062, Toulouse, France, zarate@irit.fr

## 1 - Patterns as building blocks in decision-tree algorithms

*Boris Delibasic*, Business Decision-Making, University of Belgrade - Faculty of Organizational Sciences, Jove Ilica 154, 11000, Belgrade, Serbia, delibasicboris@gmail.com, *Milija Suknovic*, *Milos Jovanovic*

Decision-tree classifier algorithms are usually implemented as integrated solutions. We analyzed the design of famous decision-tree algorithms (ID3, C4.5, CHAID, CART, and QUEST) and identified patterns in these algorithms. By combining the identified patterns one can: generate original algorithms, improve original algorithms and generate new algorithms. In addition all patterns can be documented well, experimented with to find rules that would help choosing a design pattern based upon user and data (type, distribution, correlation, etc) demands. Patterns can be used as decision-support tools.

## 2 - Consistency in ahp-collaborative decision making

*María Teresa Escobar*, Grupo Decisión Multicriterio Zaragoza, Universidad de Zaragoza, Gran Vía, 2-4, 50005, Zaragoza, Spain, mescobar@unizar.es, *José María Moreno-jimenez*, *Juan Aguarón*

This paper presents a new decisional tool that based on the concept of consistency deals with collaborative decision making in AHP. The procedure starts by identifying the precise values from the common consistency intervals that maximize the minimum available slack of consistency. In a second step the attitude that decision makers have towards the collaboration is incorporated. The preference structures derived from the resulting matrix, named Collaborative Consistency Consensus Matrix, reflect the position which the decision makers have achieved through collaboration and consistency.

## 3 - Academic decisions support systems: a methodology

*José G. Hernández R.*, Gestión de la tecnología, Universidad Metropolitana, Distribuidor universidad, autopista, Guarenas, 78239, Caracas, 1074, Miranda, Venezuela, jhernandez@unimet.edu.ve, *María J. García G.*

Objective of this work is to present and tell how it works and how has been created the Integrating-Adaptable Methodology for the development of Decisions Support Systems (IAMDSS), which is created to facilitate the construction of Decisions Support Systems, of academic character.

The methodology for the development of the work it is the scientific method for the decisions making and the results turn out to be reflected not only for creation of the IAMDSS but for a wide group of Decision Support Systems that have been constructed making use of it.

KW: DSS, Methodology, IAMDSS, Academic

## 4 - A new way of classifying and comparing systemic methodologies

*Kalliopi Peponi*, Department of Product and Systems Design Engineering, University of the Aegean, Konstantinoupoleos 2, 84100, Syros, Greece, lina@aegean.gr, *Argyris Arnellos*, *Thomas Spyrou*, *John Darzentas*

The purpose of this paper is to present a new framework for the classification of the systemic methodologies, applied in organisational design, using basic concepts of systems thinking as a point of reference. The proposed framework would help the organisational designers to better understand the methodologies, give them the ability to choose the most appropriate one for each specific situation, and provide them with the additional advantage of creating hybrid methodologies, combining elements of different ones. The proposed framework is applied in three methodologies (VSM, SSM, and CSH).

## ■ WC-24

Wednesday 11:20-12:40

GSI - S 20

### Mutiobjective Optimization

Stream: Nonlinear Programming

*Invited session*

Chair: *Jorge Sá Esteves*, Dep. of Mathematics, University of Aveiro, Campus Santiago, 3810-193, AVEIRO, Portugal, saesteves@ua.pt

#### 1 - The call centers staffing problem: a multicriterion approach

*Jorge Sá Esteves*, Dep. of Mathematics, University of Aveiro, Campus Santiago, 3810-193, AVEIRO, Portugal, saesteves@ua.pt

A call center is a service network in which agents provide telephone-based services. Customers who seek these services are delayed in tele-queues. This talk addresses optimal staffing of call centers, modeled as a multidimensional M/M/N queue with N, the number of agents, being large. The problem is formulated by using a tricriteria approach (economic criteria, overall efficiency criteria and equity criteria). An algorithm for traveling on the set of Pareto optimal solutions is proposed and computational results are presented.

#### 2 - A lexicographic approach for multi-objective dynamic portfolio optimization

*Bartosz Sawik*, Department of Applied Computer Science, AGH University of Science & Technology, Faculty of Management, Al. Mickiewicza 30, PL-30-059, Krakow, Poland, B\_Sawik@yahoo.com

Mixed integer programming formulation with a lexicographic approach is proposed for dynamic portfolio optimization over many investment periods, each consist of 250 historic quotations. The objective is to allocate wealth on securities to maximize the portfolio expected return with the threshold of the probability that the return of portfolio is not less than a required level. The auxiliary objective is the minimization of risk probability of portfolio loss. A real data from stock exchange were used as a tool for computational experiments. 3500 historical daily quotations were considered.

#### 3 - The direct support method to solve a multiobjective linear program

*Radjef Sonia*, USTO university, Oran, 31000, Oran, Oran, soniaradjef@yahoo.fr

In multicriteria optimization, several objective functions, conflicting with each other, have to be optimized simultaneously. Here, we propose an efficient method for defining the solution set of a multi-objective programming problem, where the objective functions involved are linear, the set of feasible points is a set of linear constraints and the decision variables are of two types: the upper and lower bounded variables and the nonnegative variables. The algorithm is an extension of the direct support method for solution a single-objective linear program.

#### 4 - New labeling algorithms for minimum-hop bicriteria path problems

*Marta Pascoal*, Departamento de Matemática, Universidade de Coimbra, INESC-Coimbra, Largo D. Dinis - Apartado 3008, 3001-454, Coimbra, Portugal, marta@mat.uc.pt

The number of hops (or arcs) of a path is a frequent objective function with applications when network resources utilization is to be minimized. We solve bicriteria path problems involving that objective function and 2 other metrics, the path cost and the path capacity. We introduce labeling algorithms using a breadth-first search tree in order to compute the maximal and the minimal sets of non-dominated paths. The properties of this data structure are explored to better suit the number of hops function. Computational experiments on random problems are reported and discussed.

## ■ WC-25

Wednesday 11:20-12:40

GSI - S 25

### Graph Games

Stream: Cooperative Game Theory

*Invited session*

Chair: *Agnieszka Rusinowska*, CNRS - Univesity of Lyon 2, GATE, 93 Chemin des Mouilles, BP 167, 69131, Ecully, rusinowska@gate.cnrs.fr

#### 1 - Tree solutions for graph games

*Sylvain Béal*, GREDEG, University of Nice Sophia Antipolis, 250 rue Albert Einstein, 06560, Valbonne, beals@gredeg.cnrs.fr, *Eric Rémila*, *Philippe Solal*

We study cooperative games with limited cooperation possibilities. We introduce natural extensions of the average tree solution [see Herings, van der Laan, Talman, 2008]: the marginalist tree solutions and the random tree solutions. We provide an axiomatic characterization of each of these sets of solutions. By the way, we obtain a new characterization of the average tree solution.

#### 2 - Random walks on set systems and games with communication graphs

*Fabien Lange*, Keleti Faculty of Economics, Budapest Tech, Tavaszméz"o u. 15-17, 1084, Budapest, Hungary, fabien.lange@kgk.bmf.hu

We address a framework leading to games with communication graphs, where the set of feasible coalitions forms a poset whose all maximal chains have the same length. We analyze for these games the set of order-compatible values, and focus on some of them. We propose as an application the study of the behavior of a random walker in a graph, where it is shown that the Shapley value is the most natural solution concept. By observing these graphs in the context of the electric networks theory, we consider notions such as potential drop, current, resistance and power, which find here an equivalent.

#### 3 - Internal slackening scoring methods

*Marco Slikker*, IE&IS, Technische Universiteit Eindhoven, P.O. Box 513, 5600 MB, Eindhoven, m.slikker@tue.nl, *Peter Borm*, *Rene van den Brink*

We deal with the ranking problem of the nodes in a directed graph. We introduce scoring methods, indexed by a single nonnegative parameter  $\alpha$ . This parameter reflects the internal slackening of a node within an underlying iterative process. The class of so-called internal slackening scoring methods consists of the limits of these processes. It is seen that for  $\alpha=0$  and  $\alpha=\infty$  these methods extend the Invariant and the Fair Bets scoring method, respectively. For  $\alpha=1$ , a compromise between the extremes, it corresponds with the  $\lambda$ -method of Borm et al. (2002). A social choice application is included.

## ■ WC-26

Wednesday 11:20-12:40

GSI - S 35

### Transportation and Logistics

Stream: Discrete Optimization

Contributed session

Chair: *Christian Huber*, Institut für Fördertechnik und Logistiksysteme, Gotthard-Franz-Str. 8, 76131, Karlsruhe, BW, Germany, christian.huber@ifl.uni-karlsruhe.de

#### 1 - Solving the vehicle positioning problem

*Carlos Cardonha*, Optimization, ZIB, Takustrasse 7, Berlin-Dahlem, D-14195, Berlin, Berlin, Germany, carlos.cardonha@gmail.com, *Ralf Borndörfer*

The Vehicle Positioning Problem (or Depot Management Problem) consists of the assignment of vehicles to parking positions and to timetabled trips. The assignments are constrained by the depot topology and by the vehicle types accepted by the trips. We present solutions based on linear integer programming and quadratic integer programming for the problem and compare them from a theoretical and a computational point of view. In particular, we can show that quadratic programming yields the first nontrivial lower bound on problems that require shunting.

#### 2 - Automatic generation of continuous queries for event based logistics monitoring

*Kerstin Werner*, SAP Research CEC Dresden, SAP AG, Chemnitz Strasse 48, 01187, Dresden, Germany, kerstin.werner@sap.com

The potential of distributed event data captured by modern Auto-ID technologies is currently not efficiently used to enable real time logistics monitoring. This is due to the domain specific knowledge and cumbersome design time generation of queries required by existing event processing mechanisms. We introduce approaches to integrate event data and run automatically generated continuous queries on it to detect quality constraint violations. Our formal model of existing SQL-based event query languages allows for the dynamic adaption of queries according to frequently changing business needs.

#### 3 - Throughput analysis of manual order picking systems with blocking

*Christian Huber*, Institut für Fördertechnik und Logistiksysteme, Gotthard-Franz-Str. 8, 76131, Karlsruhe, BW, Germany, christian.huber@ifl.uni-karlsruhe.de

In manual order picking systems blocking might occur when pickers cannot pass each other due to narrow aisles. Thus order lead times will increase with each additional picker in the system. First results of a DFG-funded research project seeking to quantify system performance will be presented. To consider the dynamic effects caused by blocking, queueing models are applied to an exemplary system and average order lead times are calculated. The analysis shows that throughput is systematically overestimated when using static approaches for the evaluation of such systems.

#### 4 - Non-dominated time-window policies in city distribution

*Derya Eren Akyol*, Department of Industrial Engineering, Dokuz Eylul University, Buca, 35160, IZMIR, Turkey, derya.eren@deu.edu.tr, *René de Koster*

Local authorities in Western European countries try to improve social sustainability issues in urban areas by applying time-window regulations. Such regulations reduce the hinder for the shopping public. However, increasing time window pressure significantly affects retailers' distribution costs and has potentially negative impacts on the environment. The objective of this research is to find cooperative and non-cooperative non-dominated policies for municipalities by taking into consideration the conflicting objectives of the municipalities and the retailer.

## ■ WC-27

Wednesday 11:20-12:40

GSI - S 21

### Location and allocation problems in facilities

Stream: Facility Logistics

Invited session

Chair: *Kees Jan Roodbergen*, Rotterdam School of Management, Erasmus University, P.O. Box 1738, 3000 DR, Rotterdam, Netherlands, kroodbergen@rsm.nl

Chair: *René de Koster*, Rotterdam School of Management, Erasmus University Rotterdam, Room T10-56, PO Box 1738, 3000 DR, Rotterdam, Netherlands, rkoster@rsm.nl

#### 1 - Shared stacking policy for stacking export containers at container yards

*Amir Hossein Gharehgozli*, Rotterdam School of Management, Erasmus University Rotterdam, Postbus 1738, 3000 DR, Rotterdam, Netherlands, agharehgozli@rsm.nl, *Yugang Yu*, *René de Koster*, *Jan Tijmen Udding*

Reshuffling is very costly and time consuming in retrieving containers from their stacks. In order to minimize the number of reshufflings, this paper proposes a dynamic programming model to determine stacking positions of incoming containers. A shared stacking policy is applied, which allows containers belonging to multiple ships to share a common stacking area. The dynamic programming can only provide optimal solutions for small scale problems in a reasonable time. Using these solutions, we develop a heuristic to solve large scale ones. The results show that the shared policy performs well.

#### 2 - Improving warehouse performance by choosing proper storage and order picking systems

*Manolo Mizzi*, Department of Management, Economics and Industrial Engineering, Politecnico di Milano, P.zza Leonardo da Vinci, 32, 20133, Milan, Italy, Italy, manolo.mizzi@polimi.it, *René de Koster*

Warehouses play a crucial role for efficiency and effectiveness of supply chains. Using survey data from warehouses in the Netherlands we use data envelopment analysis (DEA) to establish the warehouse efficiency. These results are used to find relations between types of storage and order picking systems and warehouse performance. This may help warehouse managers to select systems appropriate for their warehouse.

#### 3 - Managing warehouse empty storage space

*René de Koster*, Rotterdam School of Management, Erasmus University Rotterdam, Room T10-56, PO Box 1738, 3000 DR, Rotterdam, Netherlands, rkoster@rsm.nl, *Yugang Yu*

During warehouse operations open locations tend to spread over the storage area, which negatively impacts load retrieval times. We present a method to manage these open locations such that the system travel time for processing storage and retrieval jobs is minimized. We introduce the effective storage area (ESA): those locations closest to the depot containing all products, but only a part of the open locations. We determine the optimal number of effective open locations and the ESA boundary. This policy reduces the travel time of storage and retrieval jobs by more than 10% on average.

## ■ WC-28

Wednesday 11:20-12:40

GSI - S 1

### Financial Optimization 5

Stream: Financial Optimization

Invited session

Chair: *Michi Nishihara*, Graduate School of Economics, Osaka University, 1-7, Machikaneyama, Toyonaka, Osaka, 560-0043, Osaka, Japan, [nishihara@econ.osaka-u.ac.jp](mailto:nishihara@econ.osaka-u.ac.jp)

#### 1 - On securitization, market completion and equilibrium risk

*Traian Pirvu*, McMaster University, Hamilton Hall, Room 218, L8S 4K1, Hamilton, Ontario, Canada, [pirvu@math.mcmaster.ca](mailto:pirvu@math.mcmaster.ca), *Ulrich Horst*, *Goncalo Dos Reis*

We propose an equilibrium framework within to price financial securities written on non-tradable underlyings. In this model, agents's preferences are convex dynamic risk measure generated by the solution of a backward stochastic differential equation. The agents can hedge their financial risk in the stock market and trade a structured derivative whose payoff depends on both financial and external risk factors. We find the equilibrium market price of risk in terms of a solution to a non-linear BSDE and provide numerical simulations.

#### 2 - Fixed-income portfolio in serbia —hedging against changes in svensson model parameters

*Mikica Drenovak*, Operational research, Statistics and IT, Faculty of Economics, Djure Pucara Starog 3, 34000, Kragujevac, Serbia, Serbia, [mikicadrenovak@yahoo.com](mailto:mikicadrenovak@yahoo.com)

This paper aims to determine the potential of hedging Serbian fixed-income portfolio against changes in Svensson model parameters. Dataset underlying this research comes from Serbian euro denominated sovereign bonds. We attempt to discover limitations of these semi hedged strategies and to provide scenarios implying their dominance compared to alternative strategies. Obtained results are consistent with idiosyncrasies of Serbian spot yield curves.

#### 3 - Dynamic evolution for risk-neutral densities

*Ana Monteiro*, School of Economics, University of Coimbra, Av. Dias da Silva, 165, 3004-512, Coimbra, Portugal, [ammm@fe.uc.pt](mailto:ammm@fe.uc.pt), *Reha Tütüncü*, *Luís Nunes Vicente*

Given the prices of a set of options on the same underlying asset with different strikes and maturities, we propose a nonparametric approach for estimating the evolution of the risk-neutral density in time. Our method uses bicubic splines and an optimization model to choose the spline functions that best fit the price data. Semidefinite programming is employed to guarantee the nonnegativity of the densities. We also used the risk-neutral densities that we computed to price exotic options.

#### 4 - Real options with multi-dimensional state variables

*Michi Nishihara*, Graduate School of Economics, Osaka University, 1-7, Machikaneyama, Toyonaka, Osaka, 560-0043, Osaka, Japan, [nishihara@econ.osaka-u.ac.jp](mailto:nishihara@econ.osaka-u.ac.jp)

This paper investigates the real options written on a multi-dimensional underlying stochastic process. Although many models of real options are based on a one-dimensional optimal stopping problem because of its analytical simplicity, those models cannot treat real options related to several projects. We use a multi-dimensional optimal stopping problem in order to represent the specific risk of each project. We analytically show the features of the optimal investment strategy and the option value, and then clarify how they are changed from the one-dimensional case.

## ■ WC-29

Wednesday 11:20-12:40

GSI - S 2

### Short-term operation and management in energy markets

Stream: Energy and Emission Markets

Invited session

Chair: *Pilar Vázquez*, Energy Management, Iberdrola, Tomás Redondo, 1, 28033, Madrid, Spain, [pvazquez@iberdrola.es](mailto:pvazquez@iberdrola.es)

#### 1 - The impact of co2, so2 and other pollutant emissions constraints on the operation of the generation plants: managing emissions limits in the short run

*Inigo Ruperez*, Energy Management, Iberdrola, Tomas Redondo, 1, 28033, Madrid, Spain, [i.ruperez@iberdrola.es](mailto:i.ruperez@iberdrola.es), *Pilar Vázquez*

In the last decade, the EU has been actively developing an environmental policy whose main objective is to reduce the pollutant emissions exhausted to the atmosphere. These new environmental laws have created several mechanisms that modify considerably the operation of generation plants. This paper analyzes the influence of these environmental constraints on the economic dispatch of the electricity system and how agents may consider the emissions limits in their decision-making process.

#### 2 - The influence of wind production on short-term operation of electricity power system and its flexibility requirements

*Pablo Rodilla*, Regulation and economics of energy, Instituto de Investigacion Tecnologica (Universidad Pontificia Comillas), C/ Santa Cruz de Marcenado 26, 28015, Madrid, Spain, [pablo.rodilla@iit.upcomillas.es](mailto:pablo.rodilla@iit.upcomillas.es)

Preserving global environment and decreasing the energy dependence are the main drivers behind the increasing trend of promoting wind generation. But these solutions don't come at a zero cost. The intermittence of its output poses a huge challenge that makes necessary both a robust market design (especially in the short term) and a correct definition of the system operator responsibilities regarding system's security. Based on the international experience up to date, this paper aims at providing a reference framework to efficiently integrate wind generation in electricity markets.

#### 3 - Gas-electricity markets convergence in spain. interaction between both commodities in the short term decision-making process

*Daniel Fernandez*, Energy Management - Western Europe, GdF Suez, 5, rue de Heliopolis, 75017, Paris,

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In the latest years, there is increasing convergence between liberalized gas and electricity markets, driven mainly by CCGT investments. Changes in gas prices directly impact on electricity variable cost structures and consequently, in the different players' strategies and short term optimization decisions. Taking into account several facts and figures from the Spanish energy sector, the purpose of the session is to give an overview of the opportunities, advantages, problems and risks of gas-electricity arbitration from an IPP prospective, which is the role of GdF Suez in the country.

#### 4 - Design of the bidding curve in uniform-price electricity auctions: pricing operational constraints under non-convexity

Miguel Vázquez, Comillas University, Sta. Cruz de Marcenado 26, Madrid, Spain, 28015, Madrid,  
mvazquez@iit.upcomillas.es, Carlos Vázquez

We consider a power producer selling her output in a pool. Then, the problem may be modeled as a profit-maximization program, where income is defined by the residual demand. It can be proved that in such a case, any bid curve containing the optimal solution is optimal. However, when uncertainty is considered, the production dispatched by the market clearing may be different of the optimal output, and may result in negative profits. We propose a new methodology to design a bid curve that ensures that in any point of the bid curve, the income of the producer is maximized.

### ■ WC-30

Wednesday 11:20-12:40

GSI - S 26

#### Nonsmooth Optimization in MP and Its Applications

Stream: Nonsmooth Optimization and its Applications

Invited session

Chair: Antonio Fuduli, Department of Mathematics, Università della Calabria, Via P. Bucci, CUBO 31B, 87036, Rende, Italy, antonio.fuduli@unical.it

##### 1 - Separation of convex sets by sets

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Two compact convex subsets  $A$  and  $B$  of a topological vectorspace  $X$  are separated by an other compact convex set  $S$  if for every point of  $A$  and  $B$  the line segment joining this two points intersects  $S$ . This is a generalization of the separation by a hyperplane. There exists an algebraic characterization for this type of separation, called the separation law. It is shown that the separation law is equivalent to the order cancellation law.

##### 2 - A new solution method for equilibrium problems

Massimo Pappalardo, Matematica Applicata, University of Pisa, Via Buonarroti 1c, 56127, PISA,  
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A globally convergent algorithm for equilibrium problems with differentiable bifunctions is proposed. The algorithm is based on descent directions of a suitable family of gap functions. The novelty of the approach is that assumptions which guarantee that the stationary points of the gap functions are global optima are not required.

##### 3 - A globally convergent descent method for nonsmooth variational inequalities

Mauro Passacantando, Dipartimento di Matematica Applicata, Università di Pisa, 56127, Pisa, Italy,  
passacantando@dma.unipi.it, Barbara Panicucci,  
Massimo Pappalardo

We propose a descent method via gap functions for solving nonsmooth variational inequalities with a locally Lipschitz operator. Assuming monotone (not necessarily strongly monotone) operator and bounded domain, we show that the method with an Armijo-type line search is globally convergent. Finally, we report some numerical experiments.

### ■ WC-31

Wednesday 11:20-12:40

GSI - S 34

#### Data Mining and Decision Making 2

Stream: Data Mining and Decision Making

Invited session

Chair: Christophe Mues, School of Management, University of Southampton, SO17 1BJ, Southampton, United Kingdom, C.Mues@soton.ac.uk

##### 1 - A question of profit

Hsin-Vonn Seow, Business School, University of Nottingham- Malaysia Campus, Jalan Broga, Selangor Darul Ehsan, 43500, Semenyih, Selangor, Malaysia,  
Hsin-Vonn.Seow@nottingham.edu.my, Lai-Soon Lee

The advent of the Internet allows customers to apply to numerous financial institutions at one time thus resulting in multiple offers in particular personal financial products. There is a need to increase "take" rates of these financial institutions. Data is collected for risk assessment and such information can be used to assess the probability of acceptance, i.e. acceptance scoring. We investigate a model for the purpose based on responses to questions and the question selection itself.

##### 2 - Do novel algorithms pay off? a benchmark of data mining algorithms in management applications

Stefan Lessmann, Institute of Information Systems, University of Hamburg, Von-Melle-Park 5, 20146, Hamburg, Germany, lessmann@econ.uni-hamburg.de,  
Stefan Voss

The paper considers data mining applications in the field of customer relationship management and examines the potential of novel classification algorithms to improve corporate decision making. Using real-world datasets from past data mining cup competitions, sixteen classifiers are compared in terms of the area under the receiver operating characteristics curve and misclassification costs. The results provide some evidence for the superiority of ensemble-based techniques and demonstrate that minor improvements in predictive accuracy can indeed induce significant financial consequences.

##### 3 - Applying metacost to ensemble learners

Sebastian Schueller, Computer Science, University of Hamburg, Referat 11, Raum 209, Edmund-Siemers-Allee 1, 20146, Hamburg,  
3schueller@informatik.uni-hamburg.de, Stefan Lessmann

The paper develops a methodology to solve cost-sensitive classification tasks by integrating the random forest classifier with the Meta-Cost algorithm. A popular approach to take asymmetric misclassification costs into account is the use of statistical decision theory, which involves a post-processing of model predictions. A theoretical advantage of the integrated algorithm stems from the fact that cost-sensitivity is accounted for during learning, i.e. in an earlier stage. Empirical experiments are conducted to verify that the proposed solution offers superior predictions.

#### 4 - Maximum tolerance and maximum greatest tolerance of strict separating systems

*Xavier Molinero*, Llenguatges i Sistemes Informàtics, Escola Politècnica Superior d'Enginyeria de Manresa, Av. Bases de Manresa, 61-73, 08242, Manresa, barcelona, molinero@lsi.upc.edu, *Josep Freixas*

An important consideration when applying neural networks is the sensitivity to weights and threshold in strict separating systems representing a linearly separable function. Two parameters have been introduced to measure the relative errors in weights and threshold of strict separating systems: the tolerance and the greatest tolerance. Given an arbitrary separating system we study which is the equivalent separating system that provides maximum tolerance and maximum greatest tolerance.

## WC-32

Wednesday 11:20-12:40

GSI - S 4

### Portfolio and Risk Management

Stream: Financial Modelling

Contributed session

Chair: *Peter Letmathe*, Chair of Value Chain Management, University of Siegen, Hoelderlinstr. 3, 57076, Siegen, Peter.Letmathe@uni-siegen.de

#### 1 - Volatility forecast in financial time-series using evolutionary computing techniques

*V L Raju Chinthalapati*, Mathematics, London School of Economics, Houghton Street, London, WC2A 2AE, London, v.l.chinthalapati@lse.ac.uk

We introduce a preliminary framework for forecasting 5-day annualized volatility in GBP/USD, USD/JPY, and EUR/USD. It employs a series of standard and non-standard forecasting methods. We modify and employ Genetic Programming (GP) technique that is suggested by Neely and Weller for volatility forecasting. One challenge with volatility forecast using GP is that the learning samples form a Markovian process. We determine how many training examples must be presented to the GP in the learning phase for the learning to be successful under the Probably Approximately Correct paradigm.

#### 2 - Generating portfolio selection strategy under the lipschitz constant derivations' scope

*George S. Androulakis*, Department of Business Administration, University of Patras, University Campus, GR-265.04, Rio, Greece, gandroul@upatras.gr, *Eleni Lisgara*

Recently, we proposed an algorithm incorporating with the usage of the Lipschitz constant towards allocating any time series' future local optima. In the case of stock's movement - that is according to time, the allocated future local optima corresponds to the ideal future time to negotiate the stock. By applying this scheme simultaneously on a range of stocks it is possible to generate strategy of efficiently selecting the most qualified ones. Moreover, for the efficient management of the selected portfolio a recently proposed lexicographic optimization technique is deployed.

#### 3 - Restricted optimal retention in stop-loss reinsurance

*Roxana Ciumara*, Mathematics, Academy of Economic Studies, Calea Dorobantilor, 15-17, 71137, Bucharest, roxana\_ciumara@yahoo.com, *Vasile Preda*, *Silvia Dedu*

In this paper we propose determining the optimal retention by solving an optimization problem with inequality restrictions imposed on the retention level. We consider two optimization criteria: minimizing VaR and CTE, thus extending results from the literature. We derive conditions for the existence of optimal solution for individual and collective risk models. We prove that the features of the restricted optimal retention are not available in the case of an unrestricted optimization problem. We show the dependence of the two restricted optimal retentions and we give some practical examples.

#### 4 - Portfolio margining: strategy vs risk

*Dmytro Matsypura*, Discipline of Operations Management and Econometrics, Faculty of Economics and Business, The University of Sydney, Room 478 Merewether Building (H04), 2006, Sydney, NSW, Australia, d.matsypura@econ.usyd.edu.au, *Ed Coffman*, *Vadim Timkovsky*

The risk-based approach to margining portfolios with equity derivatives is known to yield substantially lower margin requirements in comparison with the strategy-based approach that has been used for more than 4 decades. The final approval of using the risk-based approach to margining customer accounts by the SEC at the time of the global financial crisis appears to be one of the most puzzling steps in the history of margin regulations. This paper proposes a mathematical and experimental analysis of both approaches, provides recommendations on ways that can achieve adequate margin requirements.

## WC-33

Wednesday 11:20-12:40

GSI - S 7

### Stochastic methods in Global Optimization

Stream: Global Optimization

Invited session

Chair: *Eligius M.T. Hendrix*, Computer Architecture, Universidad de Málaga, Campus de Teatinos, ETSI 2.2.28, 29017, Malaga, Spain, eligius.hendrix@wur.nl

#### 1 - Tutorial for stochastic global optimisation algorithms

*Eligius M.T. Hendrix*, Computer Architecture, Universidad de Málaga, Campus de Teatinos, ETSI 2.2.28, 29017, Malaga, Spain, eligius.hendrix@wur.nl

Stochastic GO Algorithms aim at generating good solutions in reasonable time. The aim is to come to a didactical introduction into the concepts of region of attraction, population, effectiveness and efficiency determination, design experiments etc. Small examples a student can elaborate by hand are used such that the concepts are grasped. Ideas of Sampling in high dimensional space, Multistart, Clustering, Pure Adaptive Search, Hit and Run and SA, Population variants like Controlled Random Search, Raspberries, GA, Particle Swarms etc. are elaborated. A flavour is given in the presentation

## 2 - Statistical models for global optimization

*Julius Zilinskas*, Systems Analysis Department,  
Institute of Mathematics and Informatics, Akademijos  
4, LT 08663, Vilnius, Lithuania,  
zilinskasjulius@gmail.com, *Antanas Zilinskas*

Information about objective functions in many real world applications is scarce and corresponds to the notion 'black box optimization'. We consider possibilities to enrich this model with some heuristic and statistical information. Available information is structured into a statistical model of multimodal objective functions. Our talk focuses not as much on paradigmatic problems, as on algorithmic implementation of statistical models and the corresponding global optimization algorithms.

## 3 - Global optimization solution of robust regression using the simulated annealing algorithm

*Mevlut Yetkin*, Selcuk Universitesi Jeodezi ve  
Fotogrametri, Müh. Bolumu Kampus/Konya/Turkey,  
42075, Konya, Turkey, myetkin@selcuk.edu.tr

Robust regression may be computed using the usual iteratively re-weighted least squares (IRLS) algorithm. However, although easy to compute, IRLS may fall in a locally optimum solution far from the global one. In this paper we study the solution of robust regression as a global optimization problem which can be solved using the simulated annealing (SA) method. This paper shows that the residuals resulting from the SA method have successfully shown the multiple outliers. On the other hand, multiple outlier detection by IRLS has become more difficult.

## 4 - Achieving global descent in global optimization

*Chi-Kong Ng*, Department of Systems Engineering and  
Engineering Management, Chinese University of Hong  
Kong, Shatin, N.T, Hong Kong, ckng@se.cuhk.edu.hk,  
*Duan Li*

A new method is discussed, termed global descent method, to solve a wide class of global optimization problems. The family of global descent functions, constructed at any non-global minimizer  $x^*$ , not only have a local minimizer  $x'$  over the problem domain, but they are also located in the neighborhood of a better minimizer of  $f$  with  $f(x') < f(x^*)$ . This enables a global descent at each iteration by only performing local descent methods. Computational experiments on several test problems with up to 1000 variables have demonstrated the applicability and efficiency of the proposed method.

## WC-34

Wednesday 11:20-12:40

GSI - S 8

## Multi-view Learning in Machine Learning

Stream: Machine Learning and Its Applications

Invited session

Chair: *Zakria Hussain*, Computer Science, Unvertsity  
College London, Gower Street, WC1E 6BT, London,  
United Kingdom, Z.Hussain@cs.ucl.ac.uk

## 1 - On new model selection methods for error correcting output codes (ecoc)

*Sureyya Ozogur-Akyuz*, Faculty of Engineering and  
Natural Sciences, Department of Electronics, Sabanci  
University, Sabanci University, Faculty of Engineering  
and Natural Sciences, Orhanli Tuzla, 34956, Istanbul,  
Turkey, sozogur@sabanciuniv.edu, *Terry Windeatt*

Error Correcting Output Codes (ECOC) is developed for multiclass learning problems which avoid solving multiclass problems directly and breaking it into dichotomies instead. Each dichotomy consists of a binary output code resulting with a matrix where each column is followed by a binary classifier. In this study, we choose SVM classifier for ECOC and we applied recent model selection techniques. We developed ECOC by using two recent model selection approaches in the literature where the first one is based on observed margin on test point and the second employs nonconformity measure.

## 2 - Clustering of sequences of different length with a new distance based on the kl divergence

*Emilio Parrado-Hernandez*, Signal Processing and  
Communications, Universidad Carlos III de Madrid,  
Avenida de la Universidad 31, 28911, LEGANES,  
emipar@gmail.com, *Dar Garcia-Garc*, *Fernando  
Diaz-de-Maria*

We address the problem of clustering sequences of different length. We start describing a general framework for sequence clustering. This framework combines a generative model, namely a Hidden Markov Model, with a clustering algorithm. We review the distance measures that have been proposed in the literature to compare HMMs. We then present a new distance for this framework based on the Kullback-Leibler divergence. The experimental work includes a speaker verification application where this new distance achieves a good performance.

## 3 - Re-mining positive and negative associations: does pricing matter?

*Ayhan Demiriz*, Industrial Engineering, Sakarya  
University, Esentepe Kampusu, D8 Binasi No:301,  
54187, Sakarya, ademiriz@gmail.com, *Gurdal Ertek*,  
*Ahmet Cihan*

Positive and negative association mining are well-known data mining tools to analyze vast amount of retail data. Essentially these mining tasks are performed by utilizing the transaction data. Despite being an important part of the transaction data, the pricing information has long been neglected in data mining research. A novel approach is proposed to incorporate pricing information to the data mining process and to mine the association mining results to generate new rules to understand the driving forces behind positive and negative associations.

## 4 - High-dimensional non-linear variable selection through hierarchical

*Francis Bach*, INRIA - ENS, DI/ENS Ulm, 45, rue  
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francis.bach@mines.org

We consider the problem of high-dimensional non-linear variable selection for supervised learning. Our approach is based on performing linear selection among exponentially many well-defined groups of features or positive definite kernels, that characterize non-linear interactions between the original variables. We use the natural hierarchical structure of the kernels to extend the multiple kernel learning framework to kernels that can be embedded in a directed acyclic graph, through a graph-adapted sparsity-inducing norm, in polynomial time in the number of selected kernels.

## ■ WC-35

Wednesday 11:20-12:40

GSI - S 9

### Searching Digraphs and Perfect Graphs

Stream: Graph Searching

*Invited session*

Chair: *Gena Hahn*, Informatique et recherche operationnelle, Universite de Montreal, 2920 Chemin de la tour, H3T1J8, Montreal, Quebec, Canada, hahn@iro.umontreal.ca

#### 1 - Mixed and edge search number of some perfect graph classes

*Rodica Mihai*, Department of Informatics, University of Bergen, HIB, PB 7803, 5020, Bergen, Norway, rodica\_mihai@yahoo.com, *Pinar Heggernes*

Search games in graphs have attracted significant attention in recent years, and they have applications in securing computer networks against viruses and intruders. Since graph searching is an NP-hard problem, polynomial-time algorithms have been given for solving it on various graph classes. Most of these algorithms concern computing node search number of a graph, and only few such algorithms are known for computing mixed or edge search numbers of specific graph classes. We show how to compute in linear-time mixed search number of permutation graphs and edge search number of cographs.

#### 2 - Network discovery and verification

*Matus Mihalak*, Institute of Theoretical Computer Science, ETH Zurich, 8092, Zurich, Switzerland, matus.mihalak@inf.ethz.ch, *Zuzana Beerliova*, *Alex Hall*, *Michael Hoffmann*, *Thomas Erlebach*

The Network Discovery problem is an online problem in which the input is the node set of an unknown graph  $G=(V,E)$ . The goal is to discover all edges and non-edges of  $G$  by a minimum number of measurements on  $G$ . A measurement is specified by a node of  $G$ , and it returns information about  $G$  (e.g., distances to all nodes from the specified node). We consider two different models characterized by different types of measurements. We give several upper and lower bounds on the competitive ratio (the online version) and the approximation ratio (the offline version) in both models.

#### 3 - Digraph searching

*Boting Yang*, Dept. of Computer Science, University of Regina, 3737 Wascana Parkway, S4S 0A2, Regina, Saskatchewan, Canada, boting@cs.uregina.ca

In this talk we review search problems on digraphs. We present relationships between directed searching models and undirected searching models. We show some upper bounds and lower bounds on search numbers of special digraphs. We focus on the monotonicity and complexity of directed searching problems.

## ■ WC-36

Wednesday 11:20-12:40

GSI - S 11

### Stochastic Modelling and Simulation II

Stream: Stochastic Modelling and Simulation

*Invited session*

Chair: *Zeev (Vladimir) Volkovich*, Ort Braude Academic College, Yehiam 6, 21823, Karmiel, Israel, zeev@actcom.co.il

#### 1 - Statistical games approach to machine learning

*Michael Khachay*, Ural Branch of RAS, Institute of Mathematics and Mechanics, S.Kovalevskoy, 16, 620219, Ekaterinburg, Russian Federation, mkhachay@imm.uran.ru

A general training pattern recognition task is reformulated in the statistical games theory terms. A special case of the problem, in which a given finite set of patterns is classified with the best quality, is considered. As in the general case, all information about the classes' distributions is given by finite sample, and the required decision rule is a function from the sample space to the set of colorings of the finite set to be classified. The minmax theorem for several cases of the latter problem is proved. Bayesian approach to the appropriate statistical games is considered as well.

#### 2 - On asymptotical equivalence of statistical criteria in discrete problems

*Alexander Grusho*, Probability theory, Moscow State University, GSP-2, GSP-2, GSP-2, Moscow, grusho@yandex.ru, *Elena Timonina*, *Zeev (Vladimir) Volkovich*, *Zeev Barzily*

Statistical hypothesis testing can lead in many discrete problems to tedious computational tasks as it is hard to check if the observed values belong to the critical area. Thus, simplified criteria, with possible altered statistical features, are applied. In this paper two criteria groups of simple hypotheses against composite alternatives are considered on a set of finite discrete spaces. The first sequence contains consistent rules and the second one is composed from their simplified versions. We present the conditions for which the second sequence is also consistent for all alternatives.

#### 3 - Measure valued differentiation and series expansions in positive systems

*Fazia Aoudia-rahmoune*, Operational Research, Laboratory LAMOS University of Bejaia, Laboratory LAMOS University of Bejaia, Traga Ouzemmour, 06000, Bejaia, Algeria, fofourah@yahoo.fr

Positive Systems are Stochastic Systems in the relevant variables assume a positive values such as queueing systems, traffic models, transportation systems, Markov chains etc. The performance of this systems may be depend on a design parameter. When it comes to sensitivity analysis, control or optimisation, one seeks to compute derivatives. This paper provides series expansions of the stationary distribution of a finite Markov chain. This leads to an efficient numerical algorithm. Numerical examples are given to illustrate the performance of the algorithm.

#### 4 - K-nearest neighbors' stochastic models in the cluster stability problem

*Zeev (Vladimir) Volkovich*, Ort Braude Academic College, Yehiam 6, 21823, Karmiel, Israel, zeev@actcom.co.il, *Zeev Barzily*, *Renata Avros*

We consider two K-Nearest Neighbors (K-NN) probability models related to the cluster validation problem. The partitions are estimated by pairs of clustered samples. The first model assumes the Binomial Distribution for the amount of K-NN belonging to the point's sample with a success probability of 0.5. Here, a summarizing p-values index, of the worst cluster, evaluates the partition quality. The second model uses the asymptotical behavior of the K-NN quantity. Numerical experiments exhibit a good capability of the methodologies to detect the true number of clusters.

## ■ WC-37

Wednesday 11:20-12:40

GSI - S 12

### Decision Theory and Analysis - 2

Stream: Decision Analysis

*Contributed session*

Chair: *Mauricio Ruiz-Tagle*, Facultad de Cs. de la Ingeniería, Universidad Austral de Chile, General Lagos 2086, Campus Miraflores, Valdivia, Chile, [mruiztag@uach.cl](mailto:mruiztag@uach.cl)

#### 1 - Performance indicators for the motorway infrastructure concession considering the users' requirements

*Mariana Brochado*, Road Infrastructure Concession, National Land Transportation Agency, Setor Bancário Norte (SBN), Quadra 2, Bloco C, 70.040-020, Brasília, DF, Brazil, [marianabrochado@gmail.com](mailto:marianabrochado@gmail.com), *Javier Faulin*

This paper proposes a procedure for the assessment and prioritization of performance indicators of the motorway infrastructure concessionaries' activities in Brazil. One of the National Land Transportation Agency duties is monitoring these activities to fulfill some required quality standards. A survey with experts was performed using the Quality Function Deployment-QFD. Thus, a quantitative analysis relates the user's required quality with the technical quality of the road, using a methodology of value theory. Likewise, monitoring activities were prioritized and the road performance defined.

#### 2 - Measuring bank customer behavior

*Maria Mavri*, Business Administration, University of the Aegean, 8 Michalon Street, 82100, Chios, [m.mavri@ba.aegean.gr](mailto:m.mavri@ba.aegean.gr), *Vassilis Angelis*, *Katerina Dimaki*

Banks face the hard competition by understanding the needs of their customer's and reacting to the changes of their behavior. Customer satisfaction is recognized as being highly associated with customer value. Enhancement of existing relationships with customers is of pivotal importance to banks. Customer's behavior depends on a multitude of factors, related to bank, to himself and to economical environment. The objective is to "formulate" customer's behavior, as a continuous function, to identify and quantify the factorial variables and define the form of this specified function.

#### 3 - Perturbation results for retrieving priority vectors from pairwise comparison matrices

*Esther Dopazo*, Facultad de Informatica, Universidad Politecnica Madrid, Campus de Montegancedo, 28660, Boadilla del Monte, Spain, [edopazo@fi.upm.es](mailto:edopazo@fi.upm.es), *Mauricio Ruiz-Tagle*, *Myriam Serrano*

Pairwise comparison matrices play an important role in multicriteria decision making. They are commonly used for assessing the relative importance of several competing alternatives in terms of a single criterion.

A wide range of techniques have been developed to compute priority vectors from preference information contained in a pairwise comparison matrix.

We consider pairwise comparison matrices subject to perturbations and we evaluate the effect of such perturbations in the solutions given by the different methods. Some parameters are proposed for error analysis.

#### 4 - A model for computing a group priority vector under incomplete information

*Mauricio Ruiz-Tagle*, Facultad de Cs. de la Ingeniería, Universidad Austral de Chile, General Lagos 2086,

Campus Miraflores, Valdivia, Chile, [mruiztag@uach.cl](mailto:mruiztag@uach.cl), *Esther Dopazo*

We consider a group decision-making problem where preferences given by the experts are articulated into the form of pairwise comparison matrices. In many cases, experts are not able to efficiently provide their preferences, resulting incomplete pairwise comparison matrices. Our goal is to develop a method to retrieve a group priority vector dealing with incomplete information. We establish an optimization problem in which similarity functions and a parametric consensus function are defined. A Log GP formulation is considered to provide a procedure to compute the solution

## ■ WC-38

Wednesday 11:20-12:40

GSI - S 13

### Derivative Pricing

Stream: Numerical Methods in Finance

*Invited session*

Chair: *Susanne Kruse*, S-University of Applied Sciences, Hochschule der Sparkassen-Finanzgruppe, Simrockstr 4, 53179, Bonn, Germany, [susanne.kruse@dsgv.de](mailto:susanne.kruse@dsgv.de)

#### 1 - Pricing and hedging asian basket spread options

*Michèle Vanmaele*, Applied Mathematics and Computer Science, Ghent University, Krijgslaan 281, S9, 9000, Gent, [michele.vanmaele@ugent.be](mailto:michele.vanmaele@ugent.be), *Griselda Deelstra*, *Alexandre Petkovic*

Asian, basket and spread options have been extensively studied. However, few papers deal with the pricing of general Asian basket spread options. We aim to fill this gap. We develop approximations formulae based on comonotonicity theory and moment matching methods to obtain prices and Greeks in a short computation time. We compare their relative performances and explain how to choose the best approximation technique as a function of the Asian basket spread characteristics. We give explicitly the Greeks for our proposed methods. We extend our results to options denominated in foreign currency.

#### 2 - A stochastic approach to the valuation of barrier options in heston's stochastic volatility model

*Susanne Griebisch*, School of Finance and Economics, University of Technology Sydney, PO Box 123 Broadway, 2007, Sydney, NSW, Australia, [susanne.griebisch@uts.edu.au](mailto:susanne.griebisch@uts.edu.au), *Kay Frederik Pilz*

In this study we derive (semi-)analytical solutions for the value of continuous barrier options in the presence of stochastic volatility. First we focus on the case where the underlying asset price evolves according to Heston's stochastic volatility model and restrict the interest rate spread as well as the correlation to be equal to zero. In the second part we show how approximation formulas for barrier options in the Heston model with an interest rate spread unequal to zero and specific correlation structures can be obtained. We compare our approach with other numerical pricing techniques.

#### 3 - A robust regression Monte Carlo method for pricing high-dimensional american-style options

*Christian Jonen*, Mathematical Department, University of Cologne, Weyertal 86-90, 50931, Köln, [cjonen@math.uni-koeln.de](mailto:cjonen@math.uni-koeln.de)

We propose a new Monte Carlo method based on robust regression and the dynamic programming principle in terms of the optimal stopping time for pricing multi-asset American options. By using robust regression instead of ordinary least squares, we are able to get a more accurate approximation of the continuation value due to detection of outliers. We extend approaches for variance reduction by importance sampling for American options, and we focus on stochastic approximation and optimization methods. Overall, we improve convergence in comparison to existing Monte Carlo methods significantly.

## ■ WC-39

Wednesday 11:20-12:40

GSI - S 14

### Flexible Manufacturing Systems

Stream: Scheduling

Contributed session

Chair: *Mustafa Yuzukirmizi*, Dep. of Industrial Eng., Kirikkale University, 71451, Kirikkale, Turkey, myuzukirmizi@kku.edu.tr

#### 1 - A capacity allocation problem with tooling costs in flexible manufacturing systems

*Selin Özpeynirci*, Izmir Ekonomi Üniversitesi, Sakarya Cd. No 156, 35330, Izmir, Turkey, selin.ozpeynirci@ieu.edu.tr, *Meral Azizođlu*

In this study we consider a capacity allocation problem in flexible manufacturing systems where a set of operations is assigned to the numerically controlled machines together with their required tools. The usage of the required tools incurs a cost and the machines have limited time and tool magazine capacities. We aim to maximize the net profit, i.e., the total weight of the assigned operations minus the total cost of the used tools. We obtain powerful upper and lower bounds on the optimal profit values using lagrangean relaxation based approaches.

#### 2 - Production scheduling with alternative process plans

*Roman Capek*, Department of Control Engineering, Czech Technical University in Prague, Technicka 2, 16627, Prague 6, Czech Republic, Czech Republic, capekr1@fel.cvut.cz, *Zdenek Hanzalek*, *Premysl Sucha*

We deal with a scheduling problem with alternative process plans. This article is motivated by production of wire bunches where certain parts can be processed manually or using different types of machines. We propose the problem representation based on the Petri nets formalism allowing to define alternatives and parallelism within one data structure. An ILP model is formulated to obtain optimal solution. We suggest a heuristic solution based on resolving resource conflicts by adding new precedence constraints between tasks. Finally we present performance evaluations of the proposed algorithm.

#### 3 - Optimal production strategy under fluctuating demands: technology versus capacity

*Yang Liu*, Department of Logistics and Maritime Studies, HongKong Polytechnic University, Department of Logistics and Maritime Studies, The Hong Kong Polytechnic University, Hung Hom, Hong Kong, 852, Hong Kong, Hong Kong, lgt.yangliu@polyu.edu.hk, *Chi To Ng*

This paper provides a comparative analysis of five possible production strategies under fluctuating demands with respect to two kinds of investments, namely flexible technology and flexible capacity. The study formulates a manufacturer's decision-making operation process comprising technology level, capacity amount, production quantity and price setting. We evaluate each strategy and show how production cost structure, operation timing and investment costing environments affect a firm's strategic decisions. Our results show that there are no sequential effects of the above two investments.

#### 4 - Multi-class closed queueing network models for flexible manufacturing systems with finite capacities

*Mustafa Yuzukirmizi*, Dep. of Industrial Eng., Kirikkale University, 71451, Kirikkale, Turkey, myuzukirmizi@kku.edu.tr

In this study, closed queueing network models for Flexible Manufacturing Systems are analyzed. The system consists of different classes of customers which vary in their service requirements and routes. In the model, the resources may have limited waiting spaces with Blocking After Service mechanism. We study the interference of customer classes, service times and blocking mechanism and derive several useful properties. We present a new state description to obtain equilibrium state probabilities and propose a very practical product-form approximation method.

## ■ WC-40

Wednesday 11:20-12:40

GSI - S 27

### Sustainable energy systems

Stream: SD modelling in sustainable development

Invited session

Chair: *Erik Pruyt*, MOSI, Vrije Universiteit Brussel, Pleinlaan 2, 1050, Brussels, Belgium, epruyt@vub.ac.be

#### 1 - Nuclear phase-out in Belgium: is it sustainable?

*Pierre Kunsch*, MOSI, Vrije Universiteit Brussel, Pleinlaan 2, 1050, Brussels, Belgium, pkunsch@vub.ac.be

A law has been passed in 2003 in Belgium for phasing out nuclear power plants (NPP's) in the period 2014-2025. NPP's produced in 2008 56% of the electricity in the country. Ecologists argue that the phase-out is a contribution to sustainability, but they do not provide any quantitative analysis. It is doubtful that this production can be replaced by mere energy saving, and renewable energy alone; also NPP's contribute to avoiding CO2 emissions. A system dynamics model brings more quantitative elements to the debate.

#### 2 - To biofuel OR not? how to evaluate it, that is the question!

*Cathy Macharis*, Vrije Universiteit Brussel, 1050, Brussels, Belgium, cjmachar@vub.ac.be, *Laurence Turcksin*

Several policy measures for biofuel introduction in Belgium will be evaluated. The system dynamics approach will be used to gain insight in the complex behaviour of biofuel markets over time in combination with a Multi-Actor-Multi-Criteria Analysis (MAMCA), developed by Macharis (2000). The MAMCA is a methodology to evaluate policy measures where different stakeholder's opinions are explicitly taken into account. Here, the stakeholders will be the agricultural sector, biofuel converters, -distributors, end users, car converters, government and NGOs.

### 3 - Towards a sustainable energy system? contribution and potentiality of European bio-energy

*Erik Pruyt*, Faculty of TPM, Policy Analysis Section, Delft University of Technology, Jaffalaan 5, 2600GA, Delft, Netherlands, E.Pruyt@tudelft.nl

During the recent food crisis, bio-energy was often said to increase food insecurity in developing countries. Subsequently, many European biomass projects were canceled, stalling implementation and further development of bio-energy technologies, potentially threatening long-term energy security.

This paper analyzes the potential development of European bio-energy and its contribution to a sustainability-led transition of the European energy system. The perspective taken is an exploratory system dynamics perspective with a strong focus on the exploration of deep uncertainty.

## ■ WC-41

Wednesday 11:20-12:40

GSI - S 28

### Public Applications of Simulation

Stream: Simulation Applications in Private and Public Organizations

*Invited session*

Chair: *Murat Caner Testik*, Industrial Engineering, Hacettepe University, Hacettepe Universitesi, Muhendislik Fak. Endustri Muh. Bolumu, 06800, Beytepe- Ankara, Turkey, mtestik@hacettepe.edu.tr

Chair: *Banu Yuksel Ozkaya*, Department of Industrial Engineering, Hacettepe University, Hacettepe University, Department of Industrial Engineering, 06800, Ankara, Turkey, byuksel@hacettepe.edu.tr

#### 1 - A new approach to electricity spot market modeling

*Marcus Hildmann*, Swissquant Group AG, Universitätsstrasse 9, 8032, Zürich, hildmann@swissquant.ch, *Florian Herzog*

Electricity spot markets show different behavior from other markets. The three main properties of spot markets are deterministic intraday, daily and yearly seasonality, stochastic hourly price shocks and skewed and heavy tailed prices. We present a new approach to spot price modeling, by capturing deterministic properties with a linear model with factor selection. Stochastic seasonality and shocks are modeled with structural correlation estimated with a robust factor selection algorithm. Additionally, the skewed heavy-tailed noise is modeled with corresponding distributions, such as skew-t.

#### 2 - Proposal to facilitate the process of adaptation of the balanced scorecard in the third sector for Brazilian educational organization third sector

*William Vianna*, Production Engineering, Federal University of Santa Catarina, Rua Cônego Bernardo, 100, Ap. 202, 88036570, Florianopolis, Santa Catarina, Brazil, wpwilliam@hotmail.com, *Leonardo Ensslin*, *Edilson Giffhorn*

This work is a simulation whose intention is a proposal of an adaptable construction of BSC for a nonprofit educational organization. From the difficulties was objectified to consider a facilitator process of the adaptation to unite the transitory character of the managers and the necessity of to implement corporative strategies at medium and long term. The result is the proposal of a facilitator process to BSC adaptation, composed by two phases: Stage of Consistency Evaluation of the Strategical Planning and Stage of Quality and Stage of Contextualization and the Anchor Strategy choice.

### 3 - Application of rfid technology to baggage handling system

*Stefano Carrese*, Department of Civil Engineering, University of Roma TRE, Via Vito Volterra 62, 00146, Roma, Italy, carrese@uniroma3.it, *Marialisa Nigro*, *Stefano Saracchi*

The study focus on the application of Radio Frequency Identification Data (RFID) to the Baggage Handling System (BHS) of the National flights Terminal of Fiumicino Airport. BHS presents different problems related to the times needed for the handling and the influence of these times on all the consequent airport operations. Bags can be subject to strong delays, so affecting the flights departure times and they can be lost so reducing the customer satisfaction. RFID permits to optimize the BHS, improving bags tracing, simplifying the identification procedures and ensuring a better security.

#### 4 - Simulation-based consideration of demand forecast performance evaluations

*Catherine Cleophas*, Decision Support / Operations Research Lab, University of Paderborn, Warburger Strasse 100, 33098, Paderborn, Germany, cleophas@dsor.de, *Natalia Kliewer*

As demand forecasts for revenue management influence the data they strive to predict, they are hard to evaluate. A simulation-based approach allows for the comparison of forecast evaluations given configurable market conditions. The presentation will present the model necessary for emulating a complete revenue management and booking system. This includes a complex customer model based on a set of utility functions, product sensitivities, and arrival distributions. The first experiments based on this system and their results with regard to a list of hypotheses will be described.

## ■ WC-42

Wednesday 11:20-12:40

GSI - S 3

### Recent developments from Nonconvex Programming

Stream: Nonconvex Programming: Local and Global Approaches - Theory, Algorithms and Applications

*Invited session*

Chair: *Rafael Lopez*, Mechanical Engineering, INSA Rouen, Avenue de l'Université - BP 8, 76801, Saint-Étienne-du-Rouvray Cedex - France, 76801, Saint-Étienne-du-Rouvray, rafaelholdorf@gmail.com

#### 1 - A dc programming approach for solving the symmetric eigenvalue complementarity problem

*Mahdi Moeini*, Computer Science, University Paul Verlaine - Metz, 57045, METZ, France, moeini@univ-metz.fr, *Hoai An Le Thi*, *Tao Pham Dinh*

We address the Eigenvalue Complementarity Problem (EiCP) and we offer a DC (Difference of Convex functions) programming technique for solving large scale EiCP with real symmetric matrices. This kind of problems arises in diverse engineering and scientific applications. At first, we reformulate EiCP in the form of a DC programming problem and then we apply DCA (DC Algorithm) to solve it. Computational tests show the robustness, efficiency, and high speed of the method in comparison to the commercial softwares.

## 2 - An efficient discretization method in semi-infinite optimization

Mohand Ouanes, Mathematics, University of Tizi-Ouzou Algeria, University of Tizi-Ouzou, Algeria, 15000, Tizi-Ouzou, ouanes\_mohand@yahoo.fr

An efficient discretization method in semi-infinite optimization. In this paper we propose a new decreasing method for solving semi-infinite problems by using an efficient discretization procedure. The method consists in locating all the active points of discretization with the help of a reduced technique in global optimization. The convergence of the proposed algorithm is proved and the numerical experiments on several test problems are presented that show its efficiency.

Keywords: Semi-infinite optimization, discretization, Global optimization

## 3 - Approximating the probability density function of the optimal point of non convex functions

Rafael Lopez, Mechanical Engineering, INSA Rouen, Avenue de l'Université - BP 8, 76801, Saint-Étienne-du-Rouvray Cedex - France, 76801, Saint-Étienne-du-Rouvray, rafaelholdorf@gmail.com

This paper aims at approximating the probability density function (PDF) of the optimal point of non convex functions. The polynomial chaos expansion is employed and the resulting functional is minimized using stochastic approximation techniques. Several non-convex functions are analyzed and the validation of the proposed methodology is done comparing its results to those obtained using the Monte Carlo Simulation. The numerical analysis shows that the proposed methodology has successfully approximated the PDF of the solution of the optimization process of all the tested functions.

## ■ WC-43

Wednesday 11:20-12:40

GSI - S 10

### Capital Markets and Control

Stream: Long Term Financial Decisions

Invited session

Chair: Wolfgang Bessler, BWL - Finanzierung und Banken, Justus-Liebig-Universität Giessen, Giessen, Germany, Wolfgang.Bessler@wirtschaft.uni-giessen.de

#### 1 - Are private equity investors boon OR bane for an economy? - a theoretical analysis

Christian Koziol, Chair of Corporate Finance, WHU - Otto Beisheim School of Management, Burgplatz 2, 56179, Vallendar, Germany, christian.koziol@whu.edu

We provide a theoretical foundation for the controversial debate about the economic consequences of private equity transactions. Applying a simple model framework, we compare the maximum acquisition prices for the takeover as well as the subsequent optimal investment volumes for both investors to reveal reasons for an inefficient behavior. We find that most of the usual arguments against private equity transactions cannot explain an inefficient behavior by private equity firms, whereas a high amount of leverage and informational advantages can.

#### 2 - Currency-dependent differences in the implied probabilities of default of euro and us-dollar denominated foreign currency sovereign bonds

Andreas Rathgeber, Wirtschaftswissenschaften, Universität Augsburg, Universitätsstraße 16, 86135,

Augsburg, Germany, andreas.rathgeber@wiwi.uni-augsburg.de

That credit spread curves at the single-issuer level significantly differ across currencies, is proven empirically. Despite a few smaller shortcomings these studies lack of a potential home bias. This work contributes to the literature by analyzing whether these findings also hold for sovereign implied default probabilities. By introducing a dual currency reduced form model the main result is, that the differences are due to the correlation structure between exchange rate and credit risk.

#### 3 - Capital markets and corporate control: empirical evidence from hedge fund activism in Germany

Wolfgang Bessler, BWL - Finanzierung und Banken, Justus-Liebig-Universität Giessen, Giessen, Germany, Wolfgang.Bessler@wirtschaft.uni-giessen.de

During the last decade the German financial system has changed from a bank dominated system to a more financial market oriented system. Most importantly, the corporate governance and corporate control structure underwent significant changes. In fact, hedge funds and other activist investors are increasingly taking advantage of a perceived control vacuum. One interesting question is whether this stronger capital market orientation led to an increase in shareholder value. We find empirical evidence that the engagement of activist shareholders increased shareholder value in the short run.

## ■ WC-45

Wednesday 11:20-12:40

GSI - S 33

### Modeling and Analyzing Social/Behavioral/Technical OR Problems

Stream: OR Applications in Education

Invited session

Chair: Sevgi Ozkan, Informatics Institute, Middle East Technical University, Ismet Inonu Bulvari, 06531, Ankara, Turkey, sozkan@ii.metu.edu.tr

Chair: Seren Basaran, Secondary Science and Mathematics Education, Middle East Technical University, Informatics Institute - METU, 06531 Ankara Turkey, Turkey, sbasaran@ii.metu.edu.tr

#### 1 - Examining university graduates' entrepreneurship through the design and application of an OR survey model

Vassilis Kostoglou, Department of Informatics, Alexander TEI of Thessaloniki, P.O. Box 141, 57400, Thessaloniki, Greece, vkostogl@it.teithe.gr

This work concentrates on the analysis of all principal parameters describing university graduates' entrepreneurial activities. A survey model has been designed for this purpose and a structured questionnaire was addressed to a large representative sample of self-employed graduates. The impact of factors such as gender, department and faculty of origin, place of residence, marital status, type of secondary education, degree grades and postgraduate studies, on main entrepreneurial issues is thoroughly examined with the use of appropriate statistical analysis.

#### 2 - Modelling personal learning in the use of modern technologies

Jo Smedley, Newport Business School, University of Wales, Newport, Allt-yr-yn Avenue, Newport, NP20 5DA, Newport, United Kingdom, jo.smedley@newport.ac.uk

Learning and teaching practices in Higher Education have developed rapidly in recent years with the use of modern technologies enabling learning through a range of non-traditional approaches. This presentation discusses a traditional model of learning, suggesting developments to reflect modern technological applications. Case study examples involving experiences by staff and students will demonstrate the value of communities of practice and the impact of subject differences as participants progress through their personal learning stages.

## Wednesday 12:55-14:15

### ■ WD-01

Wednesday 12:55-14:15

Beethoven

### Industrial Optimization

Stream: Combinatorial Optimization

Contributed session

Chair: *Nivaldo Coppini*, Industrial Engineering Post Graduation, Uninove University, Av. Francisco Matarazzo, 612, 05001100, São Paulo, São Paulo, Brazil, ncoppini@uninove.br

#### 1 - Optimization for siplace placement systems

*Petra Bauer*, CT PP 7, Siemens AG, Otto-Hahn-Ring 6, 81370, München, Bayern, Germany, bauer.petra@siemens.com

The challenges our team at Siemens CT is facing in the context of printed circuit board assembly range from optimizing the line performance for a given job to optimizing the overall production process by finding appropriate manufacturing and set-up strategies and providing algorithms in order to support them.

We introduce the SIPLACE machines and give insight in manufacturing concepts and setup-strategies as well as the optimization problems we have been working on.

Especially, we consider the concept of constant tables that helps our customers to save setup-times and feeder equipment.

#### 2 - Mathematical models for margin calculation

*Dmitry Krushinsky*, Department of Operations, University of Groningen, Nettelbosje 2, 9747 AE, Groningen, Netherlands, d.krushinsky@rug.nl, *Boris Goldengorin*

The problem of margin calculation (minimization of regulatory margin requirement) for an account at a brokerage company is considered. For an account containing derivatives it is a non-trivial combinatorial problem. While existing models lack flexibility to adapt to changing regulations and use unjustified heuristics, we propose two classes of models, based on the multidimensional assignment and the p-Median problems, respectively. Our models are free of the mentioned drawbacks and can be used as a tool for constructing the margining system.

#### 3 - A new cutting tool wear detection method using the lifting technique

*Nivaldo Coppini*, Industrial Engineering Post Graduation, Uninove University, Av. Francisco Matarazzo, 612, 05001100, São Paulo, São Paulo, Brazil, ncoppini@uninove.br, *Fabio Pereira*, *Elesandro Baptista*

In order to meet the current requirements of cost, quality and time in the machining process, it is imperative an adequate calibration of working parameters. If a production time reduction can be achieved by choosing higher cutting speeds, it can also accelerate the tool wear at the cutting edge, reducing the cutting tool life and creating quality problems during the machining. This work proposes a new efficient approach to cutting tool wear detection using tool images and the lifting technique. This new approach is described in this paper and results are presented to show its efficiency.

#### 4 - A new relaxation scheme for mpeccs

*Sonja Veelken*, Zentrum Mathematik, M1, Technische Universität München, Boltzmannstr. 3, 85748,

Garching, Germany, veelken@ma.tum.de, *Michael Ulbrich*

In this talk we present a new relaxation scheme for MPECs, where the complementarity constraints are replaced by a reformulation that is exact for sufficiently nondegenerate components and relaxes only the remaining conditions. A positive parameter determines to what extent the complementarity conditions are relaxed. We consider properties, stationary points and solutions of the relaxed problems and present convergence results for stationary points of a sequence of relaxed problems. Numerical results show that a corresponding solution approach combines good efficiency with high robustness.

## ■ WD-02

Wednesday 12:55-14:15

Schumann

### Heuristic Approaches for Transportation Planning

Stream: Transportation Planning

*Invited session*

Chair: *Frank Schultmann*, Business Administration, Construction Management and Economics, University of Siegen, Paul-Bonatz-Strasse 9-11, 57076, Siegen, Germany, frank.schultmann@uni-siegen.de

#### 1 - A greedy algorithm for vehicle routing problems with simultaneous pickup and delivery

*Bourguiba Moncef*, Methodes Quantitatives Appliquees, ISG Tunisie, Hamadi Boutefaha ZARZIS 4194, Hamadi Boutefaha ZARZIS 4194, 4194, ZARZIS, Tunisie, Tunisia, bourguiba.moncef@voila.fr, *Rebai Abdelwaheb*

In this paper we propose the vehicle routing problem with simultaneous pickup and delivery (VRPSPD) and greedy algorithm combined with exchange method for solving many instance of it. The method start by constructing some acceptable solution than ameliorate it in the second step. The objective function is to optimise the total distance travelled subject to vehicle capacity and customer priority. The proposed method is tested using many data sets from literature, the result obtained show a competitive results.

#### 2 - Particle swarm optimization for real-life vehicle routing problem

*Daniela Ponce*, Department of Information Technologies, Faculty of Informatics and Management, University Hradec Králové, Rokitanského 62, 50003, Hradec Králové, Czech Republic, daniela.ponce@uhk.cz, *Martin Gavalec*

A model of vehicle routing problem (VRP) is described, considering various real-life aspects such as different vehicle loading capacities, service times and costs, time-dependent route costs and service times, real-time customer demands. A real-life VRP of a small-size Czech transport company is represented as a dynamic multi-depot VRP with time windows involving heterogeneous fleet of vehicles with different service times requiring simultaneous pickup and delivery. The problem is resolved by particle swarm optimization. Several metaheuristics are presented and simulation results are reported.

#### 3 - A cross entropy based heuristic for solving the vehicle routing problem with time windows

*Tai-Yu Ma*, Laboratoire d'Economie des Transports, 14, Avenue Berthelot, 69007, Lyon, tai-yu.ma@let.ish-lyon.cnrs.fr

This study proposes a Cross Entropy based heuristic for solving the vehicle routing problem with time windows. A set of probability distributions corresponding to available number of vehicles are utilized independently to guide these vehicles towards optimal routing paths. Based on the minimization of cross entropy, optimal transition probability is iteratively estimated. The advantage of the proposed approach resides on its mathematical property based on important sampling theory. The Solomon's 100-customer benchmark instances are tested to demonstrate its efficiency and effectiveness.

## ■ WD-03

Wednesday 12:55-14:15

Reger

### TRAFFIC CONTROL

Stream: Transportation

*Invited session*

Chair: *Bernhard Friedrich*, Institut für Verkehr und Stadtbauwesen, Technische Universität Braunschweig, Pockelsstr. 3, Braunschweig, 38106, Braunschweig, Germany, friedrich@tu-braunschweig.de

#### 1 - Data fusion techniques for traffic state estimation - dino within dmotion

*Daniel Schmidt*, Leibniz Universität Hannover, Institut of Transport, Road Engineering and Planning, Appelstr. 9A, 30167, Hannover, Germany, schmidt@ivh.uni-hannover.de, *Bernhard Friedrich*

This paper presents the data fusion techniques in the R&D project - Dmotion, in which the system of real-time traffic state estimation (DINO) has been further developed. DINO is an iterating two phase algorithm: an assignment of the Origin-Destination-Matrix (3DAS, de Romph) and a calibration of the OD-Matrix (information minimization algorithm, van Zuylen). One data fusion technique is to involve Floating Car Data into the calibration algorithm. By specifying a travel time based classification an indirect calculation of correction factors within the calibration algorithm is used.

#### 2 - Practical offset optimization in urban road networks based on cell transmission model and genetic algorithms

*Jannis Rohde*, Institute of Transport, Road Engineering and Planning, Leibniz Universität Hannover, Appelstraße 9A, 30167, Hannover, Germany, rohde@ivh.uni-hannover.de, *Bernhard Friedrich*

The CTM by Daganzo was enhanced in order to deal with urban road networks characteristics, i.e. signalized multi-lane junctions and flow reductions for left-turning streams. The combination of CTM, GA and a graphical user interface allows for quick and elaborate offset optimization. The user can choose between several decision variables: delay times, number of stops, emissions and fuel consumption. This approach was applied to a real urban road network in Hannover. The impacts on all decision variables were analysed using microsimulations as well as before-after studies of real travel times.

#### 3 - Concept for a decentralized adaptive traffic signal control in urban networks based on c2i-communication data and adaptive dynamic programming (adp)

*Christian Priemer*, Institute of Transport, Road Engineering and Planning, Leibniz Universität Hannover, Appelstr. 9a, 30167, Hannover, Germany, priemer@ivh.uni-hannover.de

The paper provides a concept to process in future available C2I-data within a new traffic signal control in urban networks based on ADP. The received C2I-data will be used to forecast arrival pattern and queue lengths within each access lane. Due to the low or medium penetration rate on communication cars assumed in the near future, the received C2I- data are not sufficient to obtain validated arrival pattern and queue length. Hence, a method for queue length estimation will be used to generate additional sufficient input data for the ADP algorithm to optimize traffic signal control.

## ■ WD-04

Wednesday 12:55-14:15

Liszt

### Parallel Machine Scheduling

Stream: Scheduling

Invited session

Chair: *Müge Muhafız*, Korutürk Mah. Vali Hüseyin Ödütçen Cad. No 19 D3 Balçova, 35330, İzmir, mmuhafiz@gmail.com

#### 1 - Parallel machine scheduling with preparation times

*Wafaa Labbi*, Faculty of Mathematics, USTHB University, BP 32, El-Alia, Bab-ezzouar, 16111, Algiers, fawalab@yahoo.fr, *Mourad Boudhar*

The aim of this article is to study the scheduling problem of  $n$  jobs on  $m$  identical parallel machines, no preemption is allowed in presence of  $k$  specialized workers to minimize the makespan. In this context, the presence of specialized workers is necessary to prepare the machines and jobs. In the first time we propose an approximation algorithm based on linear programming formulations. Later on, we prove the NP-hardness of the general problem and we proposed lower bound. Polynomial subproblem, also, heuristic algorithms are presented with numerical experimentations

#### 2 - New algorithms for unrelated parallel machine scheduling problem

*Ruben Ruiz*, Departamento de Estadística e Investigación Operativa Aplicadas y Calidad, Universidad Politécnica de Valencia, Camino de Vera S/N, 46021, Valencia, Spain, rruiz@eio.upv.es, *Luis Fanjul Peyro*, *Thijs Urlings*

We consider the unrelated parallel machine scheduling problem. We present several novel algorithms, one based in iterated greedy (IG) methods, two based on Restricted Local Search (RLS), three more based on specific structural properties of the problem. Lastly, we also present a heuristic that is a hybrid of some of the previous best performing ones. We have carried out comprehensive computational campaigns and careful statistical analysis. The results prove that our proposed methods are significantly more effective and efficient than the current state-of-the-art.

#### 3 - An anticipative scheduling approach with controllable processing times

*Sinan Gürel*, Warwick Business School, Warwick University, CV4 7AL, Coventry, United Kingdom, sinan.gurel@wbs.ac.uk, *M. Selim Akturk*, *Ersin Körpeoğlu*

Preparing machine schedules by considering possible disruption times is critical for rescheduling performance. We consider parallel machine scheduling with controllable processing times. We assume a match-up time strategy such that in case of a disruption a repaired schedule has to catch-up initial schedule at some point. This implies increased manufacturing costs due to decreased processing times in repaired schedule. We show that making anticipative job sequencing decisions, based on failure and repair time distributions, one can repair a disrupted schedule by incurring less cost.

#### 4 - Dynamic lead time management

*Müge Muhafız*, Korutürk Mah. Vali Hüseyin Ödütçen Cad. No 19 D3 Balçova, 35330, İzmir, mmuhafiz@gmail.com, *Arslan Ornek*, *Selin Özpeynirci*, *Cemalettin Öztürk*, *Ozge Oktay*, *Ufuk Dumanli*

Classical MRP assumes constant lead times, which, in real life, change dynamically depending on the current load of the shop floor. This study presents a mixed integer programming model for production planning and scheduling problem in multi-level, multi-machine structure. We consider the time capacities of machines, due dates, sequence-dependent setup times and precedence relations of operations. The aim is to schedule the operations on a set of eligible machines and determine dynamic lead times of orders such that total earliness and tardiness penalties and idle times are minimized

## ■ WD-05

Wednesday 12:55-14:15

Haydn

### Railway Scheduling

Stream: Scheduling

Invited session

Chair: *Syed Hasnain Haider Gilani*, Faculty of Information Technology, University of Central Punjab Lahore Pakistan, 31 Main Gulberg Lahore Pakistan, Tele +92-24-5753314-7, 54000, Lahore, Pakistan, syedhasnain\_haider@hotmail.com

#### 1 - Scheduling trains in single-line working

*Francis Sourd*, Innovation & Research, SNCF, Paris, France, Francis.sourd@snf.fr, *Christian Weber*

On a double track railway, single-line working means that only one track out of two is used, typically because one of the tracks is out of use for maintenance or because of damage or obstruction. We study how to reschedule the trains in order to minimize the impact of the maintenance or of the damage. We show how to model the problem as a theoretical scheduling problem with setup times then we propose a pseudopolynomial algorithm to solve it. We also show how the algorithm is implemented in a tool and how the algorithm can deal with robust solutions or the re-opening of the closed track.

#### 2 - Rail track inspection scheduling

*Sebastien Lannez*, bd Menilmontant, 75011, PARIS, sebastien.lannez@gmail.com, *Christian Artigues*, *Michel Gendreau*, *Nicolas Marcos*

The Rail Track Inspection Scheduling Problem (RTISP) is an arc routing problem with capacity (CARP), time windows (CARP-TW) and an heterogeneous fleet (H-CARP). Long term horizon, graph representation size, and strong needs for a good interactivity between the tool and the user, guided us towards using heuristic methods. A decomposition based on column generation and time slot aggregation is presented and numerically tested on a generated dataset. The impacts of various column generation schemes are detailed.

#### 3 - Vehicle scheduling for rail freight services

*Hanno Schülldorf*, DB Mobility Logistics AG, Stephensonstr. 1, 60326, Frankfurt, Germany, hanno.schuellendorf@bahn.de

Due to many contributions on this subject, vehicle scheduling seems to be a solved problem. However, additional constraints like maintenance planning and homogeneity make the problem rather hard, especially for large instances. We decompose the problem in three parts which of the first is a min-cost circulation problem; the second part is a min-max-problem under certain constraints, and the third part includes the maintenance planning which we describe as a multicommodity flow problem. Each part can be solved separately, or can be omitted because of other available solutions.

#### 4 - An optimization of multi objective single track train scheduling problem

*Syed Hasnain Haider Gilani*, Faculty of Information Technology, University of Central Punjab Lahore Pakistan, 31 Main Gulberg Lahore Pakistan, Tele +92-24-5753314-7, 54000, Lahore, Pakistan, syedhasnain\_haider@hotmail.com, *Syed Muhammad Zaki, Asim Raza, Yasir Imtiaz Khan*

Single track train scheduling focused toward finding overall optimal solution of the whole system. Researchers ignored the individual schedule of each train. In this paper the meaning of optimal schedule is redefined. We define sets of stations having predefined priorities. Schedule of each train at each station of a particular set is an objective of our system. First, in this model every train meets its schedule time for those stations that belong to highest priority set than low priority set.

#### ■ WD-06

Wednesday 12:55-14:15

Koch

#### GOR Diploma Awards

Stream: GOR-Awards

*Invited session*

Chair: *Stefan Nickel*, Institut fuer Operations Research, Universitaet Karlsruhe, Geb 11.40, 76128, Karlsruhe, Baden-Wuerttemberg, Germany, Stefan.Nickel@kit.edu

Chair: *Alf Kimms*, Mercator School of Management, University of Duisburg-Essen, Lotharstr. 65, LB 125, 47057, Duisburg, Germany, alf.kimms@uni-due.de

#### 1 - Optimization and simulation of traffic flows in the case of evacuating urban areas

*Klaus-Christian Maassen*, Mercator School of Management, University of Duisburg-Essen, Lotharstrasse 65, 47048, Duisburg, Germany, klaus-christian.maassen@uni-due.de

When urban areas need to be evacuated, a large number of vehicles must be routed through street networks in such a way that e.g. the total evacuation time is as small as possible. Hence, a traffic routing optimization model has to be solved. However, traffic flows are dynamic in nature so that traffic simulation is required for adequate consideration of such effects. This master thesis presents a two-staged evacuation planning approach that contains optimization and simulation of traffic flows. The applicability to real-world-sized problems is approved for a neighborhood in a German city.

#### 2 - Distance-constrained vehicle routing

*Markus Reuther*, Optimization, Zuse-Institut Berlin, Takustrasse 7, 14195, Berlin, Germany, reuther@zib.de

The Distance-constrained Vehicle Routing Problem (DVRP) deals with the construction of a minimum length set of tours in a graph, each of bounded individual length, that start from a depot and visit all nodes. We propose lower bounds from a new flow formulation of the DVRP, which is of polynomial size, but implies all subtour elimination constraints. We also show that the Lin-Kernighan heuristic for the TSP can successfully be adapted to solve large scale DVRPs. These techniques are used to solve DVRPs arising in an application at DB Stadtverkehr GmbH.

#### 3 - Branch-and-price algorithms for the traveling tournament problem (ttp)

*Ulrich Schrempf*, Mauerstr. 60, 52064, Aachen, Germany, ulli.schrempf@googlemail.com

The TTP is a sports league scheduling problem. The talk presents a branch-and-price algorithm based on a new compact formulation. The variables of this formulation correspond to arcs in a network. The extensive formulation resulting from Dantzig-Wolfe decomposition is well-structured with a set-partitioning master problem. We identify the pricing problem as a shortest-path problem (SPP) with resource constraints. By expanding the network, it is possible to solve it as an ordinary SPP. Exact techniques allow the elimination of arcs in the network in order to accelerate the algorithm.

#### ■ WD-07

Wednesday 12:55-14:15

GSI - S 29

#### Public transportation network design

Stream: Optimization in Public Transport

*Invited session*

Chair: *Leo Kroon*, Rotterdam School of Management (RSM), Erasmus University Rotterdam, P.O. Box 1738, 3000 DR, Rotterdam, Netherlands, LKroon@rsm.nl

Chair: *Anita Schoebel*, Fakultät für Mathematik, Georg-August Universität Göttingen, Lotzestr. 16-18, 37083, Göttingen, Germany, schoebel@math.uni-goettingen.de

#### 1 - Optimisation of public transportation network configuration and frequency

*Hiroshi Shimamoto*, Graduate School for International Development and Cooperation, Hiroshima University, 1-5-1, Kagamiyama, Higashi-Hiroshima City, 739-8529, Japan, 739-8529, Higashi Hiroshima, Hiroshima, Japan, shimamoto@hiroshima-u.ac.jp, *Fumitaka Kurauchi, Jan-Dirk Schmoecker, Michael Bell*

This paper proposes a model for deciding optimal public transportation configuration and frequency considering transferring behaviour. The proposed model is formulated as a bi-level optimisation problem, minimising both the route and frequency of each line. The upper problem is formulated as multi-objective optimisation problem, minimising both passengers' total travel cost and total operational cost. The lower problem is a capacity-constrained transit assignment model, therefore, it is possible to consider passengers' route choice behaviour including transferring at some stops.

#### 2 - Designing complementary networks of public transport

*Mireia Roca-Riu*, CENIT - Centre for Innovation in Transport, C/ Jordi Girona, 29, 2-A, (Building NEXUS II), 08034, Barcelona, Spain, mireia.roca-riu@upc.edu, *Miquel Estrada*

A bi-level formulation and a methodology based on Tabu Search are studied to solve Bus Network Design problem for Interurban Buses. Public transport among big cities and smaller areas around should be competitive in order to decrease social and user cost. The objective function of the first level is designed to reduce global cost. In the second level, user's performance is described; an assignment where users choose the best alternative of available ones. Finally, it is applied to two theoretical networks and to Barcelona, where the results show a 5% reduction with regard to present situation.

#### 3 - Link restoration for rapid transit network incidences

*Esteve Codina*, Statistics and Operational Research, UPC, Edifici C5, Desp 216 Campus Nord, 08034,

Barcelona, Spain, esteve.codina@upc.edu, *Ángel Marín*

In this work a network design model is proposed for local link restoration in case of complete or partial disruption/malfunction of a Rapid Transit Network. The model must decide the complementary bus services to attend the demand uncovered by the disruption. The model takes into account bus capacity limitations and fleet availability as well as the dwell times of buses at stations. Also, approximations of the waiting time of passengers at stations and the possibility of balking due to excess waiting time are considered in the formulation of the problem

#### 4 - Effectiveness of control strategies for transit line operation

*Konstantinos Gkoumas*, DITS (Dipartimento di Idraulica Trasporti e Strade), Sapienza Università di Roma, Via Eudossiana 18, 00184, Rome, konstantinos.gkoumas@uniroma1.it, *Giuseppe Bellei*

The aim of this study is to test the results obtained by applying an integrated conditional priority and vehicle holding strategy to intermediate capacity transit systems. The strategy is tested within the framework of a stochastic operation model, where perturbation formation and diffusion phenomena are duly represented. A simulation model is implemented and the performance of the proposed strategy is evaluated by setting the control parameters at values, determined by a standard probabilistic optimization algorithm, so that the total transit passenger and road user journey time is minimised.

### ■ WD-08

Wednesday 12:55-14:15

GSI - S 30

#### Supply Chain Planning and Forecasting

Stream: Supply Chain Management

*Invited session*

Chair: *M.Furkan Uzar*, Industrial Engineering, Sabanci University, Sabanci University OrhanlıTuzla, 34956, Istanbul, mfuzar@su.sabanciuniv.edu

##### 1 - A multistage supply chain planning with price dependent stochastic demand

*Cheng-Chang Lin*, Transportation and Communication Management Science, National Cheng Kung University, 1 University Road, 701, Tainan, Taiwan, cclin@mail.ncku.edu.tw, *Hui-Xuan Wang*

We study a 3-echelon supply chain, material providers, manufacturer and customers in a spatial market. Even though Demands depend on the prices that the manufacturer sets, they are stochastically distributed. Manufacturer will announce the price, and plan and execute the sourcing, production and distribution operations prior to the realized demand. We used L-shaped to generate cuts for all consecutive stages and are embedded into the price decision in multistage supply chain planning. The computational results for both 2-stage and multistage will be discussed.

##### 2 - A demand substitution estimation framework for configurable products

*Emel Aktas*, Industrial Engineering Department, Istanbul Technical University, ITU Isletme Fakultesi, Macka, 34367, Istanbul, Turkey, aktasem@itu.edu.tr, *E. Alper Murat*, *Ratna Babu Chinnam*, *Gint Puskorius*, *Dingzhou Cao*

A framework is proposed to estimate the option substitution probabilities of configurable products (vehicles). Substitution probabilities are calculated based on sales events given the channel inventory data. Some substitutions are low probability events due to the large number of vehicle configurations and small sales event sample size. We propose several remedies, such as aggregation and present application results for a North American vehicle manufacturer.

##### 3 - Distribution planning of bulk lubricants at an energy company

*M.Furkan Uzar*, Industrial Engineering, Sabanci University, Sabanci University OrhanlıTuzla, 34956, Istanbul, mfuzar@su.sabanciuniv.edu, *Bülent Çatay*

We address the distribution planning problem of bulk lubricants at an energy company operating in Turkey. The problem is a multi-product, multi-period, heterogeneous fleet management problem that involves the assignment of customer orders and routing of tank trucks. The objective is to minimize the routing cost and the setup costs associated with the product changeovers. To solve this problem we develop a mixed-integer linear programming model. Since the problem is intractable for real world data we propose a greedy linear programming relaxation-based algorithm and discuss its performance.

### ■ WD-09

Wednesday 12:55-14:15

GSI - S 5

#### Transport Workforce Scheduling II

Stream: Timetabling and Rostering

*Invited session*

Chair: *Willem-Jan van Hove*, Tepper School of Business, Carnegie Mellon University, 5000 Forbes Avenue, 15213, Pittsburgh, PA, vanhove@andrew.cmu.edu

##### 1 - Tactical crew planning at Turkish state railways

*Birol Yuçeoğlu*, Faculty of Engineering and Natural Sciences, Sabanci University, Orhanlı, 34956, Tuzla, Istanbul, Turkey, biroly@su.sabanciuniv.edu, *Güvenc Sahin*

Tactical crew planning problem at Turkish State Railways involves finding the minimum crew size to operate a train schedule. The problem is to be solved for each regional crew-base station by satisfying various rules and regulations including a day-off constraint which makes the problem computationally intractable. Mimicking the current practice, we first solve the problem with a sequential approach: a minimum flow problem over a space-time network followed by an assignment problem. Then, we develop an integrated approach by using a layered network representation of the problem.

##### 2 - Truck driver scheduling and regulation (ec) no 561/2006

*Asvin Goel*, MIT-Zaragoza International Logistics Program, Zaragoza Logistics Center, Avda. Gómez Laguna 25, 1ª Planta, 50009, Zaragoza, Spain, asvin@mit.edu

European road transport undertakings must organise the work of truck drivers in a way that drivers are able to comply with driving and working hour restrictions imposed by regulation (EC) No 561/2006. This contribution presents a method for scheduling work weeks of truck drivers which fully considers this regulation for journeys made on roads in the European Union. It is proven that under certain circumstances the approach is guaranteed to succeed in finding a schedule complying with the regulation if such a schedule exists.

### 3 - Bus driver rostering problem: confronting bi-objective heuristic approaches

*Margarida Moz*, ISEG, Technical University of Lisbon, Centro de Investigação Operacional, University of Lisbon, Rua do Quelhas n<sup>o</sup> 6, 1200-781, Lisboa, Portugal, mmoz@iseg.utl.pt, *Margarida Pato, Ana Respicio*

The Bus Driver Rostering Problem is to build a roster complying with labour contract rules and company regulations plus covering all timetabled trips of vehicle tours in a specific area. Good rosters are not necessarily considered as such for both company and drivers. The problem is formulated as a bi-objective optimisation problem to minimise salary costs and to equitably distribute overtime work among drivers. Evolutionary heuristic approaches are designed and tested on a set of real-world instances while points from the true Pareto frontier are used to assess the heuristics' performance.

### 4 - Domain filtering for the intersection of set variables

*Willem-Jan van Hoeve*, Tepper School of Business, Carnegie Mellon University, 5000 Forbes Avenue, 15213, Pittsburgh, PA, vanhoeve@andrew.cmu.edu, *Ashish Sabharwal*

Many combinatorial problems can be conveniently expressed using set variables and constraints over these variables. In the context of constraint programming, the structure captured by the set variable representation can be exploited in domain filtering algorithms, and thus facilitate the solution process. We present the first polynomial-time bounds-consistency algorithm for the constraint that forbids the intersection of two set variables to have cardinality larger than one, which can be used, e.g. in sport scheduling applications. Computational results show the effectiveness of our algorithm.

## ■ WD-10

Wednesday 12:55-14:15

GSI - S 6

### Vector and Set-Valued Optimization III

Stream: Vector and Set-Valued Optimization

*Invited session*

Chair: *Elvira Hernández*, Matemática Aplicada, Universidad Nacional de Educación a Distancia, Juan del Rosal 12, 28040, Madrid, Spain, ehernandez@ind.uned.es

### 1 - A general approach for studying duality in multiobjective optimization

*Sorin-Mihai Grad*, Faculty of Mathematics, Chemnitz University of Technology, 09107, Chemnitz, Sachsen, Germany, grad@mathematik.tu-chemnitz.de, *Radu Ioan Bot*

A general duality framework in convex multiobjective optimization is established using the scalarization with  $K$ -strongly increasing functions and the conjugate duality for composed convex cone-constrained optimization problems. Other scalarizations used in the literature arise as particular cases and the general duality is specialized for some of them, namely linear scalarization, maximum(-linear) scalarization, set scalarization, (semi)norm scalarization and quadratic scalarization.

### 2 - Graphical differentiation in vector analysis and its application in optimization

*Miguel Sama*, Matemática Aplicada, Universidad Nacional de Educación a Distancia, C/Juan del Rosal, 12, 28040, Madrid, Spain, msama@ind.uned.es, *Bienvenido Jiménez, Vicente Novo*

In this talk we present new results on the existence and computation of graphical derivatives of vector maps, in special we deal with the notions of contingent epiderivative and contingent derivatives. We apply these results in order to extend some well-known result from scalar to vector optimization.

### 3 - Subgradients of set-valued maps and set optimization

*Elvira Hernández*, Matemática Aplicada, Universidad Nacional de Educación a Distancia, Juan del Rosal 12, 28040, Madrid, Spain, ehernandez@ind.uned.es, *Luis Rodríguez-Marin*

In this talk, we consider weak subgradients of a set-valued map and present a notion of strong subgradient of a set-valued map. Conditions for the existence of both types of subgradients are given. Finally, we establish several optimality conditions for a set optimization problem.

## ■ WD-11

Wednesday 12:55-14:15

GSI - S 17

### PROMETHEE & GAIA : Tutorial

Stream: Multiple Criteria Decision Analysis

*Invited session*

Chair: *Bertrand Mareschal*, Solvay Brussels School of Economics and Management, Université Libre de Bruxelles, Boulevard du Triomphe CP 210/01, 1050, Brussels, Belgium, bmaresc@ulb.ac.be

### 1 - The promethee & Gaia multicriteria decision aid methods

*Bertrand Mareschal*, Solvay Brussels School of Economics and Management, Université Libre de Bruxelles, Boulevard du Triomphe CP 210/01, 1050, Brussels, Belgium, bmaresc@ulb.ac.be, *Yves De Smet, Quantin Hayez*

The first part of the paper introduces the foundations of the PROMETHEE & GAIA methods. While PROMETHEE is used to rank a set of actions according to several criteria, GAIA provides the decision-maker with a graphical view of the decision problem including information on conflicts to solve and on the impact of the weights of the criteria on the PROMETHEE ranking. We also stress new developments including an original PROMETHEE I partial ranking display and new GAIA-type tools designed to improve the efficiency of the decision-making process and to enhance the link between PROMETHEE and GAIA.

### 2 - D-sight: a new promethee-based software

*Quantin Hayez*, SMG - Faculty of Engineering, ULB - Brussels Free University, Boulevard du Triomphe CP210/01, 1050, Brussels, Belgium, qhayez@ulb.ac.be, *Yves De Smet, Bertrand Mareschal*

D-Sight is a new software that implements the PROMETHEE & GAIA methods, including their newer extensions. It introduces new visual modelling tools and graphical representations of the results of the multicriteria analysis. The interaction with the decision-maker has been emphasized through several sensitivity analysis tools. Numerical examples will be used to illustrate the features of the software.

## ■ WD-12

Wednesday 12:55-14:15

GSI - S 18

### Stochastic Programming Models

Stream: Stochastic Programming

*Invited session*

Chair: *Rüdiger Schultz*, Mathematics, University of Duisburg-Essen, Lotharstr. 65, D-47048, Duisburg, Germany, schultz@math.uni-duisburg.de

#### 1 - A stochastic model for fixed-income securities portfolio selection with transaction costs and default probabilities

*Larraitz Aranburu*, Economía Aplicada III, UPV-EHU Facultad de Ciencias Económicas y Empresariales, Avda. Lehendakari Aguirre, 83, 48015, Bilbao, Spain, larraitz.aranburu@ehu.es, *Laureano Fernando Escudero*, *M. Araceli Garín*, *Gloria Pérez*, *Gloria Pérez*

The aim of the stochastic model for fixed-income securities portfolio selection developed in this paper is to construct an immunized portfolio against interest rate changes all over the time. The model also allows the introduction of both transaction costs and different bond ratings, so different default probabilities. Several objective functions are proposed for introducing this risk into the model, so that any investor can reach its optimum portfolio according to its risk averseness. A stochastic model is proposed and some computational experience is reported.

#### 2 - Contamination techniques for mixed stochastic programming problems

*Martin Branda*, Department of probability and mathematical statistics, Charles University in Prague, Ke Karlovu 3, 121 16, Prague, Czech Republic, martin.branda@seznam.cz

Contamination techniques play an important role in post-analysis of solutions of stochastic programming problems. We consider two special models: two stage stochastic programming problem with mixed probabilities in the second stage and Conditional Value at Risk with mixed-integer loss function. We derive explicit formulas for Gateaux directional derivatives of optimal value functions and propose construction of contamination bounds with respect to underlying distribution. We include numerical study and practical construction of contamination bounds.

#### 3 - Stochastic dominance constraints induced by mixed-integer linear recourse

*Rüdiger Schultz*, Mathematics, University of Duisburg-Essen, Lotharstr. 65, D-47048, Duisburg, Germany, schultz@math.uni-duisburg.de

We discuss structural properties and algorithms for stochastic programs involving a special type of dominance constraints. The latter concern random variables which are induced by the overall costs in a two-stage stochastic program with mixed-integer linear recourse. In particular, our analysis includes some first stability results and decomposition algorithms.

## ■ WD-13

Wednesday 12:55-14:15

GSI - S 31

### Competitive location 2

Stream: Location Analysis

*Invited session*

Chair: *Knut Haase*, Institut für Wirtschaft und Verkehr, Technische Universität Dresden, Andreas-Schubert-Str. 23, 01062, Dresden, Germany, knut.haase@tu-dresden.de

#### 1 - Competitive discrete facility location problem with residual demand and distance threshold

*Arifusalam Shaikh*, Kent Business School, University of Kent, CT2 7PE, Canterbury, United Kingdom, arifkfupm@yahoo.com, *Said Salhi*, *Malick M. Ndiaye*

A competitive discrete location problem is considered. We assume that for an open outlet the total attracted demand is prorated to the level of service. This leaves a residual demand that has to be eventually allocated to other competitors. The decision of such residual customers to select any of the open facilities may depend on trade off between its distances to the next best competitor. A variant of the well known MAXCAP model is introduced to incorporate the distance threshold. A mathematical model as well as a heuristic approach based on GA will be provided and comparative results given.

#### 2 - Simultaneous decisions in competitive discrete location problems

*Joana Matos Dias*, FEUC / INESCC, University of Coimbra, Av. Dias da Silva, 165, 3004-512, Coimbra, joana@fe.uc.pt, *Pedro Godinho*

In this work, discrete location problems with two decision makers simultaneously deciding where to locate facilities in a competitive environment are studied. Two different situations are considered: the decision makers are able to open facilities at the same location or at most one facility can be open at each location. The links between these problems and the Stackelberg location problems are investigated, as well as links with game theory (namely the existence of Nash equilibrium solutions).

#### 3 - Competitive location models using a threshold-sensitive customer choice rule

*Dolores R. Santos-Peñate*, Métodos Cuantitativos en Economía y Gestión, University of Las Palmas de Gran Canaria, Campus de Tafira. Edificio Dptal de Ciencias Económicas y Empresariales D-4-22, 35017, Las Palmas de Gran Canaria, Canarias, Spain, drsantos@dmc.ulpgc.es, *Rafael Suárez*, *Pablo Dorta-González*

We study a competitive location problem on networks. Goods are assumed to be essential and the customer choice rule represents a threshold-sensitive customer behaviour. Depending on the differences in distance between a customer and the competing firms, the demand is totally captured by only one firm or it is distributed among the competitors. With a customer's threshold of indifference, this rule modifies the assumption of "all or nothing" behaviour represented by the binary choice rule. The model proposed is analysed and some results are obtained.

#### 4 - Discrete location planning

*Knut Haase*, Institut für Wirtschaft und Verkehr, Technische Universität Dresden, Andreas-Schubert-Str. 23, 01062, Dresden, Germany, knut.haase@tu-dresden.de

Two new models for discrete location planning under static competition are introduced. The probability that a customer chooses a specific store is obtained from a multinomial logit (MNL) model. In the first model we apply the basic MNL model, where we take advantage of the property of constant substitution patterns. In the second model we consider the case where flexible substitution patterns are accounted for. The model is based on the decision behaviour of a large number of simulated individuals.

## ■ WD-14

Wednesday 12:55-14:15

GSI - S 32

### Inventory Management IV

Stream: Inventory Management

Invited session

Chair: *Baris Balcioglu*, Mechanical and Industrial Engineering, University of Toronto, 5 King's College Road, M5S 3G8, Toronto, ON, baris@mie.utoronto.ca

#### 1 - Optimal policy for a capacitated assembly problem

*Alexandar Angelus*, Operations Management, Singapore Management University, Lee Kong Chian School of Business, 50 Stamford Road, #04-90, 178899, Singapore, Singapore, angelus@smu.edu.sg

We consider a multi-echelon inventory model of an assembly system with limits on production capacities. In the spirit of Rosling (1989), we provide conditions under which system can be reduced to an equivalent capacitated series system. We generalize existing two-echelon results by showing that a capacitated multi-echelon series system achieves the Clark-Scarf decomposition. We find the form of the optimal inventory policy, whose critical thresholds are increasing functions of echelon inventories at upstream stages. A numerical example for a three-echelon system illustrates the results.

#### 2 - Optimal ordering policies with stochastic demand and price processes

*Kimitoshi Sato*, Nanzan University, d07mm002@nanzan-u.ac.jp, 489-0863, seto, Japan, d07mm002@nanzan-u.ac.jp, *Katsushige Sawaki*

Supply Chain risks with respect to product demand and component cost uncertainties are taken quite seriously in various industries. In this paper, we consider a model in which a firm uses the spot market for procurement in order to accomplish the minimization of total discounted costs. The model can be formulated as quasi-variational inequality problem where the demand and spot price follow diffusion stochastic processes. We derive an optimal policy as an  $(s,S)$  policy where  $s$  and  $S$  are uniquely determined as a solution of simultaneous equation.

#### 3 - Modeling multi-echelon inventory systems with several repair modes under non-stationary demands

*Yael Perlman*, Department of Interdisciplinary Studies, Bar-Ilan University, 6 Dulchin St., 76516, Rehovot, Israel, perlman@mail.biu.ac.il, *Eugene Levner*

Consider an inventory system dedicated to serve an aircraft located at several geographically distributed operating locations or bases. We analyze several modes of repair service with different repair times and formulate a network model of the problem which permits to efficiently solve the problem for both stationary and non-stationary demands.

#### 4 - Strategies for a single product m/g/1 multi-class make-to-stock queue

*Baris Balcioglu*, Mechanical and Industrial Engineering, University of Toronto, 5 King's College

Road, M5S 3G8, Toronto, ON, baris@mie.utoronto.ca, *Hossein Abouee-Mehrizi*, *Opher Baron*

We consider a centralized production facility that serves distinguishable markets for a single product. We provide the exact analysis of the decentralized priority policy with dispatching decisions postponed to the end of production and the centralized inventory rationing and Strict Priority (SP) policies for general service times. We numerically demonstrate that the centralized inventory rationing policy minimizes costs and that the slightly costlier SP policy and the decentralized priority policy might still be useful due to their simplicity.

## ■ WD-15

Wednesday 12:55-14:15

Einstein

### Fairness in Sports

Stream: OR in Sports

Invited session

Chair: *Dirk Briskorn*, Department for Production and Logistics, University of Kiel, Olshausenstrasse 40, 24098, Kiel, Germany, briskorn@bwl.uni-kiel.de

#### 1 - Scheduling sports tournaments on a single court minimizing waiting times

*Sigrid Knust*, Institute of Mathematics, Technical University of Clausthal, Erzstr. 1, 38678, Clausthal-Zellerfeld, Germany, sigrid@informatik.uni-osnabrueck.de

We consider a single round robin sports tournament, partitioned into rounds, where for every round only a single sports court is available and all teams have to travel to this location. In order to reduce the number of travels, each team is supposed to play twice in each round. The objective is to find a schedule which minimizes the waiting times for the teams. We study two variants in which zero waiting times are allowed or not and construct schedules (based on graph theory) for any odd number of teams minimizing the number of long waiting times and the total waiting time simultaneously.

#### 2 - A study of fairness in fourball golf competition

*Patrick Siegbahn*, Royal Institute of Technology, Stockholm, SE-11420, Stockholm, Stockholm, Sweden, siegbahn@gmail.com, *Donald Hearn*

The golf handicap system has been modified and improved over many decades, with a primary emphasis on golf games in which two players compete against each other. However, handicaps are also used when golf is played as a team game with the minimum of the individual scores as the team score. Thus team scores are the minimum of independent random variables. The purpose of this study is to investigate the issue of fairness in the particular team game known as fourball. We present a number of results, both theoretical and computational, when handicaps are used in this manner.

#### 3 - Does the carry-over effect exist?

*Dries Goossens*, Operations Research and Business Statistics (ORSTAT), Katholieke Universiteit Leuven, Naamsestraat 69, 3000, Leuven, Belgium, Dries.Goossens@econ.kuleuven.be, *Frits Spieksma*, *Frits Spieksma*

In a round robin tournament, a team  $i$  gives a carry-over effect to a team  $j$ , if some other team  $t$ 's game against  $i$  is immediately followed by a game against team  $j$ . In some sports, it is assumed that these effects can influence the outcome of the tournament. Indeed, if team  $i$  is a very strong team, then its opponent, team  $t$ , could be exhausted and discouraged after this game, which could benefit its next opponent, team  $j$ . In this work, we measure whether carry-over effects have an influence on the eventual outcome of the highest division of the Belgian soccer league.

#### 4 - A hybrid heuristic for minimizing weighted carry-over effects in round robin tournaments

Allison Guedes, Universidade Federal Fluminense, 24210240, Brazil, Brazil, aguedes@ic.uff.br, Celso Ribeiro

The carry-over effects value is one of the various measures one can consider to assess the quality of a round robin tournament schedule. We introduce and discuss a new, weighted variant of the minimum carry-over effects value problem. The problem is formulated by integer programming and a heuristic based on the hybridization of the Iterated Local Search metaheuristic with a multistart strategy is proposed for its approximate solution. Numerical results are presented.

## ■ WD-16

Wednesday 12:55-14:15

Koenig

### Preference Learning from Data II

Stream: Preference Learning from Data

Invited session

Chair: *Krzysztof Dembczynski*, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, kdembczynski@cs.put.poznan.pl

#### 1 - Learning intransitive preference relations with regularized least-squares

Willem Waegeman, Department of Applied Mathematics, Biometrics and Process Control, Ghent University, Coupure links 653, 9000, Ghent, willem.waegeman@ugent.be, *Tapio Pahikkala*, *Evgeni Tsivtsivadze*, *Bernard De Baets*, *Tapio Salakoski*

In different fields it has been observed that (reciprocal) preference relations on humans and animals can be intransitive. We present a kernel-based machine learning algorithm for inferring such relations from paired-comparison data, by extending the existing RankRLS algorithm. It is shown how a joint pairwise feature mapping like the Kronecker-product defines the transition from transitive to intransitive relations. We empirically demonstrate on benchmark problems in game theory and biology that our algorithm outperforms the traditional (transitive) ranking approach.

#### 2 - Three approaches to ordinal classification

*Krzysztof Dembczynski*, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, kdembczynski@cs.put.poznan.pl, *Wojciech Kotlowski*

We will discuss the nature of ordinal classification, in which a meaningful order between class labels exists. There are two different views on this problem: as a special form of the ranking problem and as an extension of ordinary classification. We will show three approaches to deal with this problem. The first one consists in reducing the problem to a sequence of binary problems. The second one relies on introducing a threshold loss function. The last one is based on rank loss minimization. We will analyze and compare these approaches using different learning algorithms and applications.

#### 3 - Learning of preference rules in variable consistency dominance-based rough set approaches

*Jerzy Blaszczynski*, Institute of Computing Science, Poznan University of Technology, ul. Piotrowo 2, 60-965, Poznan, Poland, jurek.blaszczynski@cs.put.poznan.pl, *Salvatore Greco*, *Roman Slowinski*, *Marcin Szelag*

We present VC-DomLEM algorithm for induction of decision rules in Variable Consistency Dominance-based Rough Set Approaches (VC-DRSA). These approaches extend DRSA to deal with problems characterized by a considerable amount of inconsistency in the data. We induce preference rules characterized by a controlled degree of consistency. We compare VC-DomLEM with a wide range of learning models and classification methods on real and benchmark data sets. We show benefits from learning with ordinal (multi-criteria) models as opposed to models that ignore information about preference ordering in data.

#### 4 - The classification methods decision tree and proaftn: a comparative study

*Nabil Belacel*, Knowledge discovery group, NRC-Institute for Information Technology-e-Business, 55 Crowley Farm, E1A 7R1, Moncton, New Brunswick, Canada, nabil.belacel@nrc.gc.ca, *Feras Al-Obeidat*

The objective of this paper is to conduct a comparative and analytical study between two classification methods: the decision tree and the PROAFTN which belongs to the multicriteria decision analysis. We have introduced the PROAFTN method which also has the capability of generating decision rules that can be easily interpreted. This comparative study examines the differences between PROAFTN and the decision tree in terms of their learning methodology, classification accuracy, and interpretability. The experimental results show that PROAFTN method outperforms the decision tree algorithms.

## ■ WD-17

Wednesday 12:55-14:15

Rheinaue

### Combinatorial Optimisation for microelectronics

Stream: Graphs and Networks

Invited session

Chair: *Nadia Brauner*, G-SCOP - Grenoble, 46 av Felix Viallet, 38000, Grenoble, France, nadia.brauner@g-scop.inpg.fr

#### 1 - Scan chain optimization for integrated circuits testing: an operations research perspective

*Zaourar Lilia*, Grenoble, laboratoire G-SCOP, 46 avenue Félix Viallet, 38031 Cedex 1, Grenoble, lilia.zaourar@g-scop.inpg.fr, *Yann Kieffer*

Today, integrated circuit testing costs amount to 40% of the overall production cost, for chip having millions of memory elements. Therefore, tools are required in order to reduce testing costs of the chip. The Scan chain methodology is the most common technique for testing digital circuits after production. But Scan chain insertion can have a negative impact on the chip characteristics and performance. Our goal is to optimize the additional chip area and power. We present a model for this problem based on graphs; we suggest a way to solve it, and give numerical results on actual test cases.

#### 2 - Automatizing the sharing of bist-blocks for low-power testing of embedded memories

*Yann Kieffer*, laboratoire G-SCOP, 38031 Cedex 1, Grenoble, France, yann.kieffer@g-scop.inpg.fr, *Zaourar Lilia*, *Jihane Alami-Chentoufi*

Today, memories embedded in electronic chips are tested after production with the help of additional dedicated circuitry, a methodology known as 'memory-BIST'.

Until recently, testing was done using one BIST design block for each memory on chip. The increase of the number of memories calls for sharing BIST circuitry among memories, while keeping watch on three parameters: testing time, testing power, and additional dedicated surface.

A model for this real-world, multi-objective optimization problem will be given, and approaches for an algorithmic solution will be presented.

### 3 - The layout design of a semiconductor fab with spine and perimeter interbay guide paths

*Ying-Chin Ho*, Institute of Industrial Management, National Central University, No.300, Jhongda Rd, 320, Chung-Li, Taoyuan, Taiwan, ho@cc.ncu.edu.tw,  
*Ta-Wei Liao*

Traditional layout methods often solve bay layout design and interbay guide path layout design as separate problems. Layout methods of these kinds often cannot generate ideal results after interbay guide path layouts have been conducted. In this study, we propose a layout method that treats these two problems as one problem. We assume bays will be connected by two types of interbay guide paths — a spine configuration and a perimeter configuration. The proposed method relies on mathematical programming models and heuristic procedures to simultaneously solve these two problems.

## ■ WD-18

Wednesday 12:55-14:15

Lenné

### Mathematical Programming in Networks 1

Stream: Mathematical Programming

Invited session

Chair: *Armin Fügenschuh*, Optimierung, Zuse Institut Berlin, Takustraße 7, 14195, Berlin, Germany, armin.fuegenschuh@googlemail.com

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

#### 1 - Piecewise linear approximation methods for the layout optimization in recovered paper production

*Christine Hayn*, Department of Mathematics, TU Darmstadt, Schlossgartenstr. 7, 64289, Darmstadt, Germany, hayn@mathematik.tu-darmstadt.de, *Armin Fügenschuh*

An MINLP model for the simultaneous optimization of process variables and machine layout in recovered paper production is presented. For solving the model the nonlinear nonconvex functions occurring are approximated by piecewise linear ones, either directly or after transformation to separable functions. Several techniques for incorporating piecewise linear functions in an MILP are compared computationally using Cplex, Scip and Cbc. The results are furthermore compared to those obtained using the NLP solver Ipopt as well as the MINLP solvers Baron and Bonmin directly for the nonlinear models.

#### 2 - Experimental design techniques applied to the measurement of traffic in large networks

*Guillaume Sagnol*, CMAP, INRIA Saclay, CMAP Ecole Polytechnique, Route de Saclay, 91128, Palaiseau, France, guillaume.sagnol@inria.fr, *Mustapha Bouhtou*, *Stephane Gaubert*

We study the problem of inferring the traffic on each Origin-Destination pair of a large network. The aim is to optimize the use of network-monitoring tools; to this end, we formulate a combinatorial optimization problem, whose objective is to find the "best" subset of measurements which should be performed. The experimental design approach consists in minimizing the variance of a certain estimator of the flows. We show that this problem can be solved very efficiently by Second Order Cone Programming, and we present experimental results comparing our method with previously proposed ones.

### 3 - The coolest path problem

*Armin Fügenschuh*, Optimierung, Zuse Institut Berlin, Takustraße 7, 14195, Berlin, Germany, armin.fuegenschuh@googlemail.com, *Martin Frank*, *Michael Herty*, *Lars Schewe*

We introduce the coolest path problem, which is a mixture of two problems from distinct mathematical fields: The shortest path problem from combinatorial optimization and the heat conduction problem from the field of partial differential equations. Together, they make up a control problem, where some geometrical object traverses a digraph in an optimal way, with constraints on intermediate or the final state. We discuss some properties of the problem and demonstrate that it can be formulated as a linear mixed-integer program. Numerical results are presented.

## ■ WD-19

Wednesday 12:55-14:15

Haber

### Metaheuristics I

Stream: Metaheuristics and Information Systems

Contributed session

Chair: *Edilson Castro*, DIN - Departamento de Informática, UEM - Universidade Estadual de Maringá, Av. Colombo, 5.790 - Jd. Universitário, Bloco 019-020, 87020-900, Maringá, Paraná, Brazil, edilsoncastro@uol.com.br

#### 1 - Using a greedy random adaptive search procedure to solve the cover printing problem

*Tuytens Daniel*, Mathematics and Operations Research, Faculté Polytechnique of Mons, Rue de Houdain, 9, 7000, Mons, Belgium, daniel.tuytens@fpms.ac.be, *Arnaud Vandaele*

In this paper, the cover printing problem, which consists in the grouping of book covers on offset plates in order to minimize the total production cost, is discussed. As the considered problem is hard, we discuss and propose a greedy random adaptive search procedure (GRASP) to solve the problem. The quality of the proposed procedure is tested on a set of reference instances, comparing the obtained results with those found in the literature. Our procedure improves the best known solutions for some of these instances. Results are also presented for larger, randomly generated problems.

#### 2 - Self-regulated multiple simulated annealing: minimizing input parameters dependency and increasing solutions space exploration

*Edilson Castro*, DIN - Departamento de Informática, UEM - Universidade Estadual de Maringá, Av. Colombo, 5.790 - Jd. Universitário, Bloco 019-020, 87020-900, Maringá, Paraná, Brazil, edilsoncastro@uol.com.br, *Ademir Constantino*, *Silvio Araujo*

This paper proposes a new metaheuristic, called Self-Regulated Multiple Simulated Annealing (SRM-SA). Its main advantage is not to require SA's parameters values to be entered by a user, because SRM-SA works with a population of solution containers, and their own costs are used to regulate their temperatures. Only population size remains as an external parameter. Also, SRM-SA explores solutions space as widely as possible: a non-convergent approach, unlike SA, GA and others. In tests over Set Covering Problem, SRM-SA's implementation has reached the best results known for each instance.

## ■ WD-20

Wednesday 12:55-14:15

Mann

### DEA Applications III

Stream: DEA and Performance Measurement

Invited session

Chair: *Heinz Ahn*, Institut für Controlling und Unternehmensrechnung, TU Braunschweig, Pockelsstr. 14, 38106, Braunschweig, Germany, hw.ahn@tu-bs.de

#### 1 - DEA software evaluation and development

*Kersten Hentrich*, Lehrstuhl f. Controlling u. Unternehmensrechnung, TU Braunschweig, Pockelsstr. 14, 38106, Braunschweig, khentrich@gmx.de, *Heinz Ahn*

Based on the so-called requirements engineering approach, commercial and non-commercial DEA software is compared by means of over 60 criteria. Within this evaluation, different types of stakeholders are taken into account. On one hand, the approach gives insight into the stakeholder-oriented strengths and weaknesses of common DEA software. On the other hand, it provides a framework for customized DEA software development.

#### 2 - New features and capabilities of data envelopment analysis online software (deaos)

*Mohammad Reza Alirezaee*, School of Mathematics, Iran University of Science and Technology, Hengam St., Resalat Sq., 16846, Tehran, Iran, Islamic Republic Of, mralirez@yahoo.com, *Ali Niknejad*, *Nassrin Alirezaee*

As the field of DEA has grown and blossomed, so have the varieties of models, data, and types of analysis, similarly, as DEA software technology has to emerge. DEAOS could present as professional web application including several available models, useful features, user friendly interface and reporting, importing data, exporting results and easy to use on internet. Here the new features and capabilities, added to DEAOS, including advance models, trade-off analysis, and many other items will be presented. DEAOS is available at [www.DEAOS.com](http://www.DEAOS.com).

#### 3 - Performance improvement management software for the advanced user

*Ali Emrouznejad*, Aston Business School, Aston University, B4 7ET, Birmingham, United Kingdom, a.emrouznejad@aston.ac.uk, *Emmanuel Thanassoulis*

This paper presents software that takes its features closer to the latest developments in the DEA literature. The new software addresses a variety of issues such as: Assessments under a variety of possible assumptions of returns to scale including NIRS and NDRS; truly unlimited number of assessment units (DMUs); Analysis of groups of data by estimating automatically separate boundaries by group; Malmquist Index and its decompositions; Super efficiency; Automated removal of super-efficient outliers under user-specified criteria; Cross efficiency; Bootstrapping.

#### 4 - Evaluation of school of law efficiency in Turkey by using data envelopment analysis

*Erhan Berk*, Hava Duragi Lojmanlari 4.Blok Daire:1, 06790, ANKARA, Turkey, eberk@kho.edu.tr

Countries become prominent in economy and policy with their human resources in the global world. Universities are one of the important phases in this human resource growth process. School of law in universities has an important role in educating people that have effect in mass communities. This study focused on the efficiency of law schools in Turkey. Efficient virtual reference values have been found for the inefficient decision units. Factor results that has to be for the reference units have been determined. In the light of the results, public and private schools were compared.

## ■ WD-21

Wednesday 12:55-14:15

Hauptmann

### Theory of Boolean Functions

Stream: Boolean Programming

Invited session

Chair: *Gyorgy Turan*, Math., Stat. and Comp. Sci., Univ. of Illinois at Chicago, 851 S.Morgan, M/C 249, 60608-7045, Chicago, IL, United States, gyt@uic.edu

#### 1 - The complexity of sign matrices

*Hans Simon*, Department of Mathematics, Ruhr-University Bochum, 44780 Bochum, 44780, Bochum, NRW, hans.simon@rub.de

Sign matrices represent distributed Boolean functions. In the last decade, there has been a growing interest in complexity measures for sign matrices that can be bounded from above or below by algebraic methods. In this talk, we discuss some relations between these measures and mention some connections to learning theory.

#### 2 - Nondisjoint decompositions of boolean functions

*Jan Corstiaan Bioch*, Dept. of Computer Science, Erasmus University Rotterdam, FEW, H10-30, PO BOX 1738, 3000DR, Rotterdam, Netherlands, bioch@few.eur.nl

We discuss nondisjoint decompositions of a Boolean function  $f$  of the form  $f = F(A, B, g(B, C))$ , where  $A, B$  and  $C$  are disjoint sets of variables. If  $B$  is the empty set then the theory of decompositions, studied in game theory, reliability theory etc. is well understood. However, in the general case little or nothing is known. We present some results on the lattice of components  $g$  of  $f$  for a fixed partition  $A, B$  and  $C$ , and we generalize the famous three modules theorem.

#### 3 - Statistical query learning and strong sq dimension for some formula classes

*Balazs Szorenyi*, Lehrstuhl Mathematik & Informatik, Ruhr-Universität Bochum, Universitätsstraße 150, D-44801, Bochum, Germany, szorenyi@inf.u-szeged.hu

In statistical query learning we have some distribution and a Boolean function class fixed, and want to find some function having high correlation with some unknown element  $f$  of the class. We cannot access  $f$  directly, but can measure (query) its correlation with any function—up to some accuracy. Simon has introduced and shown the notion of strong SQ dimension to be polynomially related to the minimal number of queries needed. In this talk we further investigate this notion and give bounds for its value for some specific classes like conjunctions, monotone conjunctions and read-once DNFs.

#### 4 - A restricted boolean consensus method for the transitive closure of a digraph

Bruno Simeone, Dept. of Statistics, University of Rome La Sapienza, Piazzale Aldo Moro 5, 00185, Rome, Italy, bruno.simeone@uniroma1.it, *Endre Boros, Stephane Foldes, Peter L. Hammer*

The classical Consensus method generates all prime implicants of a Boolean function. Restricted versions, e.g. the disengagement and the input consensus ones, are also known. We present a combination of the latter two, resulting in a new and fast algorithm for the transitive closure of digraphs, which works for suitable arc scanning orders. We give characterizations of "good" orders in dipaths, and show how to get one such order in arbitrary digraphs. The problem of finding the smallest number of input arcs that generate the transitive closure in directed trees is also solved.

#### WD-22

Wednesday 12:55-14:15

Arndt

#### AHP V

Stream: Analytic Hierarchy Processes, Analytic Network Processes

*Invited session*

Chair: *Coskun Hamzaçebi*, Business Administration, Z. Karaelmas University, Incivez, 67100, Zonguldak, Turkey, coskunh@karaelmas.edu.tr

#### 1 - Stock selection in food sector

*Coskun Hamzaçebi*, Business Administration, Z. Karaelmas University, Incivez, 67100, Zonguldak, Turkey, coskunh@karaelmas.edu.tr, *Sedat Erdogan*

The people and firms compose their investments according to the risk and return. An applicable method is to give investment decisions according to the firms' financial ratios such as productivity, profitability, efficiency, indebtedness, liquidity. In this study, the usage of MCDM techniques in food sector stock investments is examined. The firms were selected from Istanbul Stock Exchange. AHP and TOPSIS techniques were used as MCDM tool. Found results were compared with actual ranking of stocks. Finally, the accuracy of such selection is examined.

#### 2 - Application of AHP and fuzzy multicriteria linear programming in selecting suppliers and determining purchasing quotas

*Tunjo Peric*, Pekarne Sunce d.o.o., Rakitje, Rakitska cesta 98, 10437, Bestovje, Croatia, tunjo.peric1@zg.t-com.hr, *Zoran Babic*

This paper investigates the problem of supplier selection and determination of flour purchasing quotas for a bakery. In addition to the purchasing cost as the basic criterion the authors also take the quality of flour and supplier reliability as the relevant criteria. To evaluate suppliers according to the adopted criteria they use the AHP method, while the purchasing quotas are determined by use of fuzzy linear programming. In the end they perform sensitivity analysis of the presented model by testing the effect of changes in criteria priorities on the final evaluation of suppliers.

#### WD-23

Wednesday 12:55-14:15

Planck

#### Distributed DSS

Stream: Decision Support Systems

*Invited session*

Chair: *Pascale Zaraté*, Institut de Recherche en Informatique de Toulouse, 118 route de Narbonne, 31062, Toulouse, France, zarate@irit.fr

#### 1 - A multi-agent framework for a web dss applied to manufacturing system

*Taghezout Noria*, Computer Science Department, University of Es-Senia Oran, BP 1524 El-M'Naouer, 31000, Oran, Algeria, taghezoutnour@yahoo.fr

Combination of Web services and software agents provides a promising computing paradigm for efficient service selection and integration of inter-organizational business processes. This paper proposes an agent-based Web DSS; the main contribution of our study is to provide an efficient tool that helps users find information resources available as an online service within an Intranet. In order to solve conflicts, Integrated Station of Production (ISP) agents use Web service to conduct various complementary tasks.

#### 2 - Participating in competitive online games: analyzing competitive and hedonic decision elements

*Thomas Weiss*, Dept. of Business, Media and Technology Management, University of Cologne, Pohligstr. 1, 50969, Koeln, thomas.weiss@uni-koeln.de, *Claudia Loebbecke*

Competitive online gaming has been a major engine of the rapidly growing online game market in recent years. Its market success depends on the acceptance and use of such games. So far, only few studies have investigated related players' decisions. To fill this gap, based on the Uses and Gratifications approach (Rosengren 1974), this paper analyzes players' decisions to participate in competitive online games combining competitive and hedonic aspects.

#### 3 - Distributed decision making goes multiscale

*Christian Wernz*, Grado Department of Industrial and Systems Engineering, Virginia Tech, 250 Durham Hall, Virginia Tech, 24061, Blacksburg, VA, United States, wernz@vt.edu

Decision makers (DMs) in business organizations should make decisions taking into account their influence on other DMs, and the effect of other DMs on them. The mutual influence occurs across various hierarchical levels, or scales. We develop a multiscale decision making model — based on distributed decision making and game theory — which provides analytical results guiding hierarchically interacting DMs. Furthermore, our model lays the foundation for a comprehensive multiscale decision making framework which integrates the organizational, temporal and informational scales.

#### WD-24

Wednesday 12:55-14:15

GSI - S 20

#### Convex programming and applications

Stream: Nonlinear Programming

*Invited session*

Chair: *Domingos Cardoso*, Departamento de Matematica, Universidade de Aveiro, Campus Universitario de Santiago, 3810-193, Aveiro, Portugal, dcardoso@ua.pt

### 1 - Truncated codifferential method for nonsmooth convex optimization

*Adil Bagirov*, School of Information Technology & Mathematical Sciences, University of Ballarat, University Drive, Mount Helen, P.O. Box 663, 3353, Ballarat, Victoria, Australia, a.bagirov@ballarat.edu.au, *Ali Hakan Tor*

In this paper a new algorithm to minimize convex functions is developed. This algorithm is based on the concept of codifferential. Since the computation of whole codifferential is not always possible we propose an algorithm for computation of descent directions using only a few elements from the codifferential. The convergence of the proposed minimization algorithm is studied and results of numerical experiments using a set of test problems with convex objective function are presented. We also compare the new algorithm with the bundle method using the results of numerical experiments.

### 2 - Recent results on graphs with convex quadratic stability number

*Maria F Pacheco*, Instituto Politécnico de Bragança - ESTiG, Quinta de Santa Apolónia, Gab. 112, 5301-857, Bragança, Portugal, pacheco@ipb.pt, *Domingos Cardoso*

The main results about graphs with convex quadratic stability number (that is, graphs for which the stability number can be determined by convex quadratic programming) are surveyed including the most recently obtained. Furthermore, a few algorithmic techniques for the recognition of this type of graphs in particular families are presented.

### 3 - An upper bound on the 2-club number of a graph

*Carlos J. Luz*, Math, Escola Sup. Tecnologia Setúbal / Instituto Politécnico de Setúbal, Campus do IPS, Estefanilha, 2910-761, Setúbal, Portugal, cluz@est.ips.pt

A 2-club of a graph is a subset of nodes that induces a subgraph of diameter 2. This communication deals with the maximum 2-club problem which consists on finding a maximum 2-club in an undirected given graph. The cardinality of a maximum 2-club of a graph is usually called the 2-club number of that graph. We first present a convex quadratic programming upper bound for the 2-club number of a graph. Then, we state a sufficient condition for a graph to attain the proposed upper bound. Finally, we improve the offered upper bound and report on its application to several graphs.

## ■ WD-25

Wednesday 12:55-14:15  
GSI - S 25

### Cooperation in assignment and inventory situations

Stream: Cooperative Game Theory  
*Invited session*

Chair: *Judith Timmer*, Dept. of Applied Mathematics, University of Twente, P.O. Box 217, 7500 AE, Enschede, Netherlands, j.b.timmer@utwente.nl

#### 1 - The maximum and the addition of assignment games

*Silvia Miquel*, C/ Jaume II 73, 25001, Lleida, smiquel@matematica.udl.cat, *Marina Nunez*

Shapley and Shubik (1972) define assignment games as cooperative TU games for two-sided markets. Here, we consider a finite set of assignment games and each set of players can choose to play in one of those games. This is represented by the maximum of assignment games and a balancedness condition is obtained. We also consider that each set of players can play simultaneously more than one assignment game and then add the profits. This is represented by the sum of assignment games which is balanced. Under some conditions, the core of the sum game coincides with the sum of the cores.

#### 2 - Cooperation in stochastic inventory models with continuous review

*Judith Timmer*, Dept. of Applied Mathematics, University of Twente, P.O. Box 217, 7500 AE, Enschede, Netherlands, j.b.timmer@utwente.nl

We study the inventory management of multiple firms facing stochastic demand. All inventories are monitored continuously. Firms may form a coalition and place joint orders for replenishment of their inventories. In particular, as soon as one firm reaches its reorder point all other firms in the coalition join this firm and order up to their desired inventory levels. The corresponding cost game is studied for properties and nice solutions. Analytical studies show that the game is concave and balanced. Hence, the Shapley value is a natural candidate for cost allocation among the firms.

#### 3 - Inventory transportation networks: benefits by collaboration

*Ana Meca*, Operations Research Center, Universidad Miguel Hernández, Avda. Universidad s/n, Edificio Torretamarit, 03202, Elche, Alicante, Spain, ana.meca@umh.es, *M<sup>a</sup> Gloria Fiestras-Janeiro*, *Ignacio García-Jurado*, *Manuel Alfredo Mosquera Rodríguez*

The aim of this talk is to study inventory situations where transportation costs are different for each agent. The underlying allocation cost problem is analyzed by defining a class of cooperative TU cost games. We characterize the situations for which cooperation is profitable and propose some allocations of the total cost. One of these allocations is obtained "à la Shapley" by computing the average of some marginal costs which belong to the core. We provide a characterization of this rule using properties as E-Balanced Contribution (EBC), Extreme agent solidarity (EAS), and E-Transfer (ETR).

## ■ WD-26

Wednesday 12:55-14:15  
GSI - S 35

### Lot Sizing II

Stream: Discrete Optimization  
*Contributed session*

Chair: *Jan Christian Lang*, Chair of Operations Research, Department of Law, Business and Economics, Technische Universität Darmstadt, Germany, Hochschulstr. 1, 64289, Darmstadt, Germany, jclang@bwl.tu-darmstadt.de

#### 1 - Lot sizing by considering purchase discount in mrp system

*Fahimeh Shamsaei*, De Lismortel 340, 5612 AK, Eindhoven, Eindhoven, Netherlands, f\_shamsaei@ind.iust.ac.ir, *Mehdi Heydari*

It is usual for lot-sizing to use the classical methods for each of the products. Lot sizing in each level of MRP and for each product without considering sub assemblies would have some consequences such as total system costs increasing, lead time increasing and resources shortage. This paper represents a model which can decrease the inventory total system cost. The proposed mathematical model is a nonlinear programming which is solved with a heuristic algorithm. At last, with a numerical example the result of the presented model solution has compared with the other lot-sizing methods and models.

## 2 - Mip-based heuristics for capacitated lot-sizing with sequence-dependent setups and substitutions

*Jan Christian Lang*, Chair of Operations Research, Department of Law, Business and Economics, Technische Universität Darmstadt, Germany, Hochschulstr. 1, 64289, Darmstadt, Germany, jclang@bwl.tu-darmstadt.de

We consider a capacitated single-level dynamic lot-sizing problem with sequence-dependent setup costs and times that includes product substitution options. The model is motivated from a real-world production planning problem at a manufacturer of plastic sheets used as an interlayer in car windshields. We develop a mixed-integer programming (MIP) formulation of the problem and outline MIP-based Relax&Fix as well as Fix&Optimize heuristics. Computational experiments with generated instances indicate that Fix&Optimize variants with a time-oriented decomposition perform best.

## 3 - Heuristics for the multi-item capacitated lot-sizing with lost sales

*Nabil Absi*, Ecole des Mines de Saint-Etienne, EMSE - CMP - Site Georges Charpak, 880 route de Mimet, 13541, GARDANNE, absi@emse.fr, *Boris Detienne*, *Stéphane Dauzere-peres*

In this work we address the multi-item capacitated lot-sizing problem with lost sales. Demand cannot be backlogged, but can be totally or partially lost. This problem is NP-hard. We propose different mathematical formulations. To find a near optimal solution, different heuristic approaches are developed. They are mainly based on a Lagrangian relaxation of the resource capacity constraints. Computational results will be presented in order to compare our approaches to monolithic resolutions of the proposed models using a commercial solver.

## ■ WD-27

Wednesday 12:55-14:15

GSI - S 21

### Analytical Models in Facilities Logistics

Stream: Facility Logistics

*Invited session*

Chair: *Sunderesh Heragu*, Industrial Engineering, University of Louisville, 200, JB Speed Building, 40292, Louisville, KY, United States, s.heragu@louisville.edu

#### 1 - Analytical models for automated warehouses

*Sunderesh Heragu*, Industrial Engineering, University of Louisville, 200, JB Speed Building, 40292, Louisville, KY, United States, s.heragu@louisville.edu, *Cai Xiao*, *Ananth Krishnamurthy*, *Charles Malmborg*

Automated storage and retrieval systems (AS/RS) and automated vehicle storage and retrieval systems (AVS/RS) are two competing technologies that have been used extensively for unit-load handling and storage/retrieval in the reserve area of an automated warehouse. We model variants of the two systems as an open queuing network model and analyze them using an existing tool for OQNs called the manufacturing system performance analyzer (MPA). Experimental results with MPA are provided to show that the OQN methodology can be applied effectively to analyze AS/RS and AVS/RS.

#### 2 - Design insights for an autonomous vehicles-based storage and retrieval system

*Ananth Krishnamurthy*, Industrial and Systems Engineering, University of Wisconsin-Madison, ME 3258, 1513 University Avenue, 53706, Madison, WI, United States, ananth@engr.wisc.edu, *Debjit Roy*, *Sunderesh Heragu*, *Charles Malmborg*

Autonomous Vehicle based Storage and Retrieval System (AVS/RS) is an alternative to crane-based AS/RS. In AVS/RS, the transaction cycle time is composed of the waiting time for vehicles and lifts, horizontal and vertical travel times, and load/unload times. We investigate how decisions such as tier configuration, dwell point policies and vehicle assignment influence the average cycle time to process transactions. We model the system as a multi-class semi-open queuing network model with class switching and develop a decomposition approach to evaluate system performance and obtain insights.

#### 3 - Shared storage assignment policy in a compact storage system

*Nima Zaerpour*, Department of Management of Technology and Innovation, RSM Erasmus University, Rotterdam School of Management (RSM), Erasmus University Rotterdam Department of Management of Technology and Innovation, P.O. Box 1738, 3000 DR, Rotterdam, Netherlands, nzaerpour@rsm.nl, *Yugang Yu*, *René de Koster*

This paper studies how to store pallets in a compact storage system in order to minimize the makespan for retrieving pallets. The system stores pallets multi deep. In practice, dedicated storage is commonly used; every storage lane in the system stores only one product type to avoid reshuffling. This paper proposes a mathematical model considering a shared storage policy. The policy allows different product types to share the same lanes. A heuristic algorithm is proposed which can solve large-scale problems. Our results show that the shared storage policy can outperform dedicated storage.

## ■ WD-28

Wednesday 12:55-14:15

GSI - S 1

### Economic Lot Scheduling Problem

Stream: Economic Lot Scheduling Problem

*Invited session*

Chair: *Erik van der Sluis*, Quantitative Economics, University of Amsterdam, Roetersstraat 11, 1018 WB, Amsterdam, Netherlands, H.J.vanderSluis@uva.nl

#### 1 - Big-bucket lotsizing problems with synchronization

*Christian Almeder*, Department of Business Administration, University of Vienna, Bruennerstrasse 72, 1210, Vienna, Austria, Christian.Almeder@univie.ac.at, *Bernardo Almada-Lobo*

Small-bucket models consider lotsizing and scheduling decisions simultaneously. However, they are difficult to solve, because the period-length is mainly determined by the smallest possible lot. Big-bucket models determine lots but postpone the scheduling decisions to a subsequent planning step. For some applications there are interdependencies between different operations/resources, such that the result of a big-bucket model is not implementable as the remaining scheduling problem is infeasible. We present a formulation which considers such interdependencies within a big-bucket model.

## 2 - Capacitated lotsizing and scheduling with non triangular sequence-dependent setup times and costs

*Bernardo Almada-Lobo*, Industrial Engineering and Management, Faculty of Engineering of Porto University, Rua Dr. Roberto Frias s/n DEIG, 4200-465, Porto, Portugal, [almada.lobo@fe.up.pt](mailto:almada.lobo@fe.up.pt), *Alistair Clark*

In production planning, sequence dependent setups are often incurred for product switchovers. When setups do not respect the triangular inequality, the optimal solution may include more than one batch of the same product in a single period. By allowing setup crossovers, flexibility is increased and better solutions can be found. In tight capacity conditions, or whenever setup times are significant, setup crossovers are needed to assure feasibility. We present an extension for the capacitated lotsizing and scheduling problem incorporating the features of sequence sub tours and setup crossovers.

## 3 - A heuristic to solve the economic lot scheduling problem even when there is a high utilization of the facility

*Erik van der Sluis*, Quantitative Economics, University of Amsterdam, Roetersstraat 11, 1018 WB, Amsterdam, Netherlands, [H.J.vanderSluis@uva.nl](mailto:H.J.vanderSluis@uva.nl), *Anders Segerstedt*

Here we present a heuristic that starts with the common cycle solution finding an optimal time interval for the common frequencies; thereafter in "powers of two" try to reduce or increase the frequency for one item at a time, find the right and lowest possible inventory holding costs (for these different frequencies); and continue in this way until no better solution is found. This heuristic can also be combined with costs for operating the production facility depending on the number of hours the facility is operating per working day.

## ■ WD-29

Wednesday 12:55-14:15

GSI - S 2

### Energy Models and Ethical Implications

Stream: Energy and Emission Markets

*Invited session*

Chair: *Michael Lueken*, Research Domain Sustainable Solutions, Potsdam Institute for Climate Impact Research, P.O. Box 60 12 03, 14412, Potsdam, Germany, [lueken@pik-potsdam.de](mailto:lueken@pik-potsdam.de)

#### 1 - Analysis of emission trading markets with system dynamics

*Stefan Pickl*, Department for Computer Science, Universität der Bundeswehr München, heisenbergstr. 39, 85577, Neubiberg-München, Bavaria, Germany, [stefan.pickl@unibw.de](mailto:stefan.pickl@unibw.de)

The authors present a new approach applying system dynamics techniques to the analysis of emission trading markets. Economic aspects are as well reflected as ethical implications. The role of efficiency measures is discussed in detail.

#### 2 - Epistemic uncertainties in climate predictions: a challenge for epistemology and ethics

*Rafaella Hillerbrand*, RWTH Aachen, 52056, Aachen, Germany, [rafaella.hillerbrand@gmail.com](mailto:rafaella.hillerbrand@gmail.com)

While the vast majority of experts agrees on the reality of an anthropogenic climate change, few and far between sceptics demur that this consensus only rests upon highly uncertain information obtained from numerical models. Granted, but prognoses on the future climate will always remain uncertain. This paper addresses both questions, the former, epistemological one that resides with philosophy of science, and the later, normative question belonging to the realm of ethics.

#### 3 - Measuring efficiency in complex energy systems

*Bo Hu*, Universität der Bundeswehr München, 85577, Neubiberg München, Germany, [bo.hu@unibw.de](mailto:bo.hu@unibw.de)

The author presents a new model which simulates efficiency measures in complex energy models. The impact on the price mechanism in these new (emission trading) markets should be analysed. The ethical dimension of "cap and trade" principles in general should be discussed. As a result, criteria for a fair trade of emission certificates will be derived. The author intends to present first results of an agent based approach for the simulation of such a specific situation.

#### 4 - Distributive impacts of technological flexibility — an application of environmental system modeling

*Michael Lueken*, Research Domain Sustainable Solutions, Potsdam Institute for Climate Impact Research, P.O. Box 60 12 03, 14412, Potsdam, Germany, [lueken@pik-potsdam.de](mailto:lueken@pik-potsdam.de), *Nico Bauer*, *Brigitte Knopf*, *Marian Leimbach*, *Ottmar Edenhofer*

Climate change mitigation will lead to significant welfare redistributions among world regions. We analyze the mechanisms behind regional mitigation costs, focusing on the linkages between the availability of low-carbon energy technologies and the initial allocation of emission permits, which are crucial factors for the regional cost distribution. We apply the multi-regional integrated assessment model REMIND-R, which couples an economic growth model with an energy system model and a simple climate model, and includes inter-regional interactions via trade flows, using the Negishi-approach.

## ■ WD-30

Wednesday 12:55-14:15

GSI - S 26

### Applications of nonsmooth optimization techniques

Stream: Nonsmooth Optimization and its Applications

*Invited session*

Chair: *Julien Ugon*, CIAO, University of Ballarat, P.O. Box 663, 3350, Ballarat, Victoria, [j.ugon@ballarat.edu.au](mailto:j.ugon@ballarat.edu.au)

#### 1 - Conic functions in classification problems

*Gurkan Ozturk*, Industrial Engineering, Anadolu University, AU-MMF-Industrial Engineering, Iki Eylul Campus, 26480, Eskisehir, Turkey, [gurkan.o@anadolu.edu.tr](mailto:gurkan.o@anadolu.edu.tr), *Retail Kasimbeyli*

Polyhedral conic functions have recently been presented and used to solve classification problems in the frame of mathematical programming approach. Polyhedral conic functions are obtained by augmenting the linear functions with  $l_1$  norm. Level set of this functions is a convex polyhedral set and it separates the space to two parts as inside and outside of this level set. In this study, we generalize this approach by using different norms. The classification algorithms obtained by this way are tested on real world dataset and results are discussed.

## 2 - Multiobjective portfolio optimization problem and solution methods

*Ozden Ustun*, Department of Industrial Engineering, Dumlupınar University, The Central Campus, 43100, Kütahya, [oustun@dpu.edu.tr](mailto:oustun@dpu.edu.tr), *Refail Kasimbeyli*

In this study, we propose a three-stage integrated approach which combines various forecasts, the conic scalarization method and the modified subgradient algorithm based on feasible values (F-MSG) to solve the extended mean-variance-skewness model for portfolio optimization. The integrated approach is applied to Istanbul Stock Exchange data. The comparison is conducted with respect to different levels of investor preferences over return, variance, and skewness and the obtained results are discussed.

## 3 - Applying nonsmooth optimization to analyse nonsmooth sleep signals

*Nadezda Sukhorukova*, CIAO, University of Ballarat, P.O. Box 663, 3350, Ballarat, Victoria, [n.sukhorukova@ballarat.edu.au](mailto:n.sukhorukova@ballarat.edu.au)

The problem of sleep stage identification plays a key role in sleep research, including sleep disorder diagnostics. At present, there is no automatic technique which is able to identify sleep stages with a level of accuracy satisfactory to doctors. One of the reasons why this problem cannot be solved accurately enough is its dimension. In our study we suggest an optimisation based technique which allows one to considerably reduce the dimension of the corresponding problems.

## 4 - A novel piecewise linear classifier based on polyhedral conic and max-min separabilities

*Julien Ugon*, CIAO, University of Ballarat, P.O. Box 663, 3350, Ballarat, Victoria, [j.ugon@ballarat.edu.au](mailto:j.ugon@ballarat.edu.au), *Adil Bagirov*

An algorithm for finding piecewise linear boundaries between pattern classes is proposed. This algorithm consists of two main stages. First a polyhedral conic set is used to identify data points close to the boundary. Then a piecewise linear boundary is computed incrementally starting with one hyperplane using only those data points. This approach allows one to reduce the computational effort. Numerical results demonstrate that this algorithm requires a reasonable training time and it consistently produces a good test set accuracy on most data sets compared with other mainstream classifiers.

## ■ WD-31

Wednesday 12:55-14:15  
GSI - S 34

### Various Topics on Data Mining and Decision Making

Stream: Data Mining and Decision Making

*Invited session*

Chair: *Christophe Mues*, School of Management, University of Southampton, SO17 1BJ, Southampton, United Kingdom, [C.Mues@soton.ac.uk](mailto:C.Mues@soton.ac.uk)

## 1 - Corba objects to implement ai agents

*Yaici Malika*, computer, university of bejaia, 36, Cite zerara, 06000, bejaia, Algeria, [yaici\\_m@hotmail.com](mailto:yaici_m@hotmail.com)

Many environments were proposed to facilitate development of distributed applications. Currently, among dominant technologies is CORBA. This model proves to be a support system for many emergent fields such as Distributed Artificial Intelligence which propose the concept of agents and Multi-agents. The idea is to use a corba object to design and implement an agent. An agent is characterized by autonomy, sociability and reactivity, and so can be designed an object. We developed a Chess Game which consisted on a two player agents (corba objects), and on an intelligent help agent (corba object).

## 2 - Virtual web services

*Hassina Talantikite*, department of computer science, university of bejaia, universite de bejaia, departement d'informatique, targa ouzamour, 06000, bejaia, [sino\\_nacer@yahoo.fr](mailto:sino_nacer@yahoo.fr), *Djamil Aissani*

Web services Discovery rely on the facilities offered by the providers in describing the functionalities of their services semantically and on the description of the client's requests. We propose a model of Semantic Annotations for Web Services which can find several services satisfying the client's needs. But the client must choose one according to his profile and web services conditions. This technique takes advantages from artificial intelligence and knowledge management. We illustrate the robustness and the efficiency of our proposed approach by the prototype implemented in java.

## 3 - Towards conflict resolution in agent systems

*Jair Minoro Abe*, Paulista University, Rua Dr Bacelar 1212, 04026-002, Sao Paulo, SP, Brazil, [jairabe@uol.com.br](mailto:jairabe@uol.com.br), *Fábio Romeu de Carvalho*

Agents' conflicts arise for different reasons and involve different concepts. Conflicts can be expressed as mere differences or as logical contradictions. Since more and more concern is attached to agents' teamwork and agents' dialogue, conflicts naturally arise as a key issue to be dealt with, not only with application dedicated techniques, but also with more formal and generic tools. In this work we propose a logical framework for conflicting knowledge based on the so-called paraconsistent logics which can deal with inconsistency and paracompleteness in a non-trivial manner.

## ■ WD-32

Wednesday 12:55-14:15  
GSI - S 4

### Taxation and Public Finance

Stream: Financial Modelling

*Contributed session*

Chair: *Takashi Shibata*, Graduate School of Social Sciences, Tokyo Metropolitan University, 1-1, Minamiosawa,, Hachioji, 192-0397, Tokyo, Japan, [tshibata@tmu.ac.jp](mailto:tshibata@tmu.ac.jp)

## 1 - A mathematical model to optimize the taxation on transferring income to a gmbhs shareholder

*Jörg Kalcsics*, Chair for OR & Logistics, Saarland University, P.O. Box 15 11 50, 66041, Saarbrücken, Germany, [j.kalcsics@orl.uni-saarland.de](mailto:j.kalcsics@orl.uni-saarland.de), *Stephan Meyerling*

As a large part of the 455000 German GmbHs are small and medium sized entities, a considerable amount of the operating income of these corporations is required for the shareholders' livelihood. Hence, it is a major challenge to minimize the taxation on the transfer of income from the corporation to the shareholders. We introduce a mixed-integer linear program that determines a combination of the transfer possibilities which minimizes the total taxation and hence maximizes the transfer to the shareholders. We also present a computational analysis, deriving first insights into the problem.

## 2 - Optimization of public co-financing of investment projects under crisis circumstances

*Vadim Arkin*, Central Economics and Mathematics Institute, Nakhimovskii prospekt, 47, 117418, Moscow, Russian Federation, arkin@cemi.rssi.ru,  
*Aleksandr Slastnikov*

During a period of crisis, participation of the State in financial support of major business projects increases. We propose a stochastic model for studying potentialities of public-private partnership in financing of investment projects for the creation of new enterprises. The model is based on a combination of real options and game theory approaches. We derive explicitly the Stackelberg equilibrium for the game "investor-government", which characterizes an optimal share of public co-financing in investment project.

## 3 - Consolidated government-sector budget identity and total seignorage.

*Zlatica Ivanicová*, Operations Research and Econometrics, FHI EU Bratislava, 85235, Bratislava, Slovakia, zivanicova@hotmail.com

The budget identities of the Treasury and the Central Bank can be combined to produce the consolidated government-sector budget identity. This identity describes that government purchases plus its payment of interest on outstanding privately held debt must be funded by revenues generated by taxes (other as inflation), by borrowing from private sector and printing currency. Divided the above-mentioned values by the price level and real output is possible to separate seignorage revenue.

## 4 - Employees' provident fund (epf) of singapore, malaysia, india and sri lanka: a comparative study

*Siti Aida Sheikh Hussin*, The Centre for the Analysis of Risk and Optimisation Modelling Applications, Brunel University, School of Information Systems, Computing and Mathematics, UB83PH, Uxbridge, Middlesex, mapgsas@brunel.ac.uk, *Diana Roman*, *Gautam Mitra*

The increase in life expectancy is significant particularly in Asia, the expected growth of elderly aged 65 and above from year 2000 to 2050 is 314%. Pension reform is going to be an important challenge to be addressed. This paper will concentrate on the Provident Fund of Singapore, Malaysia, India and Sri Lanka. The similarities as well as the variations of current system will be discussed in term of size, performance, investments, dividends, contributions, withdrawals and etc. Proposed strategies in order to enhance the system as well as risk and difficulties faced will also be discussed.

## ■ WD-33

Wednesday 12:55-14:15

GSI - S 7

## New Methods in Global Optimization

Stream: Global Optimization

Invited session

Chair: *Leocadio G. Casado*, Computer Architecture and Electronics, Universidad de Almeria, Ctra Sacramento s/n, La Canada de San Urbano, 04120, Almeria, Spain, leo@ual.es

### 1 - From infeasibility in lp to global optimization

*Paula Amaral*, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, Departamento de Matemática, Campo da Caparica, 2829-516, Caparica, Lisbon, Portugal, paca@fct.unl.pt

Deciding about interesting regions in an infeasible LP is a difficult decision problem. Once a region is selected some action must be done to repair the constraints that are infeasible for all the points in that region. This issue can be addressed as a quadratic fractional problem. Branch and Bound approaches to find global optimal solutions are proposed given emphasis to the construction of lower bounding problems.

### 2 - On partitioning simplices and covering by spheres

*Leocadio G. Casado*, Computer Architecture and Electronics, Universidad de Almeria, Ctra Sacramento s/n, La Canada de San Urbano, 04120, Almeria, Spain, leo@ual.es, *Eligius M.T. Hendrix*, *I. Garcia*

Simplices are used as partition sets in Branch-and-Bound algorithms for instance to determine mixture designs. One of our questions is how to partition them in an efficient way. The second question is how to prove that they cannot contain the optimum or a feasible set if spheres around the vertices are given that are proven not to contain solutions of the problem to be solved. We show a new way to apply overlapping regular simplices and proof several results of the covering problem.

### 3 - Global optimization of a generalized linear multiplicative program

*Claudio Sodini*, Statistics and Applied Mathematics, University of Pisa, Via Cosimo Ridolfi, 10, 56124, Pisa, Italy, csodini@ec.unipi.it, *Riccardo Cambini*

In this paper a solution algorithm for a class of generalized linear multiplicative programs having a polyhedral feasible region is proposed. The algorithm is based on the so called optimal level solutions method. Some optimality conditions are used to improve the performance of the proposed algorithm. Results of a computational test are provided.

### 4 - A practical approach for derivative-free simulation-based constrained optimization

*Benoit Couet*, Schlumberger-Doll Research, 02139, Cambridge, MA, United States, couet1@slb.com, *Hugues Djikpesse*, *David Wilkinson*

We propose an original, derivative-free, lexicographic scheme to efficiently solve optimization problems subject to both analytical and simulation-based constraints. After classifying all constraints depending on their computational costs, points not satisfying the linear constraints are feasilized. A sequential lexicographic ordering is then applied in which the inexpensive nonlinear constraints take precedence over expensive ones, which in turn take precedence over objective values. The usefulness of the proposed method is demonstrated using oilfield-production optimization examples.

## ■ WD-34

Wednesday 12:55-14:15

GSI - S 8

### Data Mining in Healthcare Informatics

Stream: Machine Learning and Its Applications

*Invited session*

Chair: *Nazife Baykal*, Middle East Technical University, Informatics Institute, 06531, Ankara, Turkey, baykal@ii.metu.edu.tr

#### 1 - Toward effective information retrieval in medical domain

*Mohammed AL Zamil*, Information Systems, Middle East Technical University, METU, 06531, ANKARA, ANKARA, Turkey, e152255@metu.edu.tr

We present a new model for domain-specific IR. It is emulating the gravitational law of gravity on bodies by extracting the degree of attractiveness among documents. The purpose is to make domain search engines, specifically medical engines, as effective as general ones. The relationships among documents are represented by a document network that reflects the semantic associations among documents. The importance of such network is to assess the quality of discovered documents because recent experiments in the field showed that closely related documents tend to be relevant to the same request.

#### 2 - Data mining and knowledge discovery at the sleep laboratory studies in psychophysiological and paradoxical sleep apnea patients

*Beyza Kaymakoglu*, XXX, 06810, Ankara, Turkey, beyzakaymakoglu@irim.com.tr, *Akin Akyuz*, *Sureyya Ozogur-Akyuz*, *Nazife Baykal*, *Fuat Ozgen*

The quantities and amplitudes of delta waves for paradoxical sleep apnea patients are different than other sleep apnea patients. As a consequence of the changes in delta waves, paradoxical sleep apnea patients' sleep perceptions are negatively affected which could be the result of previous psychiatric pathological problems. The distribution/scattering of delta waves in EEG, percentage, total delta quantity, amplitude of delta waves, comparison of paradoxical apnea with normal and psychophysiological apnea. We are obtaining subjective sleep evaluation of the patients using the post-sleep forms.

#### 3 - Fraud in healthpayment; a streamline from business intelligence to data mining

*Alp Timurhan Cevik*, Tepe International, 06531, Ankara, Turkey, acevik@tepeinternational.com.tr, *Gulsultan Dogan*

According to statistics, between 7% to 25% of health expenditures are coming from fraud. Although there are control mechanism while the health expenditures occurs, e.g. Electronic Claim Processing Systems, still there have to be retrospective controls. At the beginning of 2000s, BI applications made easy to analyse the data and detect fraud cases. Although BI applications are very helpful for the analyser to detect fraud, still this models depend on the person who makes analysing. Data mining could help to create a magic box that contains algorithms to determine the fraud in the health expenditures.

## ■ WD-35

Wednesday 12:55-14:15

GSI - S 9

### Simulations and Forbidden Minors

Stream: Graph Searching

*Invited session*

Chair: *Nancy Clarke*, Mathematics and Statistics, Acadia University, 12 University Avenue, B4P2R6, Wolfville, Nova Scotia, Canada, nancy.clarke@acadiau.ca

#### 1 - Searching simulations: from digraphs to hypergraphs to graphs

*Paul Hunter*, Computing Laboratory, Oxford University, Parks Road, OX1 3QD, Oxford, United Kingdom, paul.hunter@comlab.ox.ac.uk

Recent years have seen the use of graph searching games move from a tool for providing intuition about various graph measures to a means for defining them. In this talk, we take a general look at these games and introduce the notion of searching simulations - a formalisation of the idea of replicating one kind of searching game with another. As a consequence, we show how the well-established notions of directed tree-width (on digraphs) and hypertree-width (on hypergraphs) are related, and how both can be defined in terms of a graph searching game on undirected graphs.

#### 2 - Forbidden minor constructions for 4-searchable graphs

*Oznur Diner*, Mathematics, Memorial University of Newfoundland, St. John's, NL, A1C5S7, St. John's, Canada, oয়ার@mun.ca, *Danny Dyer*, *Boting Yang*

Search number of a graph  $G$  is the minimum number of searchers needed to capture an intruder in  $G$ . Those graphs that require small number of searchers are of interest. We are aiming to obtain the set of minor minimal graphs for which four searchers are not sufficient. We give the complete list of forbidden minors for biconnected outerplanar graphs. We give a set of 17 base graphs from which we constructively obtain many forbidden minors for 4-searchable series-parallel graphs. The set of forbidden minors is finite, however, no general construction method is known.

#### 3 - Playing games and proving theorems

*Isolde Adler*, Institutt for informatikk, Universitetet i Bergen, Postboks 7803, 5020, Bergen, Norway, isolde.adler@ii.uib.no

Pursuit-evasion games can be seen as a link between games such as "Scotland Yard" on one hand and structural graph theory on the other hand. After an introduction, this talk gives a short glimpse behind the curtain of current research in the field.

## ■ WD-36

Wednesday 12:55-14:15

GSI - S 11

### Stochastic Modelling and Simulation III

Stream: Stochastic Modelling and Simulation

*Invited session*

Chair: *Evelyn Buckwar*, Department of Mathematics, Heriot-Watt University, Riccarton, EH14 4AS, Edinburgh, United Kingdom, e.buckwar@hw.ac.uk

#### 1 - Empirical estimates in stochastic optimization via special cases

*Vlasta Kaňková*, Econometrics, Institute of Information Theory and Automation of ASCR, Pod

Vodárenskou věží 4, Praha 8, CZ 18208, Prague, Czech Republic, Czech Republic, kankova@utia.cas.cz

Optimization problems depending on a probability measure correspond to many applications. It happens often that the "underlying" probability measure is completely unknown and, consequently, an empirical measure has to replace the unknown measure. A lot of efforts have been paid to introduce assumptions under which the corresponding estimates have "good" properties. However, these assertions have been proven under known "classical" assumptions and it is known that the problems corresponding to new situations have not fulfilled them. We plan to deal with just these cases.

## 2 - Insensitivity bounds for the moments of the sojourn times in m/gi systems under state-dependent processor sharing

*Manfred Brandt*, Optimization, Konrad-Zuse-Zentrum für Informationstechnik Berlin (ZIB), Takustr. 7, 14195, Berlin, Germany, brandt@zib.de, *Andreas Brandt*

We consider a system with Poisson arrivals and i.i.d. service times and where the requests are served according to the state-dependent (Cohen's generalized) processor sharing discipline, where each request receives a service capacity which depends on the actual number of requests in the system. For this system we derive asymptotically tight upper bounds for the moments of the conditional sojourn time of a request with given required service time. The bounds generalize corresponding results given for the single-server processor sharing system by Cheung et al.

## 3 - Linear stability analysis for stochastic theta-methods applied to systems of sodes

*Evelyn Buckwar*, Department of Mathematics, Heriot-Watt University, Riccarton, EH14 4AS, Edinburgh, United Kingdom, e.buckwar@hw.ac.uk

In the first part of the talk I will consider a scalar equation driven by several Wiener processes and compare the stability behaviour of Theta-Maruyama and Theta-Milstein methods. In the second part I will study certain systems of ODES that are subject to stochastic perturbations with a structure that is known to a.s. stabilise or destabilise equilibrium solutions. Then I will present a mean-square and a.s. stability analysis of the Theta-discretisations of these test equations. The talk is based on joint work with Conall Kelly and Thorsten Sickenberger.

## ■ WD-37

Wednesday 12:55-14:15

GSI - S 12

### Simulation Metamodeling

Stream: Simulation, Metamodeling and Optimization

*Invited session*

Chair: *Inci Batmaz*, Statistics, Middle East Technical University, Middle East Technical University, Department of Statistics, 6531, Ankara, Turkey, ibatmaz@metu.edu.tr

## 1 - A statistical approach for comparing performances of alternative metamodels

*Inci Batmaz*, Statistics, Middle East Technical University, Middle East Technical University, Department of Statistics, 6531, Ankara, Turkey, ibatmaz@metu.edu.tr, *Elcin Kartal*

There are several metamodeling techniques for modeling simulation data. To evaluate the performance of a metamodel developed, various performance measures are used. We usually face with a problem when we use alternative metamodeling techniques, and then, need to determine which one performs the best (if any) among the others. In this study, we present a statistical approach to select the best model that represents the relationship between the response and the predictors. We also extend the approach to handle when more than one response variables are involved in the study.

## 2 - Comparison of linear and robust regression methods for metamodeling complex systems

*Ayca Donmez*, Statistics, Middle East Technical University, Statistics Department / METU, Ankara/TURKEY, 06531, Ankara, Turkey, ayca007@yahoo.com, *Elcin Kartal*, *Inci Batmaz*, *Bayindir Kuran*

The response surface methodology (RSM) is a popular approach for approximating complex systems. In RSM, least squares estimators lose efficiency in the existence of outliers. Since outliers are common in complex systems, in this study, we consider robust regression techniques which are not sensitive to data anomalies. Both linear and robust regression techniques such as Least Trimmed Squares (LTS), M-estimation, MM-estimation, S-estimation and MML-estimation are performed and compared on a solid rocket engine problem.

## 3 - A modification of mars by tikhonov regularization and conic quadratic programming for modeling quality data

*Fatma Yerlikaya Ozkurt*, Scientific Computing, Institute of Applied Mathematics, Aksemsettin Mah. Latif Sok., Ertürk Ap. 5/5 Sincan-Ankara, 06930, Ankara, Turkey, fatmayerlikaya@gmail.com, *Pakize Taylan*, *Inci Batmaz*, *Gulser Koksak*, *Gerhard-Wilhelm Weber*

In this study, we developed an alternative approach to a well-known data mining tool MARS, named as CMARS, which is particularly powerful in handling multivariate and nonlinear data. We construct a penalized residual sum of squares for MARS as a Tikhonov regularization problem and treat this problem by using conic quadratic programming. The boundaries of this optimization problem are determined by multiobjective optimization approach. We also applied CMARS, MARS and linear regression methods on quality data which is multivariate and nonlinear in nature, and compared their performances.

## ■ WD-38

Wednesday 12:55-14:15

GSI - S 13

### Financial Mathematics and Stochastic Control

Stream: Numerical Methods in Finance

*Invited session*

Chair: *Alexander Szimayer*, Faculty of Economics and Law, University of Bonn, Department of Business Administration III, Adenauerallee 24-42, 53113, Bonn, NRW, Germany, szimayer@uni-bonn.de

## 1 - A worst-case approach to continuous-time portfolio optimization

*Ralf Korn*, Dept. Mathematics, University of Kaiserslautern, 67653, Kaiserslautern, Germany, korn@mathematik.uni-kl.de

The main ideas, results and methods behind the worst-case approach to portfolio optimization in continuous time will be presented. This will cover the indifference approach, the HJB-system approach and the very recent martingale approach. We illustrate the difference to conventional portfolio optimization with explicitly solved examples.

### 2 - Optimal leverage factor for the constant proportion debt obligations: a martingale approach

*Aysegul Iscanoglu*, Financial Mathematics, Institute of Applied Mathematics, INSTITUTE OF APPLIED MATHEMATICS -, MIDDLE EAST TECHNICAL UNIVERSITY, 06531, ANKARA,  
iscanoglu@yahoo.com, *Ralf Korn*, *Ömür Ugur*

The Constant Proportion Debt Obligation (CPDO) is a newly developed product of the structured credit market. The important concept of the CPDO is the leverage factor which provides the additional returns to the holders. In the study, we provide a solution to the optimal leverage factor by Martingale Method. In the analysis, we try to optimize the Euclidean distance between the hedging portfolio and CPDO at maturity.

### 3 - Numerical methods for nonlinear black-scholes equations

*Pascal Heider*, Mathematisches Institut, Universität zu Köln, Weyertal 86-90, 50931, Köln,  
pheider@mi.uni-koeln.de

In recent years non-linear Black-Scholes models have been used to build transaction costs, market liquidity or volatility uncertainty into the classical Black-Scholes concept. The non-linear equations can be discretized by BDF - methods. These algorithms are fully implicit but require additional Newton iterations. We show that the numerical solution converges to the viscosity solution. The mathematical framework is handy and a wide range of models can easily be handled. The flexibility of the method is shown by application to four representative non-linear models.

## WD-39

Wednesday 12:55-14:15

GSI - S 14

### Multi-mode Project Scheduling

Stream: Scheduling

Contributed session

Chair: *Abbas Seifi*, Head of Industrial Engineering and Productivity Research Center, Amirkabir University of Technology, Tehran, Iran, 15875-4413, Tehran, Tehran, Iran, Islamic Republic Of, aseifi@aut.ac.ir

#### 1 - Project scheduling with flexible resources: formulation and inequalities

*Francisco Saldanha-da-Gama*, CIO/DEIO, University of Lisbon, FCUL-DEIO, Bloco C6, Piso 4, 1749-016, Lisbon, Portugal, fsgama@fc.ul.pt, *Isabel Correia*, *Lidia Lourenço*

We study an extension of the resource constrained project scheduling problem in which each resource can perform more than one skill and such that each activity may need several resources with the same skill. A mixed-integer linear programming formulation is proposed. Additional inequalities are also proposed as well as a heuristic to obtain a valid upper bound. Computational experience is reported showing that for instances of reasonable size the problem can be efficiently solved using a general solver.

#### 2 - Multi-mode project scheduling problem with flexible resource constraints

*Jiyin Liu*, Business School, Loughborough University, Loughborough, Leicestershire, LE11 3TU, United Kingdom, j.y.liu@lboro.ac.uk, *Bing Wu*, *Ronggui Luo*

We study the multi-mode resource-constrained project scheduling problem and consider flexible resources. An integer programming model is developed. The model is then used to investigate the impacts of problem parameters, such as network complexity, capability demand strength, capability supply strength, resource flexibility and resource number, on the problem difficulty, project makespan and resource utilization. The results indicate that increasing resource flexibility and resource number help decreasing the project makespan on average, but may also result in lower resource utilization.

#### 3 - An efficient heuristic method for multi-mode resource constrained project scheduling with resource vacation and activity splitting

*Abbas Seifi*, Head of Industrial Engineering and Productivity Research Center, Amirkabir University of Technology, Tehran, Iran, 15875-4413, Tehran, Tehran, Iran, Islamic Republic Of, aseifi@aut.ac.ir,  
*Mohammad Khalighi Sikaroudi*

This paper presents a new heuristic method for solving large scale multi-mode resource constrained project scheduling problems (MR-CPSP). The main objective is to minimize the project makespan. All resources are renewable and some of them may not be available at all times due to resource vacations. In order to reduce the project makespan, we split the activities during scheduling. The method has shown significant computational superiority over the existing method especially for large problems.

## WD-40

Wednesday 12:55-14:15

GSI - S 27

### Methodologies in complex systems

Stream: SD modelling in sustainable development

Invited session

Chair: *Alfred Fettweis*, Electrical Engineering and Information Science, Ruhr-Universität Bochum, Germany, Universitätsstrasse 150, D-44780, Bochum, fettweis@nt.rub.de

#### 1 - Communications, fluid dynamics, and some fundamental issues in physics

*Alfred Fettweis*, Electrical Engineering and Information Science, Ruhr-Universität Bochum, Germany, Universitätsstrasse 150, D-44780, Bochum, fettweis@nt.rub.de

Starting from Maxwell's equations, concepts such as field velocity, rest field, basal electromagnetic (EM) field etc. are introduced. Flow equations are derived, in particular for basal fields, that are structured like those of fluid dynamics. Electrons and photons are modelled this way as EM fluids, thus as complex dynamical systems that involve aspects of different disciplines (electromagnetics, fluid dynamics, classical and alternative relativistic dynamics). The results agree with known properties and experimental observations.

## ■ WD-41

Wednesday 12:55-14:15

GSI - S 28

### Private Sector Applications of Simulation

Stream: Simulation Applications in Private and Public Organizations

*Invited session*

Chair: *Murat Caner Testik*, Industrial Engineering, Hacettepe University, Hacettepe Universitesi, Muhendislik Fak. Endustri Muh. Bolumu, 06800, Beytepe- Ankara, Turkey, [mtestik@hacettepe.edu.tr](mailto:mtestik@hacettepe.edu.tr)

Chair: *Banu Yuksel Ozkaya*, Department of Industrial Engineering, Hacettepe University, Hacettepe University, Department of Industrial Engineering, 06800, Ankara, Turkey, [byuksel@hacettepe.edu.tr](mailto:byuksel@hacettepe.edu.tr)

#### 1 - Simulation analysis of a cold-standby system

*Ebru Yuksel*, Industrial Engineering, Hacettepe University, Beytepe, 06800, Ankara, Ankara, Turkey, [eyuksel@hacettepe.edu.tr](mailto:eyuksel@hacettepe.edu.tr), *Guldal Guleryuz*

In this study, a stochastic system with  $N$  identical, independent units and  $S$  cold-standby units with  $R$  repairmen is considered. The units are subject to random failures and it is assumed that both failure rates and repair rates are exponential. The system has large number of units, consequently it has fast switches. The system is simulated for different sets of parameters. Observed trajectory of the simulated system is represented with an analytical function. Behavior of the trajectory is investigated in transient phase with respect to different values of the system parameters.

#### 2 - Evaluation of var and cvar as decision criteria in supply contracts

*Berrak Dag*, ER1-030 Enterprise Research Centre University of Limerick, -, Limrerrick, Ireland, [berrakdag@yahoo.com](mailto:berrakdag@yahoo.com), *Paul Liston*, *Cathal Heavey*

In this study, we aim to help companies with the contract selection process by proposing some decision criteria. These decision criteria are based on risk measurements in financial analysis; Value at Risk (VaR) and Conditional Value at Risk (CVaR). We use case study data and a contract costing simulation model, which examines the cost drivers in a typical outsourced manufacturing supply chain, to investigate the decision criteria and the decision process and then draw conclusions as to which criterion is better in different situations.

#### 3 - A hybrid forecasting approach for a rental company's purchasing decisions

*Ruohui Yang*, School of Informatics, University of Bradford, 61 Quinton Road, CV3 5FE, Coventry, [reena.yang@gmail.com](mailto:reena.yang@gmail.com), *Peter Cowling*, *Keshav Dahal*

This paper proposes a hybrid approach for a real-world accumulative equipment usage forecasting problem as a key component of a purchasing decision support system (PDSS) to assist a rental company's decision on whether to sub-hire or purchase equipment to meet shortfalls. The hybrid approach adds the company's revenue data as a parameter into the forecasting model to model demand growth. With simulations designed in MatLab, results show that the proposed hybrid approach significantly improves the accuracy of forecasts, compared with the best single forecasting method merely on previous data.

## ■ WD-42

Wednesday 12:55-14:15

GSI - S 3

### Novel opportunities of DC programming and DCA for Industry and Finance

Stream: Nonconvex Programming: Local and Global Approaches - Theory, Algorithms and Applications

*Invited session*

Chair: *Anh Son Ta*, LMI, INSA de Rouen, +33, Rouen, France, [taanh\\_son@yahoo.com](mailto:taanh_son@yahoo.com)

#### 1 - Dc programming approach for berth scheduling

*Babacar Mbaye Ndiaye*, BP 45087 Dakar-Fann, 99000, Dakar, Senegal, [ndiayebm@insa-rouen.fr](mailto:ndiayebm@insa-rouen.fr), *Tao Pham Dinh*, *Hoai An Le Thi*

We present the DC (Difference of Convex functions) Programming and the DC Algorithm (DCA) for solving the continuous berth-scheduling problem in port container terminals. The objective is to determine the berthing times and positions of containerships during the loading and unloading operations of containers. Every vessel requires a specific amount of space in a wharf for a predetermined length of time to load and unload containers. We formulated a mixed integer programming model and the performance of the algorithm is tested on a set of data. The computational results are presented.

#### 2 - Dc programming approach for portfolio decision with higher order moments

*Yi-Shuai Niu*, Laboratoire de Mathématiques de l'INSA (LMI), National Institute for the Applied Science (INSA-ROUEN), INSA de Rouen LMI - Place Emile Blondel - BP 08 76131 Mont-Saint-Aignan, France, 76131, Rouen, France, [niuys@insa-rouen.fr](mailto:niuys@insa-rouen.fr), *Tao Pham Dinh*

We propose a new efficient method based on DC Programming and DC Algorithm for solving the portfolio selection problem with higher moments (Mean-Variance-Skewness-Kurtosis based). The problem is characterized as a nonconvex, large-scale, fourth order polynomial programming problem, which is difficult to be solved, especially when a large number of variables are encountered. The proposed approach is significantly efficient for relatively large-scale problem. Numerical results and comparisons with other methods are reported, which show the feasibility, efficiency, and globality of our method.

#### 3 - Dca for solving continuous min max problem for single period portfolio selection

*Hoai An Le Thi*, Computer Science, University Paul Verlaine - Metz, Ile du Saulcy, 57 045 , Metz, [lethi@univ-metz.fr](mailto:lethi@univ-metz.fr), *Duc Quynh Tran*

We consider the continuous min-max model to worst-case portfolio selection with multiple scenarios of risks where the return forecast of assets belongs to an interval. The problem can be formulated as minimizing a linear function under linear/quadratic constraints with additional complementarity constraints. DC (Difference of Convex functions) programming and DCA (DC Algorithm), an innovative approach in nonconvex programming framework has been developed for solving this problem. Numerical experiments on several test problems are reported that show the efficiency of the proposed algorithm.

#### 4 - Optimal spectrum balancing in multi-user dsl network by d.c programming and dca

*Anh Son Ta*, LMI, INSA de Rouen, +33, Rouen, France, [taanh\\_son@yahoo.com](mailto:taanh_son@yahoo.com), *Hoai An Le Thi*, *Tao Pham Dinh*, *Tho Le Ngoc*

Dynamic spectrum management (DSM) is an effective technique for mitigating detrimental effect of crosstalk in Digital Subscriber Lines (DSL). Among various DSM techniques, centralized Optimal Spectrum Balancing(OSB) achieves the maximum data rates by computing the optimal PSDs for all modems in DSL systems. In this paper we investigate a new and efficient algorithm based on DC (Difference of Convex functions) programming and DCA (DC Algorithms) for solving nonconvex optimization problems in OSB. Preliminary numerical experiments on real-world data show the efficiency of the proposed algorithm.

## ■ WD-43

Wednesday 12:55-14:15

GSI - S 10

### Long Term Financing and Investment 1

Stream: Long Term Financial Decisions

*Invited session*

Chair: *Ursula Walther*, Frankfurt School of Finance and Management, Sonnemannstrasse 9-11, 60314, Frankfurt/M, Germany, u.walther@frankfurt-school.de

#### 1 - The profitability of investment certificates in different tax systems ? do structured products benefit from taxation?

*Peter Scholz*, Frankfurt School of Finance and Management, 60314, Frankfurt am Main, Germany, p.scholz@frankfurt-school.de, *Ursula Walther*

Despite the strong growth of the open interest of investment certificates their profitability is questionable. Previous research has concentrated on costs, portfolio-theoretical issues and counterparty risk. So far, the impact of taxes has not been systematically analysed. In order to fill this gap we run historical simulations based on market data under three different taxation schemes: a world without taxes, the previous German tax system and the new flat-tax system. To compare the resulting return distributions and measure relative advantages we adapt concepts of stochastic dominance.

#### 2 - Credit dynamics in a first-passage time model with jumps

*Natalie Packham*, Quantitative Finance, Frankfurt School of Finance and Management, Sonnemannstr. 9-11, 60314, Frankfurt am Main, Germany, n.packham@frankfurt-school.de

The payoff of many credit derivatives depends on the level of credit spreads. In particular, the payoff of credit derivatives with a leveraged component is sensitive to jumps in the underlying credit spreads. In the framework of first-passage time models we extend a model by Overbeck and Schmidt (2005) to address these issues. In the extended model a credit quality process is driven by an Ito integral with respect to a Brownian motion with stochastic volatility. We examine the dynamics of the model and provide examples.

#### 3 - Financing a privately owned home - a time oriented risk analysis of combined savbings and financing acitivities

*Ursula Walther*, Frankfurt School of Finance and Management, Sonnemannstrasse 9-11, 60314, Frankfurt/M, Germany, u.walther@frankfurt-school.de, *Thomas Burkhardt*

Financing a privately owned home is a complex issue for most of us: First we save some equity, then we use this and additional dept to pay for the home, and then we have to repay the dept. The whole process is subject to interest rate and inflation risk, which depends crucially on the amount of equity used and the terms of the loan, particularly the time span for which interest rates are fixed. We set up an appropriate model to evaluate alternative strategies. As an innovative and appropriate risk measure we use the overall time needed to complete the financing process.

## ■ WD-44

Wednesday 12:55-14:15

GSI - S 16

### Meeting of the EURO WG in OR in Agriculture and Forest Management

Stream: OR in Agriculture and Forest Management

*Invited session*

Chair: *LluisM Pla*, Mathematics, University of Lleida, JaumeII,73, 25001, Lleida, Spain, lmp1a@matematica.udl.es

#### 1 - Euro wg in OR in agriculture and forest management

*LluisM Pla*, Mathematics, University of Lleida, JaumeII,73, 25001, Lleida, Spain, lmp1a@matematica.udl.es

Meeting of the EURO WG in OR in Agriculture and Forest Management

## ■ WD-45

Wednesday 12:55-14:15

GSI - S 33

### Various Topics of OR in Education

Stream: OR Applications in Education

*Invited session*

Chair: *Annette Hohenberger*, Middle East Technical University (METU), Informatics Institute, Cognitive Science Program, Inonu Bulvari, 06531, Ankara, Turkey, hohenberger@ii.metu.edu.tr

Chair: *Heiner Müller-Merbach*, Wirtschaftswissenschaften, Universität Kaiserslautern, Postfach 3049, 67653, Kaiserslautern, Germany, hmm@bior.de

Chair: *Seren Basaran*, Secondary Science and Mathematics Education, Middle East Technical University, Informatics Institute - METU, 06531 Ankara Turkey, Turkey, sbasaran@ii.metu.edu.tr

#### 1 - Management sciences and quantitative methods in management education in the uk

*Alberto Paucar-Caceres*, Business School, Manchester Metropolitan University, Aytoun Street, Aytoun Building, M1 3GH, MANCHESTER, United Kingdom, a.paucar@mmu.ac.uk, *Rosane PAgano*

We review the development of management science (MS) and management science methodologies (MSM) in management education by examining a sample of syllabuses of UG business courses and MBA courses in the UK. The academic phase of early MS/OR is outlined and a framework of four groups of MSM in use is proposed. Results indicate that most Business UG and MBA courses include a unit in Quantitative methods in the first year. Universities are still at large teaching the 'hard' methods and the type of problem solving methods developed in the 50s and 60s and 'soft' MSMs are rarely taught.

## 2 - Using a problem-based approach in the design of an OR course: targeting management student-workers

*Joao Miranda*, Area de Engenharia, Escola Superior de Tecnologia e Gest, Lugar da Abadessa, Apt 148, 7301-901, Portalegre, Portugal, jlmiranda@estgp.pt

In a Management graduation course, a Problem-Based approach and computer-aided support are used to promote the learning of OR basics by student-workers. The methodology relies in specific problems built to promote reasoning, to conjugate business or enterprise environment with OR quantitative methods, namely: decision support, game theory, Linear Programming and some special cases. The perspectives of optimality and uncertainty are aimed through a set of case problems that are designed to meet the needs of student-workers, in an introductory OR course of Bologna first cycle.

## 3 - Children born of war and the compram methodology

*Ingvill Constanze Mochmann*, EUROLAB, GESIS-Leibniz Institute for the Social Sciences, Bachemer Str. 40, 50931, Cologne, NRW, ingvill.mochmann@gesis.org, *Dorien DeTombe*

Children are born during and after wars, where the father is a member of an enemy, allied or peacekeeping force and the mother a local citizen. The human rights of these children are often at risk and little attention is paid to this group and their complex situation by authorities and humanitarian organisations. Using the COMPRAM methodology implementations which may be of particular relevance to secure the rights of this vulnerable group will be presented and discussed.

## 4 - The OR process: five item analysis

*Heiner Müller-Merbach*, Wirtschaftswissenschaften, Universität Kaiserslautern, Postfach 3049, 67653, Kaiserslautern, Germany, hmm@bior.de

The "Five Item Analysis" (FIA) is a general approach to problems in social systems of any kind. It includes: (i) Analysis of the current state of the system under study; (ii) Definition of future goals; (iii) Design of the future state of the system; (iv) Transformation of the system from the current into the future state; (v) Calculating the means (people, machinery, money etc.) for the transformation. Any item may require mathematics.

# Wednesday 14:30-16:00

## ■ WE-01

Wednesday 14:30-16:00

*Beethoven*

### Keynote WA1

Stream: Keynote Talks

*Keynote session*

Chair: *Gerhard J. Woeginger*, Department of Mathematics and Computer Science, Eindhoven University of Technology, 5600 MB, Eindhoven, Netherlands, gwoegi@win.tue.nl

#### 1 - Prime numbers and circuits

*Nitin Saxena*, Hausdorff Center for Mathematics, 53115, Bonn, Germany, ns@hcm.uni-bonn.de

Prime numbers are not only fundamental mathematical objects but also have real world applications in cryptography. But the question of efficiently distinguishing primes from the composites was fully resolved only in 2002. We will review this deterministic polynomial time primality test (colloquially called the AKS primality test). This solution relates to more general questions about circuits which we will briefly survey.

#### 2 - Combinatorial optimization in chip design

*Jens Vygen*, Research Institute for Discrete Mathematics, University of Bonn, Lennestr. 2, 53113, Bonn, Germany, vygen@or.uni-bonn.de

Chip design is one of the most fascinating application areas of mathematics. The rapid technological development, exponentially growing instance sizes, and the computational complexity of the key problems are posing continuous challenges to research. In particular, recent advances in combinatorial optimization have lead to substantially improved algorithms used in industry, and hence to better chips. We give some examples of this most fruitful interaction between theory and application, illustrating the variety of problems and techniques. Topics include partitioning, routing, resource sharing, and facility location.

## ■ WE-02

Wednesday 14:30-16:00

*Schumann*

### Keynote WA2

Stream: Keynote Talks

*Keynote session*

Chair: *Graham Kendall*, School of Computer Science It., University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, gxx@cs.nott.ac.uk

Chair: *Jacek Blazewicz*, Instytut Informatyki, Politechnika Poznańska, ul. Piotrowo 2, 60-965, Poznań, Poland, jblazewicz@cs.put.poznan.pl

#### 1 - New cutting and packing methodologies and their commercial application

*Edmund Burke*, School of Computer Science & IT, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, ekb@cs.nott.ac.uk

This talk will present an overview into research conducted by the Automated Scheduling, Optimisation and Planning Research group on cutting and packing methodologies. It will focus on advances that have been made by our team over recent years. First of all, it will address the non-guillotine variant of the rectangular packing problem. A heuristic method based on the methodology of best-fit will be presented. After this, the packing of irregular shapes will be discussed and new algorithms will be presented that maintain full accuracy with shapes that may contain lines, arcs and holes. In both the rectangular and irregular variants of the stock cutting problem, the presented algorithms produce significantly better results than the previous state of the art on a wide range of benchmarks from over 20 years of cutting and packing research. As a direct result of this work we have founded a spin-out company, Aptia Solutions Ltd, to further develop and commercialise these algorithms and the talk will conclude by discussing some of the commercial issues facing this research area.

## 2 - Sports scheduling and advances in integer and constraint programming

*Michael Trick*, Tepper School of Business, Carnegie Mellon University, Tepper Room 338, 15213, Pittsburgh, PA, United States, [trick@cmu.edu](mailto:trick@cmu.edu)

Advances in sports scheduling methods are changing how professional and amateur schedules are created. Leagues around the world are using optimization and related approaches for their team and officials scheduling. I will give some experiences in scheduling real sports leagues and outline what I believe are the major trends in optimization that are making it easier to create high quality schedules. My experiences come from leagues that range from a local children's football (soccer) league to scheduling the 2430 games that make up a single year's schedule for the US Major League Baseball. Computational methods from ten years ago are insufficient to attack these problems, even on today's computers, but recent advances in integrating integer and constraint programming, large neighborhood local search, and variable redefinition create powerful, flexible solution methods.

## ■ WE-03

Wednesday 14:30-16:00

Reger

### Keynote WA3

Stream: Keynote Talks

Keynote session

Chair: *Rolf Möhring*, Institut für Mathematik, Technische Universität Berlin, 10623, Berlin, Germany, [rolf.moehring@tu-berlin.de](mailto:rolf.moehring@tu-berlin.de)

#### 1 - Gor science award

Award Winner, x, 0000, x, Germany, [winner@uni-nrw.de](mailto:winner@uni-nrw.de)

to be announced

## Wednesday 16:15-17:00

### ■ WF-01

Wednesday 16:15-17:00

Beethoven

### Closing Session

Stream: Plenaries

Plenary session

Chair: *Erwin Pesch*, FB 5, University of Siegen, Hoelderlinstr. 3, 57068, Siegen, Germany, [erwin.pesch@uni-siegen.de](mailto:erwin.pesch@uni-siegen.de)

Chair: *Gerhard J. Woeginger*, Department of Mathematics and Computer Science, Eindhoven University of Technology, 5600 MB, Eindhoven, Netherlands, [gwoegi@win.tue.nl](mailto:gwoegi@win.tue.nl)

#### 1 - Closing session

1. Welcome
2. Announcements of awards - Winner of EURO Excellence in Practice Award - Winner of EURO Doctoral Dissertation Award - Winner of the EURO Management Science Strategic Innovation Prize (MSSIP)
3. Announcements of special journal issues organized around EURO; in particular the special issue of EJOR
4. Presentation of the ROADEF challenge/EURO 2010, an OR challenge dedicated to industrial applications: A large scale energy management problem with diversified constraints, proposed by EDF (<http://challenge.roadef.org>)
5. Announcements of future conferences - EURO'2010 in Lisboa - IFORS'2011 in Melbourne - ECCO - EuroOPT 2010 etc.
6. Concluding remarks

## Agent-based modelling

*Invited*

Massimo Genoese  
University of Karlsruhe  
massimo.genoise@kit.edu

**Track(s): 32**

**1 session**

## Analytic hierarchy processes, analytic network processes

*Invited*

Josef Jablonsky  
University of Economics Prague  
jablon@vse.cz

Y. Ilker Topcu  
Istanbul Technical University  
ilker.topcu@itu.edu.tr

**Track(s): 5 20 21 22 23**

**12 sessions**

## Application of fuzzy logic & real options to corporate management decision-making

*Invited*

Mikael Collan  
Åbo Akademi University  
mcollan@abo.fi

**Track(s): 34**

**2 sessions**

## Applications in business intelligence and knowledge discovery

*Invited*

Richard Weber  
University of Chile  
rweber@dii.uchile.cl

**Track(s): 34**

**3 sessions**

## Auctions

*Contributed*

Gerhard J. Woeginger  
Eindhoven University of Technology  
gwoegi@win.tue.nl

**Track(s): 27**

**1 session**

## Boolean programming

*Invited*

Endre Boros  
Rutgers University  
Endre.Boros@rutcor.rutgers.edu

**Track(s): 21**

**6 sessions**

## Clustering

*Invited*

Peter Gritzmann  
TU München  
gritzman@ma.tum.de

Andreas Brieden  
Universität der Bundeswehr München  
andreas.brieden@unibw.de

**Track(s): 6**

**1 session**

## Combinatorial optimization

*Invited*

Silvano Martello  
University of Bologna  
smartello@deis.unibo.it

**Track(s): 1**

**8 sessions**

## Combinatorial optimization

*Contributed*

Silvano Martello  
University of Bologna  
smartello@deis.unibo.it

**Track(s): 1**

**1 session**

## Complexity and optimization

*Invited*

Klaus Meer  
Technical University Cottbus  
meer@informatik.tu-cottbus.de

**Track(s): 15**

**2 sessions**

## Computational biology, bioinformatics and medicine

*Invited*

Jacek Blazewicz  
Politechnika Poznanska  
jblazewicz@cs.put.poznan.pl

Metin Turkyay  
Koc University  
mturkay@ku.edu.tr

Jonathan Garibaldi  
University of Nottingham  
jmg@cs.nott.ac.uk

**Track(s): 5**

**9 sessions**

## Computational statistics

*Invited*

Pakize Taylan  
Dicle University  
ptaylan@metu.edu.tr

**Track(s): 34**

**2 sessions**

## Container terminal operations

*Invited*

Iris F.A. Vis  
Vrije Universiteit Amsterdam  
ivis@feweb.vu.nl

Christian Bierwirth  
Martin-Luther-University Halle-Wittenberg  
christian.bierwirth@wiwi.uni-halle.de

**Track(s): 27**

**3 sessions**

## Convex optimization 1

*Invited*

Aharon Ben-Tal  
Technion-Israel Institute of Technology  
abental@ie.technion.ac.il

Amir Beck  
Technion - Israel Institute of Technology  
becka@ie.technion.ac.il

Marc Teboulle  
Tel Aviv University  
teboulle@math.tau.ac.il

**Track(s): 19**

**3 sessions**

**Convex optimization 2***Invited**Angelia Nedich*University of Illinois  
angelia@uiuc.edu*Asu Ozdaglar*Mit  
asuman@mit.edu**Track(s): 18****1 session****Cooperative game theory***Invited**Sırma Zeynep Alparslan Gök*Institute of Applied Mathematics,  
Middle East Technical University  
alzeynep@metu.edu.tr*Mariana Rodica Branzei*"Alexandru Ioan Cuza"  
University  
branzeir@info.uaic.ro**Track(s): 25****10 sessions****Cutting and packing***Invited**Jose Fernando Oliveira*Universidade do Porto  
jfo@fe.up.pt**Track(s): 16 17****8 sessions****Data mining***Contributed**Roman Slowinski*Poznan University of Technology  
roman.slowinski@cs.put.poznan.pl**Track(s): 31 32****4 sessions****Data mining and decision making***Invited**Hsin-Vonn Seow*University of Nottingham-  
Malaysia CampusHsin-  
Vonn.Seow@nottingham.edu.my**Track(s): 31****3 sessions****Data mining and knowledge discovery***Invited**Yannis Theodoridis*University of Piraeus  
ythead@unipi.gr**Track(s): 32****3 sessions****Data mining in quality improvement***Invited**Gulser Koksak*Middle East Technical University  
koksak@ie.metu.edu.tr**Track(s): 31****2 sessions****DEA and performance measurement***Invited**Ozren Despic*Aston University  
o.despic@aston.ac.uk*Dimitris Despotis*University of Piraeus  
despotis@unipi.gr**Track(s): 20****12 sessions****Decision analysis***Contributed**Graham Kendall*University of Nottingham  
gkx@cs.nott.ac.uk**Track(s): 37****8 sessions****Decision support systems***Invited**Fatima Dargam*SimTech Simulation Technology  
F.Dargam@SimTechnology.com*Pascale Zaraté*Institut de Recherche en  
Informatique de Toulouse  
zarate@irit.fr**Track(s): 23****4 sessions****Delegation and incentives***Invited**Peter Letmathe*University of Siegen  
peter.letmathe@uni-siegen.de*Christian Hofmann*University of Mannheim  
Hofmann@bwl.uni-mannheim.de**Track(s): 6****1 session****Demand and supply in consumer goods and retailing***Invited**Heinrich Kuhn*Catholic University of  
Eichstaett-Ingolstadt  
heinrich.kuhn@ku-eichstaett.de*Winfried Steiner*Clausthal University of  
Technology, Institute of  
Management and Economics  
winfried.steiner@tu-clausthal.de**Track(s): 28****4 sessions****Demand, pricing and revenue management***Invited**Alf Kimms*University of Duisburg-Essen  
alf.kimms@uni-due.de*Robert Klein*Universität Augsburg  
robert.klein@wiwi.uni-  
augsburg.de**Track(s): 23****4 sessions****Discrete and global optimization***Invited**Xiaoling Sun*Fudan University  
xls@fudan.edu.cn**Track(s): 30****1 session**

**Discrete optimal control***Invited**Dmitrii Lozovanu*Academy of Sciences of Moldova  
lozovanu@math.md*Gerhard-Wilhelm Weber*Middle East Technical University  
gweber@metu.edu.tr**Track(s): 45****2 sessions****Discrete optimization***Contributed**Tamas Kis*Computer and Automation  
Research Institute  
tamas.kis@sztaki.hu**Track(s): 26 27****17 sessions****Dynamic programming***Invited**Lidija Zadnik Stirn*University of Ljubljana  
lidija.zadnik@bf.uni-lj.si*Moshe Sniedovich*University of Melbourne  
m.sniedovich@ms.unimelb.edu.au**Track(s): 30****3 sessions****Dynamical systems and game theory***Invited**Alberto A. Pinto*University of Minho  
aapinto1@gmail.com**Track(s): 25****3 sessions****Economic lot scheduling problem***Invited**Anders Segerstedt*Luleå University of Technology  
anders.segerstedt@ltu.se**Track(s): 28****1 session****Edda***Invited**Denis Bouyssou*Cnrs-lamsade  
bouyssou@lamsade.dauphine.fr**Track(s): 1****1 session****Energy and emission markets***Invited**Hans-Jakob Lüthi*Ehtz  
luethi@ifor.math.ethz.ch*Stefan Pickl*Universität der Bundeswehr  
München  
stefan.pickl@unibw.de*Carlos Henggeler Antunes*University of Coimbra and  
INESC Coimbra  
ch@deec.uc.pt**Track(s): 29****7 sessions****Engineering optimization***Invited**Jose Herskovits*Federal University of Rio de  
Janeiro  
jose@optimize.ufjf.br**Track(s): 30****4 sessions****Evolutionary multi objective optimization***Invited**Juergen Branke*University of Warwick  
juergen.branke@wbs.ac.uk**Track(s): 10 11****5 sessions****Excellence in practice award***Invited**Geir Hasle*Sintef Ict  
Geir.Hasle@sintef.no**Track(s): 1****2 sessions****Experimental economics and game theory***Invited**Ulrike Leopold-Wildburger*Karl-Franzens-University  
ulrike.leopold@uni-graz.at*Stefan Pickl*Universität der Bundeswehr  
München  
stefan.pickl@unibw.de**Track(s): 14****1 session****Facilitated modelling interventions***Invited**L. Alberto Franco*University of Warwick  
alberto.franco@warwick.ac.uk*Gilberto Montibeller*London School of Economics  
g.montibeller@lse.ac.uk**Track(s): 35****5 sessions****Facility logistics***Invited**John Bartholdi*Georgia Institute of Technology  
john.bartholdi@isye.gatech.edu**Track(s): 27****3 sessions****Financial modelling***Invited**Georg Pflug*University of Vienna  
georg.pflug@univie.ac.at*Rita D'Ecclesia*Università di Roma  
rita.decclesia@uniroma1.it*Ronald Hochreiter*University of Vienna  
ronald.hochreiter@univie.ac.at**Track(s): 23 29****7 sessions**

**Financial modelling***Contributed**Peter Letmathe*University of Siegen  
peter.letmathe@uni-siegen.de**Track(s): 32**  
**7 sessions****Financial optimization***Invited**Gautam Mitra*Brunel University  
gautam.mitra@brunel.ac.uk*J. E. Beasley*Brunel University  
john.beasley@brunel.ac.uk**Track(s): 28**  
**6 sessions****Fuzzy systems, neural networks & artificial intelligence***Invited**Heinrich Rommelfanger*Goethe University  
Rommelfanger@wiwi.uni-frankfurt.de*Hans Georg Zimmermann*Siemens AG  
Hans\_Georg.Zimmermann@siemens.com**Track(s): 34**  
**3 sessions****Game theory***Contributed**Gerhard J. Woeginger*Eindhoven University of  
Technology  
gwoegi@win.tue.nl**Track(s): 39**  
**4 sessions****Global optimization***Invited**Eligius M.T. Hendrix*Universidad de Málaga  
eligius.hendrix@wur.nl*Janos D. Pinter*PCS Inc. & Dalhousie University  
jdpinter@hfx.eastlink.ca**Track(s): 33**  
**6 sessions****Gor-awards***Invited**Stefan Nickel*Universitaet Karlsruhe  
Stefan.Nickel@kit.edu**Track(s): 6**  
**2 sessions****Graph searching***Invited**Danny Dyer*Memorial University of  
Newfoundland  
dyer@math.mun.ca*Oznur Diner*Memorial University of  
Newfoundland  
oyasar@mun.ca*Boting Yang*University of Regina  
boting@cs.uregina.ca**Track(s): 35**  
**3 sessions****Graphs and networks***Invited**Dominique de Werra*Epfl  
dewerra@gmail.com**Track(s): 17**  
**2 sessions****Health care***Contributed**Florian Jaehn*Management Information Science  
florian.jaehn@uni-siegen.de**Track(s): 42**  
**3 sessions****Health care management***Invited**Marion Rauner*University of Vienna  
marion.rauner@univie.ac.at*Stefan Nickel*Universitaet Karlsruhe  
Stefan.Nickel@kit.edu*Teresa Melo*University of Applied Sciences  
teresa.melo@htw-saarland.de*Jan Vissers*Erasmus University Medical  
Centre  
j.m.h.vissers@erasmusmc.nl**Track(s): 21**  
**4 sessions****Inventory management***Invited**Stefan Minner*University of Vienna  
stefan.minner@univie.ac.at**Track(s): 14**  
**9 sessions****Keynote talks***Invited**Gerhard J. Woeginger*Eindhoven University of  
Technology  
gwoegi@win.tue.nl*Erwin Pesch*University of Siegen  
erwin.pesch@uni-siegen.de**Track(s): 1 2 3**  
**9 sessions****Knowledge discovery and data mining***Invited**Luís Cavique*Universidade Aberta  
lcavique@univ-ab.pt*Uwe Aickelin*University of Bradford  
uwe.aickelin@nottingham.ac.uk**Track(s): 27**  
**2 sessions**

**Knowledge discovery for decision support***Contributed*

*Roman Slowinski*  
Poznan University of Technology  
roman.slowinski@cs.put.poznan.pl

**Track(s): 30**  
**2 sessions**

**Lean accounting***Invited*

*Frances Kennedy*  
Clemson University  
fkenned@clemson.edu

**Track(s): 38**  
**2 sessions**

**Linear optimization***Contributed*

*Juan José Salazar González*  
Universidad de La Laguna  
(Tenerife)  
jjsalaza@ull.es

**Track(s): 33**  
**6 sessions**

**Location analysis***Invited*

*Frank Plastria*  
Vrije Universiteit Brussel  
Frank.Plastria@vub.ac.be

**Track(s): 12 13 14**  
**13 sessions**

**Long term financial decisions***Invited*

*Thomas Burkhardt*  
Universität Koblenz-Landau  
tburkha@uni-koblenz.de

**Track(s): 41 43**  
**7 sessions**

**Machine learning and its applications***Invited*

*Kristiaan Pelckmans*  
Katholieke Universiteit Leuven  
Kristiaan.Pelckmans@esat.kuleuven.be

*Jacob Kogan*  
Umbc  
kogan@math.umbc.edu

*Sureyya Ozogur-Akyuz*  
Sabanci University  
sozogur@sabanciuniv.edu

**Track(s): 34**  
**3 sessions**

**Mathematical models in macroeconomics***Invited*

*Claus Neidhardt*  
FH Koblenz - RheinAhrCampus  
Remagen  
neidhardt@rheinahrcampus.de

*Jürgen Kremer*  
FH Koblenz RheinAhrCampus  
Remagen  
kremer@rheinahrcampus.de

**Track(s): 42**  
**2 sessions**

**Mathematical programming***Invited*

*Karel Zimmermann*  
Charles University  
zimmermann@seznam.cz

*Alexander Martin*  
TU Darmstadt  
martin@mathematik.tu-darmstadt.de

*Tamas Terlaky*  
McMaster University  
terlaky@mcmaster.ca

*Imre Polik*  
Lehigh University  
imre.polik@gmail.com

*Gerhard-Wilhelm Weber*  
Middle East Technical University  
gweber@metu.edu.tr

**Track(s): 18**  
**12 sessions**

**Metaheuristics***Invited*

*Kenneth Sörensen*  
Universiteit Antwerpen  
kenneth.sorensen@ua.ac.be

*Marc Sevaux*  
Université de Bretagne Sud -  
UEB  
marc.sevaux@univ-ubs.fr

*Andreas Reinholz*  
University Dortmund  
andreas.reinholz@gmx.de

**Track(s): 19**  
**8 sessions**

**Metaheuristics and information systems***Contributed*

*Tamas Kis*  
Computer and Automation  
Research Institute  
tamas.kis@sztaki.hu

**Track(s): 19**  
**2 sessions**

**Methodology of societal complexity***Invited*

*Dorien DeTombe*  
Chair Euro Working Group  
detombe@nosmo.nl

**Track(s): 45**  
**3 sessions**

**Migration, education and sustainable development***Invited*

*Hanife Akar*  
Middle East Technical University  
hanif@metu.edu.tr

**Track(s): 44**  
**3 sessions**

**Mining***Invited*

*Alexandra Newman*  
Colorado School of Mines  
newman@mines.edu

**Track(s): 33**  
**1 session**

**Modelling large mips***Contributed**Oliver Bastert*Fico  
oliverbastert@fico.com**Track(s): 28****1 session****Multi-objective optimization and decision theory 1***Invited**José Rui Figueira*Technical University of Lisbon  
figueira@ist.utl.pt*Kathrin Klamroth*University of Wuppertal  
klamroth@math.uni-wuppertal.de**Track(s): 16****6 sessions****Multi-objective optimization and decision theory 2***Invited**Jutta Geldermann*Georg-August-Universitaet  
Goettingen  
geldermann@wiwi.uni-goettingen.de*Christiane Tammer*Martin-Luther-University  
Halle-Wittenberg  
christiane.tammer@mathematik.uni-halle.de**Track(s): 15 16****2 sessions****Multiple criteria decision analysis***Invited**José Rui Figueira*Technical University of Lisbon  
figueira@ist.utl.pt*Salvatore Greco*University of Catania  
salgreco@unict.it**Track(s): 7 10 11 12****18 sessions****Network optimization***Invited**Bernard Fortz*Université Libre de Bruxelles  
bfortz@euro-online.org*Luis Gouveia*University of Lisbon  
legouveia@fc.ul.pt**Track(s): 3 4****6 sessions****Nonconvex programming: local and global approaches - theory, algorithms and applications***Invited**Tao Pham Dinh*INSA Rouen  
pham@insa-rouen.fr*Hoai An Le Thi*University Paul Verlaine - Metz  
lethi@univ-metz.fr**Track(s): 42****3 sessions****Noncooperative games***Invited**Ignacio García-Jurado*Coruna University  
igjurado@udc.es**Track(s): 31****2 sessions****Nonlinear programming***Invited**E. Alper Yildirim*Bilkent University  
yildirim@bilkent.edu.tr*Tatiana Tchemisova*Aveiro University  
tatiana@mat.ua.pt*Olga Kostyukova*Belarusian National Academy of  
Sciences  
kostyukova@im.bas-net.by**Track(s): 24****7 sessions****Nonsmooth optimization and its applications***Invited**Adil Bagirov*University of Ballarat  
a.bagirov@ballarat.edu.au*Refail Kasimbeyli*Izmir University of Economics  
refail.kasimbeyli@ieu.edu.tr*Antonio Fuduli*Universita' della Calabria  
antonio.fuduli@unical.it**Track(s): 30****3 sessions****Numerical methods in finance***Invited**Ömür Ugur*Middle East Technical University  
ougur@metu.edu.tr**Track(s): 38****2 sessions****Operational research and quantitative models in banking***Invited**Constantin Zopounidis*Technical University of Crete  
kostas@dpem.tuc.gr**Track(s): 39****4 sessions****Optimal control***Invited**Erik Kropat*Friedrich-Alexander University  
Erlangen-Nuremberg  
kropat@am2.am.uni-erlangen.de*Gustav Feichtinger*Vienna University of Technology  
or@eos.tuwien.ac.at*Gerhard-Wilhelm Weber*Middle East Technical University  
gweber@metu.edu.tr**Track(s): 42****3 sessions**

**Optimal control in finance and insurance***Invited*

*Ulrich Rieder*  
University of Ulm  
ulrich.rieder@uni-ulm.de

*Nicole Baeuerle*  
University of Karlsruhe  
baeuerle@stoch.uni-karlsruhe.de

**Track(s): 36**  
**4 sessions**

**Optimization and data mining***Invited*

*Emilio Carrizosa*  
Universidad de Sevilla  
ecarrizosa@us.es

*Theodore Trafalis*  
University of Oklahoma  
ttrafal@ou.edu

*Renato De Leone*  
Università di Camerino  
renato.deleone@unicam.it

**Track(s): 31**  
**4 sessions**

**Optimization in public transport***Invited*

*Leo Kroon*  
Erasmus University Rotterdam  
LKroon@rsm.nl

*Anita Schoebel*  
Georg-August Universität  
Göttingen  
schoebel@math.uni-goettingen.de

**Track(s): 7 8**  
**18 sessions**

**OR and environmental management***Invited*

*Peter Letmathe*  
University of Siegen  
peter.letmathe@uni-siegen.de

*Axel Tuma*  
University of Augsburg  
axel.tuma@wiwi.uni-augsburg.de

**Track(s): 22**  
**7 sessions**

**OR and ethics***Invited*

*Fred Wenstøp*  
Norwegian School of  
Management BI  
fred.wenstop@bi.no

**Track(s): 45**  
**2 sessions**

**OR and real implementations***Invited*

*Ben Lev*  
University of Michigan -  
Dearborn  
blev@umich.edu

*Belarmino Adenso-Diaz*  
Universidad de Oviedo  
adenso@epsig.uniovi.es

**Track(s): 6**  
**9 sessions**

**OR applications in education***Invited*

*Seren Basaran*  
Middle East Technical University  
sbasaran@ii.metu.edu.tr

**Track(s): 45**  
**3 sessions**

**OR applications in industry***Invited*

*Bjarni Kristjansson*  
Maximal Software, Ltd.  
bjarni@maximalsoftware.com

*Eleni Pratsini*  
IBM Zurich Research Lab  
pra@zurich.ibm.com

*Jo van Nunen*  
RSM Erasmus University  
jnunen@rsm.nl

**Track(s): 1 22**  
**4 sessions**

**OR for development and developing countries***Invited*

*Leroy White*  
University of Bristol  
Leroy.White@bristol.ac.uk

*Gerhard-Wilhelm Weber*  
Middle East Technical University  
gweber@metu.edu.tr

*Marthi Harmse*  
Sasol Technology  
marthi.harmse@sasol.com

*Honora Smith*  
University of Southampton  
honora.smith@soton.ac.uk

**Track(s): 40**  
**6 sessions**

**OR in agriculture and forest management***Invited*

*Lluís Pla*  
University of Lleida  
lpla@matematica.udl.es

*Manfred Gronalt*  
University of Natural Resources  
and Applied Life Sciences,  
Vienna  
manfred.gronalt@boku.ac.at

**Track(s): 41 44**  
**6 sessions**

**OR in sports***Invited*

*Michael Trick*  
Carnegie Mellon University  
trick@cmu.edu

*Dirk Briskorn*  
University of Kiel  
briskorn@bwl.uni-kiel.de

**Track(s): 15 16**  
**2 sessions**

**Parametric optimization***Invited**Georg Still*University of Twente  
g.still@math.utwente.nl*Juergen Guddat*HU Berlin  
jguddat@mathematik.hu-berlin.de**Track(s): 44****2 sessions****Plenaries***Invited**Gerhard J. Woeginger*Eindhoven University of  
Technology  
gwoegi@win.tue.nl**Track(s): 1****4 sessions****Preference learning from data***Invited**Roman Slowinski*Poznan University of Technology  
roman.slowinski@cs.put.poznan.pl**Track(s): 16****2 sessions****Production and operations  
management***Contributed**Erwin Pesch*University of Siegen  
erwin.pesch@uni-siegen.de**Track(s): 41****2 sessions****Project management and  
scheduling***Invited**Rainer Kolisch*Technische Universität München  
rainer.kolisch@wi.tum.de*Christoph Schwindt*Clausthal University of  
Technology  
christoph.schwindt@tu-  
clausthal.de**Track(s): 15****3 sessions****Revenue management***Invited**Houyuan Jiang*University of Cambridge  
h.jiang@jbs.cam.ac.uk*Ayse Kocabiyikoglu*Bilkent University  
aysekoca@bilkent.edu.tr**Track(s): 37****4 sessions****Scheduling***Invited**Peter Brucker*University of Osnabrueck  
pbrucker@uni-osnabrueck.de**Track(s): 4 5****15 sessions****Scheduling***Contributed**Tamas Kis*Computer and Automation  
Research Institute  
tamas.kis@sztaki.hu**Track(s): 39 41****6 sessions****Scheduling under resource  
constraints***Invited**Jan Weglarz*Poznan University of Technology  
jan.weglarz@cs.put.poznan.pl*Joanna Jozefowska*Poznań University of Technology  
jjozefowska@cs.put.poznan.pl**Track(s): 17****5 sessions****Sd modelling in sustainable  
development***Invited**Pierre Kunsch*Vrije Universiteit Brussel  
pkunsch@vub.ac.be**Track(s): 40****2 sessions****Semi-infinite optimization***Invited**Jan-J Ruckmann*University of Birmingham  
J.Ruckmann@bham.ac.uk*Oliver Stein*University of Karlsruhe  
stein@wior.uni-karlsruhe.de*Miguel Goberna*Universidad de Alicante  
mgoberna@ua.es*Maxim Todorov*Universidad de las Americas  
maxim.todorov@udlap.mx*Marco A. López-Cerdá*Alicante University  
marco.antonio@ua.es**Track(s): 24****6 sessions****Simulation***Contributed**Horst W. Hamacher*University of Kaiserslautern  
hamacher@mathematik.uni-kl.de**Track(s): 39****2 sessions****Simulation applications in  
private and public  
organizations***Invited**Banu Yuksel Ozkaya*Hacettepe University  
byuksel@hacettepe.edu.tr*Murat Caner Testik*Hacettepe University  
mtestik@hacettepe.edu.tr**Track(s): 41 44****3 sessions**

**Simulation based decision support***Invited*

*Miroljub Kljajic*  
University of Maribor  
miroljub.kljajic@fov.uni-mb.si

*Stig C Holmberg*  
Mid Sweden University  
shbg@ieee.org

**Track(s): 40**  
**5 sessions**

**Simulation, metamodeling and optimization***Invited*

*Inci Batmaz*  
Middle East Technical University  
ibatmaz@metu.edu.tr

**Track(s): 37 38**  
**2 sessions**

**Software for or/ms***Invited*

*Robert Fourer*  
Northwestern University  
4er@iems.northwestern.edu

*Bjarni Kristjansson*  
Maximal Software, Ltd.  
bjarni@maximalsoftware.com

**Track(s): 42**  
**2 sessions**

**Stochastic modelling***Contributed*

*Horst W. Hamacher*  
University of Kaiserslautern  
hamacher@mathematik.uni-kl.de

**Track(s): 36**  
**4 sessions**

**Stochastic modelling and simulation***Invited*

*Andreas Röbler*  
TU Darmstadt  
roessler@mathematik.tu-darmstadt.de

*Erik Kropat*  
Friedrich-Alexander University  
Erlangen-Nuremberg  
kropat@am2.am.uni-erlangen.de

*Kuo-Hsiung Wang*  
National Chung-Hsing University  
khwang@amath.nchu.edu.tw

**Track(s): 36**  
**3 sessions**

**Stochastic models for service operations***Invited*

*Ger Koole*  
VU University Amsterdam  
koole@few.vu.nl

*Sandjai Bhulai*  
VU University Amsterdam  
sbhulai@few.vu.nl

*Raik Stolletz*  
Leibniz University of Hannover  
raik.stolletz@prod.uni-hannover.de

**Track(s): 36**  
**2 sessions**

**Stochastic programming***Invited*

*Jitka Dupacova*  
Charles Univ, Faculty of Math.  
and Physics  
dupacova@karlin.mff.cuni.cz

*Werner Römis*  
Huboldt-University Berlin  
romisch@math.hu-berlin.de

*Alexander Shapiro*  
Georgia Institute of Technology  
ashapiro@isye.gatech.edu

*Rüdiger Schultz*  
University of Duisburg-Essen  
schultz@math.uni-duisburg.de

**Track(s): 12 13**  
**14 sessions**

**Supply chain management***Invited*

*Herbert Meyr*  
Technical University of  
Darmstadt  
Meyr@bwl.tu-darmstadt.de

*Moritz Fleischmann*  
Rotterdam School of  
Management  
MFleischmann@rsm.nl

*Tamas Kis*  
Computer and Automation  
Research Institute  
tamas.kis@sztaki.hu

**Track(s): 8 9**  
**14 sessions**

**Sustainable living: cognitive, social, economical, ecological and world view***Invited*

*Ali Gökmen*  
Middle East Technical University  
agokmen@metu.edu.tr

*Annette Hohenberger*  
Middle East Technical University  
(METU)  
hohenberger@ii.metu.edu.tr

*Gerhard-Wilhelm Weber*  
Middle East Technical University  
gweber@metu.edu.tr

*Inci Gokmen*  
Middle East Technical University  
igokmen@metu.edu.tr

**Track(s): 43**  
**4 sessions**

**System dynamics modelling***Invited*

*Markus Schwaninger*  
Universität St.Gallen  
markus.schwaninger@unisg.ch

*Stefan Groesser*  
University of St. Gallen  
stefan.groesser@web.de

**Track(s): 43**  
**3 sessions**

**Timetabling and rostering***Invited**Dario Landa-Silva*University of Nottingham  
dario.landasilva@nottingham.ac.uk**Track(s): 9 10**  
**9 sessions****Transportation***Invited**Maurizio Bielli*Institute of Systems Analysis and  
Informatics  
bielli@iasi.cnr.it**Track(s): 3**  
**3 sessions****Transportation planning***Invited**Herbert Kopfer*University of Bremen  
kopfer@uni-bremen.de*Frank Schultmann*University of Siegen  
frank.schultmann@uni-siegen.de**Track(s): 2 3**  
**18 sessions****Uncertainty and environmental  
decision making***Invited**Jerzy Filar*University of South Australia  
j.filar@unisa.edu.au*Alain Haurie*GERAD and ORDECSYS  
ahaurie@ordecsys.com**Track(s): 44**  
**5 sessions****Value and risk in incomplete  
markets***Invited**Martin Rainer*Enamec  
martin.rainer@enamec.de**Track(s): 35**  
**5 sessions****Variational inequalities and  
bi-level problems***Invited**Stephan Dempe*Technische Universitaet Freiberg  
dempe@math.tu-freiberg.de*Christian Kanzow*Institute of Mathematics  
kanzow@mathematik.uni-  
wuerzburg.de**Track(s): 38**  
**5 sessions****Variational problems - theory,  
methods and applications***Invited**Rainer Tichatschke*University Trier  
tichat@uni-trier.de*Alexander Ioffe*Technion - Israel Institute of  
Technology  
ioffe@math.technion.ac.il*Xiaoqi Yang*The Hong Kong Polytechnic  
University  
mayangxq@polyu.edu.hk*Özlem Birgul*Tübitak Uzay  
ozlem.birgul@uzay.tubitak.gov.tr**Track(s): 38**  
**3 sessions****Vector and set-valued  
optimization***Invited**Vicente Novo*Universidad Nacional de  
Educacion a Distancia  
vnovo@ind.uned.es*Bienvenido Jiménez*Uned  
bjimenez@ind.uned.es*César Gutiérrez*Universidad de Valladolid  
cesargv@mat.uva.es**Track(s): 10**  
**3 sessions****Vehicle routing***Invited**Paolo Toth*University of Bologna  
paolo.toth@unibo.it**Track(s): 15**  
**6 sessions****Workshops***Invited***Track(s): 28**  
**1 session****Young people for system  
theory, optimization and  
education***Invited**Alexis Pasichny*National Technical University of  
Ukraine "Kyiv Politechnic  
Institute"  
alexis.pasichny@gmail.com*Kateryna Pereverza*National Technical University of  
Ukraine  
pereverza.kate@gmail.com*Alexander Makarenko*National Technical University of  
Ukraine "KPI"  
makalex@i.com.ua**Track(s): 45**  
**2 sessions**



Funaki, Yukihiko	TD-25	Hanafi, Saïd	MG-01	Keisler, Jeff	TG-07, TF-10, MC-11, TE-11
Fügenschuh, Armin	MA-18, WD-18	Hashemi Doulabi, S.Hosseini	TE-41	Kelle, Peter	TF-35
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Garibaldi, Jonathan	MG-05	Heyde, Frank	TA-16	Knoke, Thomas	MD-43
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Gnudi, Adriana	WC-18	Hurink, Johann	MC-04	Kostyukova, Olga	TE-24
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Gourdin, Eric	TG-04	Jablonsky, Josef	TF-21	Kropat, Erik	TE-05, WA-36, TG-42
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Grebennik, Igor	TF-27	Jovanovic, Milos	TC-30	Laaksoharju, Mikael	TE-45
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<b>H</b>					
Haase, Knut	WD-13	Karakaya, Gülşah	MG-10	Leopold-Wildburger, Ulrike	TB-02
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 Alpern, Steve TC-31  
 Alt, Bernhard TC-07  
 Altekin, F. Tevhide TD-27  
 Altinel, I. Kuban TD-03, WA-13, WC-13, MD-18, MG-18  
 Alvarez, Ada TA-06  
 Alvarez, Jose Fernando WC-02  
 Alvarez, Susana TF-29  
 Álvarez-Miranda, Eduardo TA-18  
 Álvarez-Mozos, Mikle MG-25  
 Alvelos, Filipe WA-05, MD-26  
 Alves, Cláudio MC-16, MG-16, TD-17  
 Amano, Kazuyuki MC-26  
 Amaral, Andre WC-01  
 Amaral, Paula WD-33  
 Amatatsu, Hirofumi TA-20, WC-20  
 Amberg, Boris WA-07  
 Ambroggi, Federico MG-05  
 Ambrosi, Klaus MD-02, WC-17  
 Amelia, Bilbao-Terol TC-24  
 Amirteimoori, Alireza TA-20  
 Amodeo, Lionel TC-09  
 Anagun, Sermet TE-44  
 Anakli, Zeynep MC-31  
 Analui, Behrad MA-31  
 Andalaft, Alejandro WA-28  
 Andersen, David MD-35  
 Andersen, Kim Allan TC-16
- André, Jean MD-29  
 Andres, Carlos TA-06  
 Andrieu, Laetitia TE-12  
 Andronikidis, Andreas MA-32  
 Androulakis, George S. WC-32, MG-33, WA-33  
 Angel-Bello, Francisco R. TA-06  
 Angelis, Vassilis WC-37  
 Angelus, Alexandar WD-14  
 Angilella, Silvia WC-11  
 Angulo Sánchez-Herrera, Eusebio WC-07, TC-38  
 Anita, Smelt TE-37  
 Anjos, Miguel WC-21  
 Anouze, Abdel Latef TE-20  
 Ansah, John TE-43  
 Antczak, Maciej MC-05, TF-05  
 Antic, Slobodan TG-14  
 Antunes, Antonio TA-13  
 Antunes, Carlos Henggeler TE-16  
 Anvary Rostamy, Ali Asghar WA-45  
 Aoudia-rahmoune, Fazia WC-36  
 Apicella, Nicola TA-32  
 Aragonés-Beltran, Pablo MC-23  
 Arana Jimenez, Manuel WA-10  
 Aranburu, Larraitz WD-12  
 Araneda-Fuentes, Cristina WA-08  
 Aras, Necati TD-03, WC-13, MG-18  
 Araujo, Silvio MA-11, WD-19  
 Arcelus, Francisco MC-06, TA-14  
 Archetti, Claudia TA-15  
 Archibald, Thomas MC-32, MG-44  
 Arda, Yasemin TA-15  
 Arenas-Arroyo, Esther TG-29  
 Argyriou, Andreas WA-34  
 Argyris, Nikolaos TF-10, TE-11  
 Arkin, Vadim WD-32  
 Armentano, Vinicius MG-01  
 Arnaldo, Risi TG-31  
 Arnellos, Argyris WC-23  
 Arneric, Josip TF-33  
 Arns Steiner, Maria Teresinha TA-30, TD-43  
 Arora Singh, Sonia TD-26  
 Arrowsmith, David TC-45  
 Arslan, Guvenc MD-31  
 Arslan, Mehmet Can WA-34  
 Artigues, Christian TG-01, WD-05, TD-15  
 Arutyunov, Aram TG-24  
 Ashayeri, Behzad TF-26  
 Askounis, Dimitris TD-11  
 Aslan, Miray MA-13  
 Aslanertik, Banu Esra MG-31

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|----------------------------------|---------------|-----------------------------|---------------|-------------------------------|--------------|
| Aspergh, Giada                   | MD-42         | Baptista, Elesandro         | WD-01,        | Beichelt, Frank               | TF-36        |
| Asproth, Viveca                  | TF-40         | TG-37                       |               | Bekesi, Jozsef                | TC-08        |
| Assimakopoulos, Vasilis          | TD-11         | Baptista, Luciana           | TG-37         | Belacel, Nabil                | WD-16        |
| Assis, Laura                     | TG-16         | Barbara, Panosch            | MA-21         | Belderrain, Mischel Carmen N. | MG-19        |
| Astorino, Annabella              | TD-18,        | Bard, Jonathan F.           | MC-21         |                               |              |
| TD-31                            |               | Barisci, Necaattin          | MD-42         | Beliakov, Gleb                | WA-30        |
| Aswal, Abhilasha                 | TA-18         | Barlas, Yaman               | TF-43         | Belianin, Alexis              | MG-39        |
| Atabarut, Altan                  | TG-41         | Baron, Opher                | WD-14         | Bell, Michael                 | WD-07        |
| Atasever, Ilknur                 | WA-30         | Barr, Steven                | MG-35         | Bell, Peter                   | TG-01        |
| Athanasopoulos, Theodore         | TF-06         | Barrios, Agustín            | MG-17         | Bellanger, Adrien             | MC-17        |
| Atici, Kazim Baris               | WA-20, TE-37  | Barro, Diana                | MC-28         | Bellei, Giuseppe              | WD-07        |
| Auger, Anne                      | MA-10         | Barthel, Daniel             | MG-05         | Bello-Dambatta, Aisha         | MG-43        |
| Avci, Filiz                      | TE-17         | Bartl, David                | TA-33         | Belousov, Mikhail             | WA-40        |
| Avellar, José Virgilio Guedes    | MG-20         | Bartolini, Enrico           | MD-15, TA-15  | Belousova, Veronika           | TA-39        |
|                                  |               | Bartolucci, Sandro          | TA-07         | Belov, Gleb                   | TE-17        |
| Aviv, Yossi                      | TC-23         | Barton, Paul I.             | MD-24         | Belton, Valerie               | TG-07        |
| Avrahami, Tsahi                  | WC-15         | Barz, Christiane            | MC-30         | Beltran-Royo, Cesar           | MD-14        |
| Avros, Renata                    | WC-36         | Barzily, Zeev               | WC-36         | Ben Amor, Sarah               | MG-11        |
| Aydin, Nursen                    | TD-23         | Basaran, Seren              | WA-45         | Ben Hmida, Abir               | TF-19        |
| Aydin, Ozlem                     | MD-31         | Baskak, Murat               | MA-23         | Ben-ameur, Walid              | TF-03, TG-18 |
| Ayhan, Dilber                    | MC-31, MD-31  | Baslé, Maurice              | TF-11         | Benallou, Abdelhanine         | TC-06        |
| Aytekin, Aycan                   | MA-23         | Basligil, Huseyin           | TE-08         | Benartzi, Shlomo              | MG-22        |
| Azad, Md. Abul Kalam             | TC-18         | Basten, Rob                 | TF-14         | Benatar, Naisan               | TA-05        |
| Aziz, Azmin Azliza               | MD-03         | Bastert, Oliver             | TC-28         | Bencivenga, Cristina          | TD-29        |
| Azizi, Nader                     | MG-09         | Bastiè, Majda               | TE-21         | Bendraouche, Mohamed          | MG-04        |
| Azizi-Sultan, Ahmad-Saher        | MC-42         | Basu, Sumanta               | TC-19         | Beneki, Christina             | TF-06        |
|                                  |               | Batmaz, Inci                | MC-31, MD-31, | Bengtsson, Jens               | TD-08        |
| Azizođlu, Meral                  | WA-39, WC-39  |                             | WD-37, WA-38  | Benjamin, Aida Mauziah        | MC-03        |
|                                  |               | Batouche, Mohamed           | MA-26         | Bennell, Julia                | TA-17        |
| <b>B</b>                         |               | Baudach, Jens               | MG-07         | Benyahia Tani, Nesrine        | TF-27        |
| Babic, Zoran                     | WD-22         | Bauer, Nico                 | WD-29         | Berenguel, Jose Luis          | WA-33        |
| Bach, Francis                    | WC-34         | Bauer, Petra                | WD-01         | Bergantinos, Gustavo          | MC-25        |
| Bader, Johannes                  | MA-10         | Baumann, Frank              | MD-05         | Berghammer, Rudolf            | TC-26        |
| Bæklund, Jonas                   | WC-09         | Baumelt, Zdenek             | WA-09         | Berk, Emre                    | WA-17        |
| Baes, Michel                     | WA-18         | Baumgartner, Alfonso        | TD-41         | Berk, Erhan                   | WD-20        |
| Baeuerle, Nicole                 | MC-36, MD-36  | Baumgartner, Bernhard       | TD-28         | Berlinska, Joanna             | MD-17        |
| Bagchi, Uttarayan                | TD-41         | Bauso, Dario                | TC-25         | Berman, Oded                  | MA-14        |
| Bagheri, Behzad                  | TA-19         | Bawa, Daljit Singh          | TA-10         | Bertazzi, Luca                | TA-15        |
| Bagherian, Hosain                | TA-40         | Bayhan, G. Mirac            | WA-19         | Bertocchi, Marida             | MA-12        |
| Baghery, Fouzia                  | WA-36         | Bayindir, Z. Pelin          | MC-09, TG-41  | Besiou, Maria                 | TG-22        |
| Bagirov, Adil                    | WD-24, WA-30, | Baykal, Nazife              | WD-34         | Bessler, Wolfgang             | WC-43        |
| WD-30                            |               | Baykasoglu, Adil            | TG-19         | Bestelmeyer, Georg            | WA-41        |
| Bahn, Olivier                    | TC-44         | Bayraktar, Demet            | WA-22         | Bettinelli, Andrea            | MC-15        |
| Baixaui, J. Samuel               | TF-29, TE-35  | Baz, Ibrahim                | MD-14         | Beullens, Patrick             | MA-39        |
| Bakal, Ismail Serdar             | MC-09         | Béal, Sylvain               | WC-25         | Bevan, Gwyn                   | TE-11        |
| Bakhrankova, Krystsina           | WA-39         | Beasley, J. E.              | MC-03, MA-28  | Beygo, Berkay                 | TD-19        |
| Bakhtavar, Ezzeddin              | TE-27         | Beccacece, Francesca        | MC-19         | Bhadury, Joy                  | TD-13        |
| Bakir, Berna                     | MC-31         | Becceneri, José Carlos      | MC-16         | Bhaja, Amit                   | TA-19        |
| Balakrishnan, Ramji              | TB-03         | Becejski-Vujaklija, Dragana | TC-30         | Bharti, Saurabh               | TC-04        |
| Balas, Egon                      | WC-01         |                             |               | Bhattacharya, Utpal           | TG-16        |
| Balcioglu, Baris                 | WD-14         | Becker, Kai Helge           | WC-17         | Bhulai, Sandjai               | TC-36        |
| Baldacci, Roberto                | MD-15, TA-15, | Becker, Nicole              | MA-39         | Bichler, Martin               | MG-27        |
| TC-15                            |               | Becker, Niels               | TD-23         | Bierwirth, Christian          | MC-27        |
| Ballestin, Francisco             | MC-06,        | Becker-Peth, Michael        | TD-14         | Biganzoli, Elia               | MG-05        |
| MG-17                            |               | Beer, Andreas               | TF-09, TA-10  | Bigaret, Sebastien            | MD-11        |
| Ballis-Papanastasiou, Panagiotis | WA-43         | Beerliova, Zuzana           | WC-35         | Bihlmaier, Ralf               | MD-22        |
|                                  |               | Begicevic, Nina             | MC-23         | Bilancioni, Riccardo          | TG-31        |
| Bana e Costa, Carlos             | MC-11         | Behzadi, Mohammad Hassan    | TC-20         | Bilbao, Jesus-Mario           | WA-25        |
| Banal-Estanol, Albert            | TA-32         |                             |               | Bilegan, Ioana                | MG-37        |
| Banik, Nilanjan                  | TG-25         |                             |               |                               |              |



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|---------------------------------|---------------------|--------------------------|--------------|--------------------------|--------------|
| Caserta, Marco                  | TG-04               | Chernov, Nikolai         | TA-17        | Collan, Mikael           | MA-34        |
| Casini, Emanuele                | WC-10               | Chesney, Marc            | MD-29, TC-44 | Colorni, Alberto         | TC-11        |
| Castro, Edilson                 | WD-19               | Chevalier, Alain         | TC-39        | Conejo, Antonio J.       | MD-28        |
| Castro, Elkin                   | MD-04               | Chevalier, Philippe      | WC-14        | Conforti, Domenico       | MD-04        |
| Catalan, Jaime                  | TD-06, TD-43        | Chew, Ek Peng            | MA-10, MD-27 | Conforti, Maria Letizia  | MD-04        |
| Çatay, Bülent                   | WD-08               | Chhatwal, Jagpreet       | MD-21        | Consigli, Giorgio        | TE-39        |
| Cauley, Fattaneh                | MG-19               | Chiang, Chang-tzu        | TA-40        | Consiglio, Andrea        | MD-28        |
| Cauley, Stephen                 | MG-19               | Chiarandini, Marco       | WA-15, TA-43 | Constans, Sophie         | MG-26        |
| Caulkins, Jonathan              | MA-21               | Chick, Stephen           | TD-06        | Constantino, Ademir      | WD-19        |
| Cavalheiro Marques, Nuno Miguel | TC-27               | Chie-Bein, Chen          | TF-28        | Constantino, Miguel      | WA-05, MD-14 |
| Cavique, Luís                   | TA-27               | Chien., George Chun Ming | MD-32        | Constas, Constantinos    | TF-20        |
| Cay, Tayfun                     | MD-14, TG-39        | Chiera, Belinda          | TD-44        | Contini, Rina Manuela    | TE-21        |
| Cedano, Juan                    | TD-05               | Chikhi, Salim            | MA-26        | Contreras, Ivan          | TE-03        |
| Cekyay, Bora                    | MD-18               | Chin, Yang-Chieh         | TF-28        | Coppini, Nivaldo         | WD-01, TG-37 |
| Çelebi, Dilay                   | WA-22               | Chin-Tsai, Lin           | TF-28        | Corbett, Charles         | MG-22        |
| Çelik, Melih                    | WA-27               | Chinnam, Ratna Babu      | WD-08        | Corchero, Cristina       | MA-12        |
| Censlive, Michael               | WA-14               | Chinthalapati, V L Raju  | WC-32        | Cordeau, Jean-Francois   | TA-01        |
| Centeno Hernández, Efraim       | MA-29               | Chiu, Chih-Wei           | TE-04        | Corman, Francesco        | MC-07        |
| Cepek, Ondrej                   | TA-21               | Chletsos, Michael        | MC-40        | Corominas, Albert        | MC-09        |
| Cervinka, Michal                | MC-38               | Chmielewski, Annette     | MG-07        | Correia, Aldina          | TE-38        |
| Cesar, Mihael                   | TC-40               | Cho, Yuh-Jen             | MD-08, MG-08 | Correia, Isabel          | TE-13, WD-39 |
| Ceselli, Alberto                | MC-15               | Choi, Jin Young          | TG-44        | Cortez, Hernan           | MA-05        |
| Cetiner, Demet                  | TE-23               | Choros, Barbara          | MG-36        | Cortina, Carla           | WA-11        |
| Cevik, Alp Timurhan             | WD-34               | Chou, Huey-Wen           | MD-08        | Coskunseda, Onur         | TD-19        |
| Cevizci, Dicle                  | TA-22               | Chou, Ying-Chyi          | MG-09        | Costa, Ana Paula         | TE-10        |
| Chabchoub, Habib                | TA-26, TD-37        | Christensen, Tue         | TE-13        | Costa, Lino              | MA-24        |
| Chakravarthy, Srinivas R.       | TG-36               | Chu, Andrej              | TF-18        | Costello, Anthony        | MD-40        |
| Chamoni, Peter                  | TC-30               | Chu, Ba                  | WA-42        | Côté, Jean-François      | MA-15        |
| Chan, Lingyau                   | MG-27               | Chu, Cheng Wei           | MA-07        | Couet, Benoit            | WD-33        |
| Chancelier, Jean-Philippe       | TE-12               | Chu, Feng                | TG-12        | Cowling, Peter           | WD-41        |
| Chang, Chien-Yen                | MD-08               | Chubanov, Sergei         | TA-33        | Crainic, Teodor Gabriel  | WA-03, TG-30 |
| Chang, Chih-Hung                | MG-08               | Chugay, Andrey           | TA-17        | Crama, Yves              | MC-04, TA-15 |
| Chang, Horng Jinh               | MD-32               | Chung, Yerim             | WC-17        | Creemers, Stefan         | TA-36        |
| Chang, Hwan                     | MA-27               | Churilov, Leonid         | MD-42        | Crema, Alejandro         | MA-16        |
| Chang, Pao-Long                 | MG-09               | Ciccarelli, Roberta      | TA-07        | Crespi, Giovanni Paolo   | MC-19        |
| Chang, Tsung-Sheng              | TD-19               | Cihan, Ahmet             | WC-34        | Crisalli, Umberto        | TF-07        |
| Chaojun, Xu                     | MD-22               | Cihelkova, Eva           | TF-33        | Cristescu, Gabriela      | TA-43        |
| Charalambous, Christoforos      | MD-16, MG-16        | Cil, Ibrahim             | TC-37        | Croci, Ettore            | MA-43        |
| Chardy, Matthieu                | TE-09               | Cinar, Didem             | TA-06        | Croft, John              | TC-43        |
| Chassiakos, Anastasios          | MA-27               | Cipriani, Ernesto        | TA-07, WC-07 | Cromvik, Christoffer     | TA-37        |
| Chatelet, Eric                  | TC-09               | Ciroth, Andreas          | TA-44        | Crone, Sven F.           | WC-06        |
| Chatterjee, Ashis               | TF-36               | Ciumara, Roxana          | WC-32        | Cruz, José               | TF-25        |
| Chen, Chao-Hua                  | MD-08               | Cizek, Ondrej            | TG-43        | Csizmadia, Zsolt         | MG-18        |
| Chen, Chie-Bein                 | TA-43               | Clark, Alistair          | WD-28        | Cullazoglu, Tuba         | WA-22        |
| Chen, Dali                      | MD-26               | Clarke, Nancy            | WA-35        | Currie, Christine        | MC-37        |
| Chen, Hai-Ming                  | TE-04               | Clasen, Christian        | MD-43        | Curseu, Alina            | TA-14        |
| Chen, Huey-Kuo                  | MD-08               | Clausen, Jens            | MD-28        |                          |              |
| Chen, Mei-Hsiu                  | TE-04               | Cleophas, Catherine      | WC-41        | <b>D</b>                 |              |
| Chen, Yen-lin                   | TA-43               | Clímaco, João            | TF-16, WA-26 | D'Acerno, Luca           | TA-07, WC-07 |
| Chen, Yi-Chun                   | TG-21, TA-37        | Coban, Elvin             | WA-02        | D'Arcangelis, Anna Maria | TA-29        |
| Chen, Yi-Shan                   | MA-23               | Codina, Esteve           | WD-07        | D'Ariano, Andrea         | MC-07        |
| Chen, Yi-Ying                   | MD-41               | Coelho, Luis             | TA-41        | D'Ecclesia, Rita         | TD-29        |
| Chen, Zhangyou                  | TE-38               | Coene, Sofie             | TC-03        | Dağlı, Emre              | MD-03        |
| Cheng, Jingde                   | TA-30               | Coffman, Ed              | WC-32        | Dabia, Said              | TE-02        |
| Cheng, T.C. Edwin               | TA-04, WC-15, MC-17 | Cohen, Guy               | TE-12        | Daduna, Hans             | MC-14        |
| Cheniany, Alireza               | TG-41               | Cohen, Yuval             | MA-11, TG-28 | Daechert, Kerstin        | TF-16        |
|                                 |                     | Colicchia, Claudia       | TF-06        | Dag, Berrak              | WD-41        |
|                                 |                     |                          |              | Dagdeviren, Metin        | TG-05        |

Dahal, Keshav	WD-41	Demiryapan, Ozge	TD-05	Drouet, Laurent	TC-44
Daniel, Liu	MD-42	Dempe, Stephan	MA-38	Drouineau, Mathilde	TF-41
Daniel, Tuytens	WD-19	Dereu, Guillaume	TG-01	Drozdowski, Maciej	MD-17
Daniele, Patrizia	WC-18	Desaulniers, Guy	MA-02	Du, Bisheng	WC-14
Dargam, Fatima	TF-23	Desmettre, Sascha	MG-28	Duarte, António	MD-26
Darlay, Julien	MC-05	Despic, Ozren	MG-20	Dul, Jan	WA-27
Darzentas, John	WC-23	Despotis, Dimitris	MG-20,	Duleba, Szabolcs	MA-23
Dascalu, Maria	MG-17		WC-20	Dumanli, Ufuk	WD-04
Dash, Gordon	TD-11	Detienne, Boris	MG-06, WD-26	Dunstall, Simon	MG-44
Dash, Sanjeeb	TC-15	DeTombe, Dorien	TA-45, WD-45	Dupacova, Jitka	TA-12
Dauzere-peres, Stéphane	WD-26	Dhouib, Emna	TD-04	Duran, Guillermo	TE-01, TD-06
Dauzère-Pérès, Stéphane	MG-06	Di Francesco, Massimo	TG-30	Duran, Serhan	TC-23
Davidau, Olivier	MA-42	Di Giacomo, Laura	MG-28	Durbach, Ian	TC-06
Davies, Ruth	MG-21	Di Paola, Luisa	TE-05	Dück, Viktor	TE-07
Davis, Stephen	TC-06	Di Puglia Pugliese, Luigi	TC-16	Dyer, Danny	WD-35
Davtalab Olyaie, Mostafa	TD-20	Diallo, Madiagne	WA-01	Dytczak, Mirosław	WC-22
Day, Robert	TF-01	Dias, José Carlos	TG-34		
De Almeida, David	TA-08,	Diaz, Javier	TE-41		
	MC-22	Diaz-de-Maria, Fernando	WC-34		
De Baets, Bernard	WD-16	Dick, Marcel	TC-09		
de Carvalho, J. M. Valério	MC-16,	Diebel, Matthew	TF-22		
	MG-16, TD-17, MD-	Diefenbach, Mel	MD-04		
	26	Diepen, Guido	TA-08, MA-22		
De Causmaecker, Patrick	WA-02,	Diesinger, Peter	MA-36		
	TC-05, TE-09	Dietsch, Michel	MA-20		
de Kok, Ton	TE-02	Dimaki, Katerina	WC-37		
De Kort, Wim	TF-01	Dimitriou, Vasileios	TE-09		
de Koster, René	WC-26, WA-27,	Dimitrov, Ned	TA-12		
	WC-27, WD-27	Diner, Oznur	WD-35		
De Lascurain, Miguel	MG-12	Dionisio, Andreia	TA-41		
De Leone, Renato	TG-31	Dittmar, Daniel	TC-14		
De Maere, Geert	WA-02	Divjak, Blazenka	MC-23		
De Reyck, Bert	TF-10	Djefal, Lakhdar	WC-09		
de Rooij, Frans	TE-42	Djikpesse, Hugues	WD-33		
De Smet, Yves	TG-11, WD-11,	do Nascimento Morais, António	WC-30		
	TD-37	Jorge	TC-27		
De Swart, Harrie	TC-26	Dobhan, Alexander	TD-08		
de Vries, Bert J.M.	TD-44	Dodin, Bajis	TG-38		
De-los-Santos, Alicia	TA-08	Doerner, Karl	TC-02, TD-02,		
Deak, Istvan	TF-12		TE-02, MC-03		
Deckmyn, Hans	TC-05	Dogan, Gulsultan	WD-34		
Declerck, Thierry	TF-34	Doherty, Patrick	MC-33		
Dedeoglu, Mehmet Cagri	MD-40	Dolgui, Alexandre	MA-17		
Dedoussis, Vassilis	MA-11, TF-20	Dominguez, Enrique	TF-31		
Dedu, Silvia	WC-32	Donmez, Ayca	WD-37		
Deelstra, Griselda	WA-28, WC-38	Donnan, Geoffrey	MD-42		
Dejaegher, Jérôme	TF-33	Dopazo, Esther	WC-37		
Dejax, Pierre	MA-15	Dorndorf, Ulrich	TB-01		
Dekker, Rommert	TF-14	Dorta-González, Pablo	TC-13,		
Delgado, Alexandrino	MG-03		WD-13		
Delibasic, Boris	WC-23, TC-30	Dos Reis, Goncalo	WC-28		
Dellaert, Nico	WC-08	Doumpos, Michael	TD-11, TD-39		
Delling, Daniel	TC-16	Dovica, Ivan	TE-07		
Dellino, Gabriella	WA-38	Dragan, Irinel	WA-25		
Delmelle, Eric	TC-13	Drechsel, Julia	WA-25		
Demange, Marc	WC-17	Drenovak, Mikica	WC-28		
Dembczynski, Krzysztof	WD-16	Drexl, Michael	MA-02		
Demiriz, Ayhan	WC-34, MG-37	Drigo Filho, Elso	MA-05		
Demirkol, Sebnem	WA-19	Drosos, Dimitrios	TA-09, TG-10		

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|-----------------------------|----------------------------|---|-------------------------------|-----------------------------|---|
| Ertogral, Kadir             | TD-03                      | Fernandes, Edite M.G.P.                 | TC-18,<br>MA-24               | Fondacci, Rémy              | MG-26                                   |
| Eryuruk, Selin Hanife       | MA-23                      | Fernandes, Kiran                        | MA-30                         | Foniok, Jan                 | TE-18                                   |
| Escobar, María Teresa       | WA-23,<br>WC-23            | Fernández, Carlos                       | MG-41                         | Fonseca, Maria da Conceicao | WA-05                                   |
| Escrivá, Gema               | TC-04                      | Fernandez, Daniel                       | WC-29                         | Fontchastagner, Julien      | WA-33                                   |
| Escudero, Laureano Fernando | MD-12, WD-12, MG-15, WA-32 | Fernandez, Elena                        | MA-01, TE-03                  | Formanowicz, Piotr          | MA-05,<br>MD-05, TC-05, TE-05,<br>TF-05 |
| Esen, Omur                  | TE-06                      | Fernandez, Jose                         | TG-15                         | Fortemps, Philippe          | TC-11,<br>WC-16, TC-41                  |
| Eshragh Jahromi, Ali        | TA-26                      | Fernandez, Pascual                      | WC-13                         | Fortz, Bernard              | TF-03                                   |
| Eskelinen, Juha             | TE-20                      | Fernández-Blanco, Matilde O.            | TE-35                         | Foss, Bjarne                | TD-30                                   |
| Espírito Santo, Isabel      | TC-18                      | Ferrante, Anna                          | MD-21, MD-42                  | Fourer, Robert              | TD-42                                   |
| Espirito Santo, Rafael      | TA-30                      | Ferreira, Carlos                        | TG-12                         | Fousekis, Panos             | MD-20                                   |
| Esposito, Emilio            | MA-09                      | Ferreira, Deisemara                     | MG-06                         | Fragniere, Emmanuel         | TC-44                                   |
| Esteves, Rosa               | TE-25                      | Ferreira, Fernanda A.                   | TG-25                         | Frahm, Gabriel              | MG-36, TC-42                            |
| Estrada, Miquel             | WD-07                      | Ferreira, Flávio                        | TG-25                         | França, Paulo Morelato      | TG-16                                   |
| Evans, Antony               | TA-13                      | Ferreira, Helena                        | TF-25                         | Francas, David              | TC-22                                   |
| Everett, Jim                | TC-34                      | Ferreira, Liliana                       | MC-41                         | Franco, Cristina            | TD-43                                   |
| Ezzeddine, Mosbah           | TA-20                      | Ferrer, Albert                          | WA-30                         | Franco, L. Alberto          | MC-35,<br>MG-35                         |
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| F. Vaz, A. Ismael           | MA-24                      | Ferrer-Martí, Laia                      | TF-44                         | Frank, Martin               | WD-18                                   |
| Fabbri, Giorgio             | TF-42                      | Ferretti, Ivan                          | MD-41                         | Fransoo, Jan C.             | WC-08, TA-14                            |
| Fabian, Csaba I.            | MD-28                      | Ferris, Michael                         | TF-18                         | Fredendall, Lawrence        | MG-40                                   |
| Facchin, Paola              | MD-21, MD-42               | Ferrucci, Francesco                     | TA-02                         | Freire de Sousa, Jorge      | MD-38                                   |
| Faco', Joao Lauro D.        | WA-24                      | Fettweis, Alfred                        | WD-40                         | Freire, Fausto              | TA-44                                   |
| Factorovich, Pablo          | MD-15                      | Feyereisl, Jan                          | TA-05                         | Freixas, Josep              | WC-31, MC-39                            |
| Fagerholt, Kjetil           | MG-01                      | Feyzioglu, Orhan                        | MD-18                         | French, Simon               | MA-35                                   |
| Fagioli, Enrico             | TC-30, TE-31               | Fiala, Petr                             | MD-23                         | Frenk, J.b.g.               | TF-14, TD-23,<br>MC-44                  |
| Fagundez, Fabio             | WA-24                      | Fiaschi, Linda                          | MG-05                         | Frensch, Steve              | MG-31                                   |
| Faigle, Ulrich              | MD-25                      | Fichtner, Wolf                          | TE-22, MC-29,<br>TA-32        | Frey, Ruediger              | MA-36                                   |
| Falbo, Paolo                | TD-29                      | Fierek, Szymon                          | TF-21                         | Fricke, Matthias            | TG-04                                   |
| Fallah-Fini, Saeideh        | WC-20                      | Fiestras-Janeiro, M <sup>a</sup> Gloria | MG-25, WD-25, TA-31           | Friedlander, Ana            | TD-38                                   |
| Fan, Wei                    | TA-07                      | Figueira, José Rui                      | TB-03, TG-07,<br>TF-10, TA-11 | Friedrich, Bernhard         | WC-03,<br>WD-03                         |
| Fanelli, Viviana            | TC-29, TE-29               | Figueiredo, Rafael M. A. de             | WA-01                         | Friedrich, Sonja            | TE-27                                   |
| Fang, Yang                  | TA-04                      | Filar, Jerzy                            | TA-26, TD-44                  | Friel, Terri                | TC-10                                   |
| Fanghaenel, Diana           | MA-38                      | Fink, Andreas                           | TD-04                         | Fuchsberger, Martin         | MD-07,<br>MC-08                         |
| Fanjul Peyro, Luis          | WD-04                      | Finkenstadt, Barbel                     | TE-25                         | Fuduli, Antonio             | TD-18, TD-31                            |
| Farahani, Poorya            | MA-06                      | Fischer, Andreas                        | TD-38                         | Fuentes, Ramon              | WA-20                                   |
| Fare, Rolf                  | MA-20                      | Fischer, Edwin O.                       | TE-35                         | Fukuda, Komei               | TE-18                                   |
| Fasano, Antonio             | TE-05                      | Fischer, Frank                          | MG-07                         | Fukushima, Masao            | TD-38                                   |
| Fasano, Giorgio             | TC-17                      | Fischer, Kathrin                        | TF-29                         | Fullerton, Rosemary         | MG-38                                   |
| Faulin, Javier              | MC-06, WC-37               | Fischer, Lars                           | WC-06                         | Funaki, Yukihiko            | TD-25                                   |
| Favaretto, Daniela          | TG-19                      | Fischer, Matteo                         | TD-07                         | Funk, Matthias              | TA-27                                   |
| Fedora, Mark                | TF-22                      | Fischetti, Matteo                       | MG-08                         | Furems, Eugenia             | TE-32                                   |
| Fehr, Max                   | MD-29                      | Flamini, Marta                          | MG-08                         | Furió, Salvador             | TA-06                                   |
| Fehr, Max                   | MD-29                      | Flapper, Simme Douwe                    | WC-08,<br>TD-22               | Fügensschuh, Armin          | MG-07,<br>WD-18                         |
| Fei, Hongying               | MA-31                      | Flatberg, Truls                         | WC-02, WA-16                  | Fylakis, Pericles           | TD-13                                   |
| Feichtinger, Gustav         | TF-08,<br>MG-14, MC-42     | Fleischmann, Moritz                     | MD-22                         | Fürnkranz, Johannes         | WC-16                                   |
| Feillet, Dominique          | TD-10,<br>MG-37            | Fleszar, Krzysztof                      | MD-16,<br>MG-16               | <b>G</b>                    |   |
| Feinberg, Eugene            | MC-36                      | Fletcher, Roger                         | TD-18                         | G. Alizadeh, Kamelia        | MD-18                                   |
| Felden, Carsten             | TG-32                      | Fliedner, Malte                         | WC-06                         | G.-Toth, Boglarka           | TD-01, TG-15                            |
| Felipe, Angel               | MA-01                      | Flier, Holger                           | MD-07                         | Gabriel, Steven             | MD-29, WA-29,<br>MD-44                  |
| Felix, Bastian              | TD-30                      | Fodstad, Marte                          | WA-29, TD-30                  | Gadhi, Nazih Abderrazzak    | MA-38                                   |
| Fellah, Nazahet             | MG-16                      | Foerster, Georg                         | WC-19                         |                             |   |
| Felletti, Daniele           | TD-29                      | Foldes, Stephane                        | WD-21                         |                             |   |
| Fendek, Michal              | TA-29                      | Fomin, Fedor                            | WA-35                         |                             |   |
| Fendekova, Eleonora         | TA-29                      |   |                               |                             |   |
| Feng, Chu                   | MC-33                      |   |                               |                             |   |

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 Galli, Laura MD-01, TD-07  
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 Garcia, Ricardo TD-07, WC-07, TC-38  
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 Garín, M. Araceli MD-12, WD-12  
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 Gather, Thorsten TF-15  
 Gatti, Elena TC-30, TE-31  
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Größler, Andreas	MC-35	Haensel, Alwin	TD-23	Hemmelmayr, Vera	MC-03
Gu, Feng	TA-05	Hagen, Matthias	TC-21	Hempesch, Christoph	MG-02
Guajardo, Mario	TE-01, TD-43	Hagiwara, Motohiro	MD-32	Hendrix, Eligius M.T.	MC-33, WA-33, WC-33, WD-33
Guardao, Luis	WC-05	Hahn, Andreas	MC-43	Henn, Sebastian	TD-02
Guedes, Allison	WD-15	Hahn, Gena	WA-35	Hennig, Alexander	WA-41
Guegan, Dominique	TF-29	Hahn, Peter	TC-01	Hennig, Axel	TF-17
Guenther, Hans-Otto	MA-06	Hahne, Felix	MD-02, WC-17	Hennig, Frank	TG-27
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Gueret, Christelle	MD-16	Haijema, René	TF-01, MD-05	Hentrich, Kersten	WD-20
Guerra-Vázquez, Francisco	MG-24	Halberstadt, Simon	TF-37	Heragu, Sunderesh	WD-27
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Guido, Rosita	MD-04	Hammer, Peter L.	WD-21	Hernández, Elvira	WD-10
Guignard-Spielberg, Monique	TC-01	Hamzaçebi, Coskun	WD-22	Hernandez, Monica	MC-41
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Gulsun, Bahadir	MA-16, MG-23	Hanen, Claire	MC-01, TD-41	Hertz, Alain	TA-15
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Gurnani, Haresh	TE-28	Hasija, Sameer	TD-06	Hiltunen, Veikko	TC-06, TA-35
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Günther, Markus	TA-43	Hayel, Yezekael	MG-37	Ho, Ying-Chin	WD-17
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Haase, Knut	WD-13	Heggernes, Pinar	WC-35	Hoheisel, Tim	MC-38
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Hoogeveen, Han	TA-08	Irlenbusch, Bernd	TA-09	Juan, Pin-Ju	MG-23
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Horozoglu, Nayat	TA-25	Iscan, Fatih	MD-14	Junqueira, Leonardo	TC-17
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Huaultme, Maud	TF-11	Jammernegg, Werner	TA-14	Kajiji, Nina	TD-11
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Huisman, Dennis	MD-07	Janssen, Fred	TE-14	Kalcsics, Jörg	WD-32
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Hunter, Paul	WD-35	Javadi, Akbar	MG-43	Kampmeyer, Thomas	TE-08
Huppmann, Daniel	WA-29	Jawtuschenko, Alexis	TD-06	Kanala, Roman	TC-44
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Hübner, Alexander	TF-28	Jiang, Houyuan	MA-37	Kanzow, Christian	MC-38, TD-38
Hüllermeier, Eyke	WC-16	Jiménez, Antonio	TA-11	Kaparis, Konstantinos	MD-01
Häll, Carl Henrik	TC-07	Jiménez, Bienvenido	WA-10,	Kapucugil-ikiz, Aysun	MG-32
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Hörmann, Wolfgang	TF-39	Jimenez-Lopez, Mariano	TC-24	Karaaslan, H. Türkan	TA-22
		Jin, Yaochu	MC-10	Karaca, Nihan	TC-19
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Iaquinta, Gaetano	TE-39	Jones, Dylan	MA-39	Karasakal, Esra	MC-31
Ibaraki, Toshihide	WB-01	Jongen, Hubertus Th.	WB-03,	Karelahti, Janne	TD-17
Igaki, Nobuko	MC-28	MC-18		Karima, Adel-aissanou	TG-03
Igel, Christian	TD-31	Jorda, Lirios	TA-39	Karlow, Denis	MG-19
Iliadis, Niko	MG-22, TE-30	Jordan, Hans	TF-43	Karmitsa, Napsu	MG-18
Imai, Akio	TA-19, MA-27	Jourdan, Laetitia	MC-10	Kartal, Elcin	MC-31, MD-31,
		Jovanovic, Milos	WC-23, TC-30	WD-37, WA-38	
				Kasimbeyli, Refail	WA-30,
				WD-30	

- |                              |                               |                            |                               |                         |                        |
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| Kasimis, Agelos              | TF-20                         | Klein, Alexandre           | MA-29                         | Kordic, Lana            | TF-33                  |
| Kassa, Rabah                 | MD-33                         | Klein, Anja                | TF-41                         | Korn, Ralf              | WD-38                  |
| Kato, Kosuke                 | TC-24, TF-24                  | Kleine, Andreas            | MD-20                         | Korotchenko, Ielyzaveta | MD-45                  |
| Katragjini, Ketrina          | TD-04                         | Kleine, Oliver             | TF-43                         | Kortbeek, Nikky         | TF-01                  |
| Katsev, Ilya                 | MC-39                         | Kleinmuntz, Don            | TG-07, MC-11                  | Koseler, Refika         | WA-45                  |
| Katsuda, Hideki              | MD-32                         | Klemmt, Andreas            | MA-06                         | Koshlai, Ludmilla       | TD-24, TA-45           |
| Kaulakys, Bronislovas        | TD-36                         | Klepper, Gernot            | TE-22                         | Kosmykov, Michael       | TF-08                  |
| Kavathatzopoulos, Iordanis   | TE-45                         | Kliegr, Tomas              | WA-37                         | Kostina, Ekaterina      | TE-24                  |
| Kaya, Ahmet                  | TC-34                         | Kliewer, Natalia           | TA-03, TE-07,<br>WA-07, WC-41 | Kostoglou, Vassilis     | WC-45                  |
| Kaya, Onur                   | WA-08, TG-28                  | Klimes, Cyril              | TD-40                         | Kostreva, Michael       | TF-18                  |
| Kayaligil, Sinan             | MC-31                         | Klingelhoef, Heinz Eckart  | WA-41                         | Kostyukova, Olga        | TE-24, MA-44           |
| Kaymakoglu, Beyza            | WD-34                         | Klingelhofer, Heinz Eckart | TE-22                         | Kotlowski, Wojciech     | WD-16                  |
| Kedziora, Pawel              | MD-05, TC-05                  | Klinghöfer, Heinz Eckart   | TE-22                         | Kotov, Vladimir         | TG-26                  |
| Keen, Steve                  | TA-42                         | Klingner, Matthias         | WC-19                         | Koutsouraki, Eleni      | TA-09                  |
| Keisler, Jeff                | TF-10                         | Kljajic, Mirosljub         | TE-40, TF-40                  | Kovacevic Vujcic, Vera  | MC-26                  |
| Keles, Dogan                 | MC-29                         | Kljajic-Borstnar, Mirjana  | TG-40                         | Kovacevic, Raimund      | TC-12                  |
| Kelle, Peter                 | TE-14, TF-35                  | Klose, Andreas             | WC-01                         | Kovacic, Andrej         | TC-40                  |
| Kellerer, Hans               | TG-26                         | Kloster, Oddvar            | WC-02                         | Kovacs, Edith           | MC-26                  |
| Kempkes, Jens Peter          | MD-22                         | Klosterhalfen, Steffen     | TC-14                         | Kovalev, Sergey         | MA-17                  |
| Kendall, Graham              | WA-16                         | Knafflic, Andrej           | TE-40                         | Kovalyov, Mikhail       | MA-17                  |
| Kennedy, Frances             | MG-38                         | Kneib, Thomas              | TD-28                         | Kozan, Erhan            | MD-04                  |
| Kerdali, Abida               | TE-36                         | Knoke, Thomas              | MC-43                         | Kozanidis, George       | MD-06                  |
| Keren, Baruch                | MA-11, TG-28                  | Knopf, Brigitte            | WD-29                         | Koziol, Christian       | WC-43                  |
| Kerner, Yoav                 | MC-39                         | Knust, Sigrid              | WD-15                         | Kraft, Holger           | MA-36                  |
| Keskin, M. Emre              | MD-18                         | Koberstein, Achim          | MD-22,<br>TD-33               | Kramkowski, Stefan      | TE-07                  |
| Ketabi, Saeedeh              | TA-40                         | Kocabiyikoglu, Ayse        | MG-37                         | Krappner, Emil          | TE-19                  |
| Khachay, Michael             | WC-36                         | Kocarev, Ljupco            | TF-06                         | Krasnogor, Natalio      | MG-05                  |
| Khalighi Sikaroudi, Mohammad | WD-39                         | Koch, Soeren               | TD-02                         | Krass, Dmitry           | MA-14                  |
| Khamisov, Oleg               | TC-38                         | Kodera, Jan                | TE-43                         | Kratica, Jozef          | MC-26                  |
| Khandelwal, Ankit            | TD-26                         | Koenig, Matthias           | MC-37                         | Kraus, Markus           | MA-21                  |
| Khosravi, Parvin             | TE-33                         | Kofjač, Davorin            | TE-40, TG-40                  | Kremer, Jürgen          | TA-42, TC-42           |
| Kicinski, Marcin             | MG-03                         | Koide, Takeshi             | TC-23, MC-32                  | Kremer, Mirko           | TD-14                  |
| Kiechle, Günter              | TE-02                         | Kojima, Masakazu           | WA-18                         | Kremers, Enrique        | TA-32                  |
| Kieffer, Yann                | WD-17                         | Kok, Esther                | TE-37                         | Krempasky, Thorsten     | TC-26                  |
| Kiehne, Rainer               | MA-08                         | Kok, Leendert              | MA-02, MC-04                  | Kress, Moshe            | TE-15                  |
| Kienitz, Karl Heinz          | MG-19                         | Kokan, Tonci               | MG-34                         | Kresz, Miklos           | TC-08                  |
| Kiesling, Elmar              | TA-43                         | Koksal, Gulser             | MC-31, MD-31,<br>WD-37, WA-38 | Krieger, Elliot         | TD-11                  |
| Kilic, Tuna                  | MD-31                         | Koksalan, Murat            | TD-16, TA-37                  | Krishnamoorthy, Mohan   | WC-13                  |
| Kilpeläinen, Harri           | MC-11                         | Kolisch, Rainer            | TE-15, MC-21                  | Krishnamurthy, Ananth   | WD-27                  |
| Kim, Chaiho                  | MA-28                         | Kolodziejuk, Ewa           | WC-22                         | Kristensen, Anders      | MC-30,<br>MA-41        |
| Kimms, Alf                   | MC-03, WC-18,<br>TE-23, WA-25 | Kolonko, Michael           | MA-08                         | Kristensen, Thomas      | MD-38                  |
| Kindler, Eugene              | TD-40                         | Koltys, Kamil              | MG-27                         | Kristjansson, Bjarni    | TD-42,<br>TE-42        |
| King, Barry                  | TC-10                         | Komiya, Toru               | MC-30                         | Krivy, Ivan             | TD-40                  |
| Kiniwa, Jun                  | MC-32                         | Komodakis, Nikos           | WA-21                         | Krokhmal, Pavlo         | TC-26                  |
| Kinoshita, Eizo              | TA-45                         | Kone, Oumar                | TD-15                         | Kronek, Louis-Philippe  | TA-21                  |
| Kirlik, Gokhan               | TD-19, TG-27                  | Kong, Guilan               | WA-23                         | Kronus, David           | TA-15, TA-21           |
| Kirschfink, Heribert         | TF-34                         | Kongo, Takumi              | TD-25                         | Kroon, Leo              | MD-07                  |
| Kirtiloglu, Osman Sami       | TC-13                         | Konings, Rob               | MA-27                         | Kropat, Erik            | TG-42                  |
| Kis, Tamas                   | MG-04                         | Konnov, Igor               | WC-18                         | Krostitz, Boris         | MG-07                  |
| Kischka, Peter               | TA-14                         | Kontolaimou, Alexandra     | MA-20                         | Kroupa, Tomas           | MG-39                  |
| Kjeldsen, Niels              | TA-43                         | Koole, Ger                 | TC-36                         | Kruger, Hennie          | TC-34                  |
| Klages, Marc                 | TF-37                         | Kopa, Milos                | TC-12                         | Krumke, Sven            | MC-01, TA-04,<br>TC-08 |
| Klamroth, Kathrin            | TE-04, TD-05,<br>TE-08, TF-16 | Kopanakis, Ioannis         | TC-32                         | Krushinsky, Dmitry      | WD-01                  |
| Klatt, Tobias                | MD-09                         | Kopfer, Herbert            | MA-02, MD-02,<br>TF-02, TA-23 | Kubali, Deniz           | TG-28                  |
| Kleber, Rainer               | TC-22                         | Koppang, Haavard           | TF-45                         | Kubiak, Wieslaw         | MC-17                  |
| Kleijnen, Jack               | WA-38                         |                            |                               | Kubo, Mikio             | WA-26                  |

Kubo, Takuma	TA-10	Lange, Fabien	WC-25	Leuthold, Florian	MD-44
Kucera, Petr	TA-21	Lange, Vanessa	MC-14	Levin, Genrikh	MA-17
Kucher, Vlad	MC-18	Lannez, Sebastien	WD-05	Levin, Mark Sh.	TE-16
Kucuk, Mahide	WA-30	Lanz, Christoph	MA-08	Levin, Yuri	TC-23, MA-37
Kucuk, Yalcin	WA-30	Laporte, Gilbert	TA-01, MA-15	Levina, Tatsiana	MA-37
Kucukaydin, Hande	WC-13	Larco, José Antonio	WA-27	Levner, Eugene	WD-14
Kuhn, Daniel	TC-41	Lari, Isabella	WC-21	Leydold, Josef	TF-39
Kuhn, Heinrich	TD-08, TE-14, TE-28, TF-28	Lariviere, Martin A.	TE-28	Li, Chun-Te	MA-07
Kuhn, Michael	MC-42	Larsen, Christian	WC-14	Li, Duan	MG-30, WC-33
Kula, Ufuk	MG-37	Larsen, Jesper	TE-19, TA-26	Li, Hongyan	MD-13
Kumar, Satyendra	TA-14	Laslo, Zohar	TC-41	Li, Jingpeng	TE-16
Kummer, Bernd	MA-44	Lattner, Andreas	TE-32	Liang, Ming	MG-09
Kunduzcu, Derya	MD-21	Latz, Jochen	MG-29	Liao, Ta-Wei	WD-17
Kunkel, Marcel	TG-02	Lau, Amy Hing-Ling	WA-08	Libura, Marek	TF-27
Kunsch, Pierre	TC-39, WC-40, TE-45	Lau, Henry	TG-38	Lidestam, Helene	MA-03
Kuran, Bayindir	WD-37	Lau, Hon-Shiang	WA-08	Liebig, Thomas	WC-19
Kurauchi, Fumitaka	WD-07	Laumanns, Marco	MD-07, MC-08, MC-10, MC-27	Lieckens, Kris	TA-22, TA-36
Kurby, Stephan	MC-07	Lavigne, Denis	TC-44	Liefooghe, Arnaud	MC-10
Kureychik, Victor	TF-17	Lavopa, Claudia	TC-17	Liers, Frauke	MD-05
Kurita, Osamu	WA-15	Lawryshyn, Yuri	MA-34	Liesiö, Juuso	TF-10, MC-11, TE-11
Kurochkin, Alexander	TF-13	Layter Xavier, Vinicius	TD-24	Lilia, Zaourar	WD-17
Kurttila, Mikko	MC-11, TA-35	Lazic, Mirjana	TC-26	Lillo, Felipe	MA-01
Kurz, Peter	TE-22, WA-41	Le Menestrel, Marc	TF-45	Lin, Bertrand	MC-17
Kuschel, Torben	TE-41	Le Ngoc, Tho	WD-42	Lin, Cheng-Chang	WD-08
Kutanoglu, Erhan	TF-14	Le Thi, Hoai An	WA-42, WC-42, WD-42	Lin, Chih-Hsun	MG-08
Kvasov, Dmitri	MG-33	Leal, Jose-Eugenio	TD-02	Lin, Chin-Tsai	MA-23, TA-40
Küfer, Karl-Heinz	MA-24, MD-24	Lebreton, Baptiste	TA-22	Lin, Gaea	WC-20
Kyriazopoulos, Panagiotis	TG-33	Lee, Hsu-Hua	TA-43	Lin, Shin-Yi	MG-23
Kürüm, Efsun	WC-12, TA-34	Lee, Lai-Soon	TC-04, WC-31	Lin, Yen-Chen	MG-09
Köhne, Florian	TE-08	Lee, Loo Hay	MA-10, MD-27	Lind-Braucher, Susanne	TE-35
König, Felix G.	TE-01	Lee, Ming-Tsung	WC-03	Lindroth, Peter	TA-37
Körpeoğlu, Ersin	WD-04	Lee, Wenyih	TF-42	Lino, M.Pilar	MC-06, TF-15, MG-17
<b>L</b>		Lefevre, Yvan	WA-33	Liour, Yuanchau	TF-28
L'Huillier, Gastón	TE-34	Legna, Carlos	TE-40	Lisboa Rocha, Marcelo	TA-19
Laaksoharju, Mikael	TE-45	Leibak, Alar	WC-12	Lisgara, Eleni	WC-32
Labbi, Wafaa	WD-04	Leimbach, Marian	WD-29	Liske, Thomas	TD-08
Laborie, Philippe	TD-15	Leitmann, George	MG-14	Listes, Ovidiu	TC-35
Labreuche, Christophe	MG-11	Leitner, Johannes	MG-14	Listiani, Mariana	WA-31
Lacerda, Rogerio	TF-37	Lejeune, Miguel	TE-12, MC-28	Liston, Paul	WD-41
Lach, Gerald	TA-01	Lemaic, Mile	TD-21	Litsardaki, Maria	TG-33
Lachout, Petr	TD-12	Lemaire, Pierre	MD-16	Litvak, Nelly	MG-21
Lacomme, Philippe	TD-41	Lenzen, Manfred	TA-44	Liu, Jingzhen	TF-38
Laguna, Manuel	MG-22	Leon, Maria Amparo	MC-41	Liu, Jiyin	WD-39
Lahdelma, Risto	TC-06	Leonov, Oleksii	MG-45	Liu, Liqiang	WA-27
Lal, A.k.	TA-10	Leopold, Ulrich	TD-44	Liu, Peihai	TA-04
Lambert, Amélie	MD-01	Leopold-Wildburger, Ulrike	MG-14	Liu, Shiang-Tai	MC-20
Lambrecht, Hendrik	MA-18			Liu, Xiaorong	TA-40
Lambrecht, Marc	TA-36	Leow, Mindy	WA-31	Liu, Yang	WC-39
Lan, Chun-Hsiung	TE-04	Lepin, Victor	TF-26	Ljubic, Ivana	TE-03
Lan, Yu Wen	MG-32	Lera-Lopez, Fernando	MC-06	Llorca, Natividad	MG-25, TA-25, TA-31
Lancranjan, Ion Ioan Ferdinand	TG-39	Leskinen, Pekka	MC-11, TA-35	Lodi, Andrea	WB-02, TC-15, WC-21
Landete, Mercedes	TD-19	Lessmann, Stefan	WA-31, WC-31	Lodwick, Weldon	MC-34
Lane, David	TG-43	Letchford, Adam	MD-01, WC-01, WC-15	Loebbecke, Claudia	WD-23
Lang, Jan Christian	WD-26	Letmathe, Peter	MA-04, MG-40	Lohmann, Christian	TG-08
Lang, Stefan	TD-28	Leung, Kwai-sun	WA-36	Lohse, Sebastian	MA-38
		Leurent, Fabien	TF-07		

Lokshtanov, Deniel	WA-35	Madlener, Reinhard	MG-29	Martin-Fernandez, Susana	TA-09, MC-41
Lopes, Andre	MA-11	Maenhout, Broos	WA-09	Martinez, Cristian	TD-43
Lopes, Isabel Cristina	MC-16	Magatti, Davide	TF-32	Martínez, Paloma	TF-34
Lopes, Maria João	MG-15	Magbagbeola, Joshua	MG-26	Martinez, Yailen	WC-04
Lopes, Rui Borges	TG-12	Maggioni, Francesca	MA-12	Martinez-Falero, Eugenio	TA-09, MC-41
Lopez, Pierre	TD-15, TF-19	Maharramov, Shahlar	TG-42	Martínez-Fernández, José Luis	TF-34
Lopez, Rafael	WC-42	Mahdi, Samir	MA-26	Martinez-Lopez, Beatriz	MA-41
Lopez, Ruben	WC-10	Mahmoud, Boufaida	TE-32	Martini, Jan Thomas	WA-37
López-Cerdá, Marco A.	TA-24	Mai, Jan-Frederik	MG-36	Martins, Cristina	TC-27
Lopez-Redondo, Juana	MD-33	Maindl, Thomas I.	TC-14	Martins, Isabel	WA-05
Lorenzo, Leticia	MC-25	Maiza, Mohamed	MD-16	Marx, Steffen	MA-08
Lorenzo-Freire, Silvia	MC-25	Maïzi, Nadia	TC-35, TF-41, MA-42	Mascis, Alessandro	TF-01
Lorion, Yann	TE-32	Mak, Kl	TF-38	Masmoudi, Youssef	TD-05
Lotzmann, Ulf	TF-39	Makarenko, Alexander	MD-45	Massei, Gianluca	WA-11
Louardi, Bradji	TE-32	Makuschewitz, Thomas	TF-08	Massim, Yamani	TC-09
Loukil, Taicir	TD-04, TC-41	Maldonado, Sebastian	TD-34	Massol, Olivier	WA-29
Lourenço, João Carlos	MC-11	Malek, Alaeddin	TE-33	Matarazzo, Benedetto	WC-11, WC-16
Lourenço, Lidia	WD-39	Malhamé, Roland	TC-44	Mateo, Manuel	MC-06
Low, Cheekiat	MC-28	Malik, Madhur	TD-34	Mateo, Pedro	TC-38
Lozano, Sebastián	TA-06	Malika, Yaici	WD-31	Mateos, Alfonso	TA-11
Lozovanu, Dmitrii	MG-14, MC-45	Malmborg, Charles	WD-27	Matias, João	TE-38
Lu, Jung-Ho	MA-23	Manger, Robert	TD-41	Matias, Sara	TA-11
Lu, Xiwen	TA-04	Manitz, Michael	TC-36	Matos Dias, Joana	WD-13
Lu, Yapeng	TG-38	Mannino, Carlo	TF-01	Matsubayashi, Nobuo	WC-13
Lubacz, Jozef	TF-35	Manohar, Senthanel Sirpi	TE-02	Matsui, Takeshi	TF-24
Lucas, Cormac	MC-13	Manolitzas, Panagiotis	TF-23	Matsypura, Dmytro	WC-32
Lucheroni, Carlo	TE-29	Mansi, Raid	TC-01	Mattfeld, Dirk Christian	TA-02
Luciani, Davide	TC-30	Manuel, Conrado M.	MG-25, TA-25	Matucci Cerenic, Marco	MD-04
Lueken, Michael	WD-29	Mar-molinero, Cecilio	TC-20, TF-32	Maturo, Antonio	TE-21
Luhandjula, Monga Kalonda	TC-24	Mar-Ortiz, Julio	TA-06	Matuszyk, Anna	TD-34
Lukasiak, Piotr	MC-05, MD-05, TF-05	Marchant, Thierry	TC-11	Maugeri, Antonino	WC-18
Lundgren, Jan T.	TC-07	Marchitto, Emilia	TG-31	Maurras, Jean François	MC-33
Luo, Ronggui	WD-39	Marciniak, Dorothea	MD-39	Mavri, Maria	WC-37
Lusa, Amaia	MC-09	Marcos, Nicolas	WD-05	Mavrotas, George	TD-11
Lusby, Richard	TA-26	Marenco, Javier	TD-06	Mayag, Brice	MG-11
Lust, Thibaut	WC-12	Mareschal, Bertrand	WD-11	Mazalov, Vladimir	TF-25
Lustosa, Leonardo	WA-08	Margaritis, Dimitris	MA-20	Mazauric, Vincent	TF-41
Luz, Carlos J.	WD-24	María, Gómez-Rúa	MC-25, TA-25	Mazorche, Sandro	TG-30
Lübbecke, Marco	TA-01, TE-01, TG-27	Marianov, Vladimir	MC-14	McKinnon, Ken	TD-30
Lyra, Christiano	TC-33	Marín, Ángel	TD-07, WD-07, MC-08	McKone, Thomas	TA-44
Lüthi, Hans-Jakob	TE-18	Marinkovic, Boban	TG-24	Meca, Ana	WD-25, TA-31
Lüthi, Marco	MC-07	Marjani Rasmussen, Kourosh	MD-28	Medernach, Emmanuel	TD-41
Löhne, Andreas	TA-16	Maroti, Gabor	MD-07	Meeraus, Alex	TF-18, MA-22
Löhr, Dirk	TC-42	Maroto, Concepcion	MG-41	Megow, Nicole	MC-01
<b>M</b>		Marques, Inês	MC-21	Meisel, Frank	MC-27
Ma, Tai-Yu	WD-02	Marschner, Andreas	MG-02	Meisel, Stephan	TA-02
Maag, Volker	MA-24	Marshall, Adele	MG-42	Meissner, Joern	MC-37
Maassen, Klaus-Christian	MC-03, WD-06	Martel, Jean Marc	MG-11	Mejia -Tellez, Juan	TG-36
Macedo, Rita	MC-16, MG-16, TD-17	Martin, Alexander	TF-30	Melchior, Philipp	TE-15
Macharis, Cathy	TD-13, WC-40	Martin, Julien	MA-29	Mellouli, Taieb	WA-07
Machemehl, Randy	TA-07	Martin-Barragan, Belen	TF-31	Melo, Teresa	MA-02, TE-13
Macq, Jean-François	WC-14	Martin-Campo, Francisco	WA-01	Meloni, Carlo	WA-38
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Menoncin, Francesco MA-43  
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Merino, María MD-12  
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Mesa, Juan A. TD-07, MC-08, TA-08, TD-10  
Meskens, Nadine MA-31, TA-36  
Mesquita, Marta WA-07  
Messine, Frederic WA-33  
Mestre, Pedro TE-38  
Meunier, Frédéric TA-21  
Mevissen, Martin WA-18  
Meyer, Christoph Manuel MA-02  
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Meyr, Herbert TD-08  
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Middelkoop, Dick MC-22  
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Migliarina, Enrico WC-10  
Miglione, Giovanna MD-37  
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Mihai, Rodica WC-35  
Mihalak, Matus WA-35, WC-35  
Mijangos, Eugenio TD-33  
Mika, Marek WA-17  
Mikhalevich, Mikhail TD-24, TA-45  
Mild, Pekka MC-11  
Miloni, Armando MG-20  
Milostan, Maciej MC-05, TF-05  
Min, Hokey MD-06  
Minchenko, Leonid TE-24  
Mingers, John WA-40, TC-45  
Mingozi, Aristide MD-15, TA-15, TC-15  
Minis, Ioannis TF-06  
Minner, Stefan WA-08, TA-14, TC-14, TC-22  
Minoux, Michel WC-21  
Miquel, Silvia WD-25  
Miranda Bront, Juan Jose TC-15, MD-37  
Miranda, Jaime TE-01, TF-31  
Miranda, Joao WD-45  
Mirbach, Tobias MC-29  
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Mishchenko, Tanya WA-43  
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Mitra, Gautam MA-13, MC-13, MC-28, MD-28, WD-32  
Mitsos, Alexander MD-24  
Miyagawa, Masashi WA-13  
Miyamoto, Yuichiro WA-26  
Mizgier, Kamil TF-08  
Mizoshita, Fumiki MG-34  
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Mochmann, Ingvill Constanze WD-45  
Moeen Moghadas, Foroogh MC-14  
Moehring, Bernhard MC-43  
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Moench, Lars TF-02, MG-06  
Moewes, Christian TE-34  
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Mohamed Aymen, Boujelbene TD-37  
Mohamed El-Amine, Chergui TD-16  
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Mohiuddin, S MA-21  
Mohr, Esther MA-28  
Molho, Elena WC-10  
Molina, Julian MC-41  
Molinero, Xavier WC-31  
Monaci, Michele TD-07  
Moncef, Abbas TD-16  
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Monge, Juan Francisco TD-19  
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Monteiro, Ana WC-28  
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Montella, Bruno TA-07, WC-07  
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Montero, Javier TD-06  
Montibeller, Gilberto MA-35, MC-35, MD-35  
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Morales, Juan Miguel MD-28  
Moreira, M. Rosario TD-04  
Moreno, Luis TE-41  
Moreno-jimenez, José María WA-23, WC-23  
Moresino, Francesco TC-44  
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Morshed, Mohammad Sarwar MD-04  
Morton, Alec TG-07, TF-10, MC-11, TE-11, TC-31, MA-35  
Morton, David TA-12  
Mosheiov, Gur TD-41  
Mosquera Rodríguez, Manuel Alfredo WD-25, TA-31  
Mosquera, Gabriela TD-17  
Mostaghim, Sanaz MD-10  
Mota, Caroline M Miranda TE-10  
Moura, Ana TF-19  
Mousseau, Vincent MD-11, WC-11  
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Mozaffari, Mohammad Reza TD-20  
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 Pagel, Christina MD-40  
 Paha, Johannes TC-29  
 Pahikkala, Tapio WD-16  
 Paías, Ana WA-07  
 Paixão, José TC-16  
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 Pales, Zsolt MA-19  
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 Papaioannou, Grammatoula WC-05  
 Papamichail, K. Nadia MA-35  
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Paradi, Joseph	MC-20, TD-20, MG-31	Peterson, Anders	TC-07	Poon, Simon	TE-34
Pardalos, Panos	MG-22, TE-30	Peterson, Sonja	TE-22	Popela, Pavel	MC-12
Pardo, Laura	TE-43	Petkovic, Alexandre	WC-38	Popenda, Lukasz	MA-05
Park, Byung-In	MD-06	Petrantonakis, Pavlos	MG-32, MG-42	Popenda, Mariusz	MA-05
Parlaktuna, Osman	TD-19	Petrelli, Marco	TA-07, WC-07	Popescu, Ioana	MG-37
Parra, Juan	TA-24	Petropoulos, Fotis	TD-11	Poppenborg, Jens	WA-04
Parrado-Hernandez, Emilio	WC-34	Petrovic, Dobrila	MD-04	Poropudas, Jirka	MA-39
Parragh, Sophie	TD-02	Petrovic, Sanja	MD-04	Portillo, Fabiola	TF-32
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Pascoal, Marta	TF-16, WC-24, WA-26	Pfetsch, Marc	TA-01	Potarusov, Roman	TF-17
Pascual-Agulló, Amadeo	MC-23	Pflug, Georg	TD-12	Potthoff, Daniel	MD-07
Pash, David	TC-08	Pham Dinh, Tao	WA-42, WC-42, WD-42	Potvin, Jean-Yves	MA-15
Pasichny, Alexis	MG-45	Phillips, Larry	TG-07	Pouly, Marc	TC-33
Pasiouras, Fotios	TD-39	Pholphan, Methee	MC-30	Poumahmoud, Jafar	TA-20
Passacantando, Mauro	WC-30	Piantadosi, Julia	MG-44	Pourakbar, Morteza	TF-14
Passaro, Renato	MA-09	Picavet, Emmanuel	TF-45	Poveda-Bautista, Rocio	MC-23
Pastor, Rafael	TF-44	Pickl, Stefan	MG-14, WD-29	Pozo, Miguel Angel	TD-10
Pastor-Ferrando, Juan P.	MC-23	Piera, Miquel Angel	TF-39	Pranzo, Marco	MC-07
Pato, Margarida	WA-07, WD-09, MC-21	Pieters, Angele	MD-42	Prasad, Kunal	TC-04
Patriksson, Michael	WA-05	Pieters, Barbara	TA-08	Prasanna, G. N. Srinivasa	TA-18
Patrizi, Giacomo	MG-28	Pilz, Kay Frederik	WC-38	Pratelli, Antonio	WC-07
Paucar-Caceres, Alberto	WD-45	Pimentel, Carina	MD-26	Pratsini, Eleni	MD-22
Paul, Anne	TC-03	Pindoria, Sandip	TE-42	Preda, Vasile	WC-32
Paul-François, Matteaccioli	TF-11	Pineda, Salvador	MD-28	Prekopa, Andras	TF-12, MC-13
Paulus, Jacob Jan	MC-04	Pinho de Sousa, Jorge	WC-05	Prescott-Gagnon, Eric	MA-02
Pavlas, Martin	MC-12	Pinter, Miklos	MA-25	Pretolani, Daniele	TC-16
Pavlovic, Ljiljana	TC-26	Pinto Ferreira, M <sup>a</sup> Eduarda	TE-17	Priemer, Christian	WD-03
Pawlak, Grzegorz	MD-17	Pinto, Alberto A.	TE-25, TF-25, TG-25	Priewasser, Jörg	MD-07
Pecek, Bojan	TC-40	Pioltini, Fabio	TC-30	Probst, Roy Wilhelm	TD-24
Pekin, Ethem	TD-13	Pires, Cesaltina	TA-41	Prochazka, Jaroslav	TD-40
Pelegrin, Blas	WC-13, MC-33	Pirlot, Marc	MD-11, MG-11, TC-11	Prot, Damien	MG-26
Pellegrini, Paola	TG-19	Pironet, Thierry	TA-15	Prskawetz, Alexia	MC-42
Penn, Michal	TE-15	Pirvu, Traian	MG-28, WC-28	Pruyt, Erik	WC-40
Peponi, Kalliopi	WC-23	Pisciella, Paolo	MD-13	Przybycien, Hubert	MC-18
Perea, Federico	TD-07, MC-08, TA-08	Pishchulov, Grigory	MD-30	Psarras, John	TD-11
Pereira, Ana I.	MA-24	Pita, João	TA-13	Pu, Junyi	MG-27
Pereira, Fabio	WD-01, TA-30	Pizarro Romero, Celeste	WA-01	Puerto, Justo	TE-03
Pereira, Fernando	TG-24	Pizzolato, Nélio	WA-01	Puhl, Christina	TD-07
Pereverza, Kateryna	MD-45, MG-45	Pla, Lluís Miquel	MA-41	Pulido Cayuela, Manuel A.	MG-25, TA-31
Perez Cebreros, Juan Arturo	WA-19	Pla, Lluís M	WD-44	Punkka, Antti	MC-11
Pérez, Gloria	MD-12, WD-12	Pla-Santamaria, David	TA-39	Pureza, Vitoria	TF-17
Pérez, M. Angeles	MC-06, TF-15, MG-17	Plancha, Carlos	TA-11	Puskorius, Gint	WD-08
Pérez-Alcalá, Gabriel M.	TG-29	Plastria, Frank	WA-13	Putcha, Chandrasekhar	TE-18
Peric, Tunjo	WD-22	Pogorelskiy, Kirill	MG-39	Pyatkin, Artem	TG-26
Perko, Igor	TC-40	Pohlmann, Tobias	WC-03	Pykäläinen, Jouni	TA-35
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Perrot, Nancy	TE-09	Politou, Alexandra	TF-08		
Pesch, Erwin	MG-04, MA-17	Polyakovskiy, Sergey	MD-16	<b>Q</b>	
Peters, Georg	TE-34	Ponce, Daniela	WD-02	Qu, Rong	TE-16
Petersen, Björn	MC-02	Ponikierska, Agnieszka	MD-09, MA-40	Quadrifoglio, Luca	MG-08
		Pons, Montserrat	MC-39	Querol, Enrique	TD-05
				Quinn, Breedge	TD-45
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| Raciti, Fabio             | TD-35               | Rinaldi, Francesco                 | TD-31               | Roy, Debjit                 | WD-27               |
| Radjef, Mohammed Said     | MD-16, TA-37        | Rinaldi, Giovanni                  | TA-01, WC-21        | Rozycki, Rafal              | WA-17               |
| Radom, Marcin             | MA-05               | Risse, Sina                        | MA-39               | Ruckmann, Jan-J             | MC-18, MG-24        |
| Rafels, Carles            | MA-25               | Rittner, Michael                   | TC-08               | Rudec, Tomislav             | TD-41               |
| Raghavan, S.              | TF-01, TF-03, MD-15 | Rizzato, Elena                     | MD-21               | Rudinskaya, Yulia           | TG-32               |
| Rahmani, Arsalan          | TE-27               | Roberti, Roberto                   | TC-15               | Rudyk, Alexander            | MD-29               |
| Rainer, Martin            | TG-35               | Roca-Riu, Mireia                   | WD-07               | Rufián-Lizana, Antonio      | WA-10               |
| Raith, Matthias           | TF-37               | Rocca, Matteo                      | MC-19               | Ruggiero, Jose Roberto      | MA-05               |
| Ram, Camelia              | MA-35               | Rocchi, Lucia                      | WA-11               | Ruiz, Ruben                 | TD-04, TF-04, WD-04 |
| Ramos, Angel Manuel       | MA-41               | Rodilla, Pablo                     | WC-29               | Ruiz-Garzón, Gabriel        | WA-10               |
| Ramos-Gallego, Ana Bel    | TE-03               | Rodrigues, Antonio                 | TF-23               | Ruiz-Tagle, Mauricio        | WC-37               |
| Ranck_Junior, Rodolfo     | MC-16               | Rodrigues, Helena Sofia            | TC-18               | Rupérez Micola, Augusto     | TA-32               |
| Randerath, Bert           | TD-21               | Rodríguez Álvarez, Margarita       | MC-24               | Ruperez, Inigo              | WC-29               |
| Rangel, Socorro           | TD-17               | Rodríguez Valbuena, Luisa Fernanda | TG-44               | Rusinowska, Agnieszka       | TC-26               |
| Rapine, Christophe        | MG-26               | Rodríguez, J. Tinguaro             | TD-06               | Russo, Valentina            | TE-05               |
| Ras, Charl                | TD-03               | Rodríguez-Chía, Antonio Manuel     | TE-03               | Rustem, Berc                | TC-41               |
| Rathgeber, Andreas        | WC-43               | Rodríguez-Marin, Luis              | WD-10               | Rusu, Alin                  | TG-35               |
| Rathjen, Christian        | WC-04               | Rodríguez-Mayol, Alberto           | TC-31               | Ruzibiza, Stanislas Sakera  | TC-24               |
| Rauf, Imran               | TC-21               | Rodríguez-Sánchez, Sara Verónica   | MA-41               | Ruzika, Stefan              | TF-16               |
| Rauner, Marion            | MA-21               | Roels, Guillaume                   | MD-37               | Ryan, David                 | TA-26               |
| Rautenbach, Dieter        | WA-15               | Rogers, Luke                       | TA-41               | Rybarczyk, Agnieszka        | TF-05               |
| Rave, Claudia             | MC-40, TD-43        | Rohde, Jannis                      | WD-03               | Rykov, Ivan                 | TG-26               |
| Ray, Ajit Kr              | TF-20               | Rojas, Jonathan                    | TA-41               | Ryley, Tim                  | MA-37               |
| Raza, Asim                | WD-05, TD-32        | Roland, Julien                     | TG-11               | Römer, Michael              | MA-08               |
| Razali, Siti Noor Asyikin | TA-40               | Roman, Diana                       | MC-28, MD-28, WD-32 | Römisch, Werner             | TE-12               |
| Rebennack, Steffen        | MG-22, TE-30        | Romanin-Jacur, Giorgio             | MD-21, MD-42        | Rømo, Frode                 | TD-30               |
| Recchioni, Maria Cristina | WC-10               | Romanova, Tatiana                  | TA-17               | Rönnqvist, Mikael           | TE-01               |
| Redmer, Adam              | MG-03               | Romauch, Martin                    | TC-02               |                             |                     |
| Redor, Etienne            | TC-39               | Romero Morales, Dolores            | TF-31               | <b>S</b>                    |                     |
| Reig, Ernest              | WA-20               | Romero, Omar                       | MG-12               | Ślodziński, Andrzej         | WC-22               |
| Reimann, Marc             | TD-02               | Romeu de Carvalho, Fábio           | WD-31, TG-37        | Sá Esteves, Jorge           | WC-24               |
| Reinelt, Gerhard          | TE-03               | Rommelfanger, Heinrich             | MC-34               | Sabharwal, Ashish           | WD-09               |
| Reinertsen, Harald        | TE-17, MG-22        | Ron, Dorit                         | TE-06               | Sadeqi, Ildar               | MD-18               |
| Rejec, Valter             | TE-40               | Roodbergen, Kees Jan               | MD-27, WA-27        | Sadoghi, Amirhossein        | WA-13               |
| Rémila, Eric              | WC-25               | Ropke, Stefan                      | TA-01               | Safari Vahed, Sara          | TC-32               |
| Ren, Changrui             | WC-09               | Rosati, Luca                       | TF-07               | Safro, Ilya                 | TE-06               |
| Renaud, Arnaud            | TF-33               | Rose, Oliver                       | MA-06               | Sagebiel, Hanno             | WA-39               |
| Rendl, Franz              | TB-02               | Rosenbaum, Ralph                   | TA-44               | Sagir Ozdemir, Mujgan       | WA-16               |
| Rene, Henrion             | TA-38               | Roshdi, Israfil                    | TD-20               | Sagir, Mujgan               | TC-10               |
| Rennen, Gijts             | MG-42               | Rosbach, Peter                     | MG-19               | Sagnol, Guillaume           | WD-18               |
| Respicio, Ana             | WD-09               | Rosseti, Isabel                    | TE-19               | Sahin, Guvenc               | WA-02, WD-09        |
| Reuther, Markus           | WD-06               | Rossi, Giovanni                    | MD-25               | Saito, Susumu               | MD-32               |
| Rezapour, Shabnam         | MD-09               | Rostamy-malkhalifeh, Mohsen        | TC-20               | Saiz, Elena                 | MC-33               |
| Ribas, Imma               | MC-06               | Rothblum, Uriel G.                 | TE-15               | Sak, Halis                  | TF-39               |
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| Ribeiro, Isabel           | MA-18               | Roubos, Alex                       | TC-36               | Sakphisal, Adisak           | MD-40               |
| Ribeiro, Rita             | TF-23               | Roubos, Dennis                     | TC-36               | Salakoski, Tapio            | WD-16               |
| Richardson, George        | MD-35               | Rousseau, Louis-Martin             | MA-02               | Salani, Matteo              | MC-15               |
| Richter, Alexander        | TF-38               | Rouvette, Etienne                  | MC-35               | Salari, Majid               | TF-03, MD-15, MG-15 |
| Richter, Knut             | MC-30               |                                    |                     | Salazar González, Juan José | MG-15               |
| Rieck, Julia              | TG-02               |                                    |                     | Saldanha-da-Gama, Francisco | TE-13, WD-39        |
| Riera-Ledesma, Jorge      | MG-15               |                                    |                     | Saleh, Yahya                | WA-17               |
| Rietz, Jürgen             | MG-16               |                                    |                     | Salhi, Said                 | TE-13, WD-13, MA-15 |
| Righini, Giovanni         | MC-15               |                                    |                     | Saliba, Sleman              | TA-04               |

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Salo, Ahti	TG-07, TF-10, MC-11, TE-11	Schickinger, Thomas	TE-07	Sell Dyminski, Andrea	TA-30
Salomon, Jörg	MG-02	Schilling, Martin	MD-35	Sellami, Khaled	MD-33
Saltzman, Matthew	TC-01	Schimmelpfeng, Katja	TC-33	Sels, Veronique	WC-05
Salum, Latif	MG-19, TD-27	Schlechte, Thomas	MC-08	Selten, Reinhard	ME-01
Sama, Miguel	WD-10	Sch lindwein, Regina	TE-20	Selvaraj, Ramkumar	TG-11
Samimi Namin, Farhad	TG-41	Schmaltz, Christian	MA-32	Semet, Frédéric	MA-15, TA-26
Samorani, Michele	MG-22	Schmid, Verena	TE-02	Sen, Halil	TC-37
Sánchez-Soriano, Joaquin	MG-25, TA-25, TA-31, TC-31	Schmidt, Daniel	WD-03	Seow, Hsin-Vonn	WC-31
Sanchez-Vizcaino, Jose Manuel	MA-41	Schmidt, Günter	MA-28	Serafini, Thomas	TD-18
Sand, Guido	MD-22	Schmidt, Kerstin	TF-44	Sergeyev, Yaroslav	MG-33
Sandoh, Hiroaki	TC-23, MC-32	Schmidt, Marie	TF-13	Serin, Yasemin	WA-14
Sandrini, Francesco	TE-39	Schmidt, Mario	MA-18	Seródio, Carlos	TE-38
Sanlaville, Eric	TD-41	Schmidt, Stefan	TC-35	Serra, Daniel	MA-14
Santos, José	TC-16	Schmoecker, Jan-Dirk	WD-07	Serrano, Myriam	WC-37
Santos, Miguel	TA-13	Schneider, Helmut	TE-14	Serrao, Amilcar	WA-37, TA-41
Santos-Peñate, Dolores R.	TC-13, WD-13	Schoebel, Anita	MC-08, TF-13, TC-26	Seydel, Ina	WC-19
Saraç, Tugba	MA-26	Schoenberger, Joern	TA-23	Seydel, Roland	MA-36
Saracchi, Stefano	WC-41	Scholz, Daniel	TC-19	Sforza, Antonio	WA-03, TC-17
Sargenti, Giulia	TD-29	Scholz, Peter	WD-43	Sha, Dan	TD-26
Sari, Meltem	WA-45	Scholz-Reiter, Bernd	TF-08	Shabalin, Pasha	MG-27
Sarig, Assaf	TD-41	Schons, Laura Marie	MG-40	Shafransky, Yakov	WC-15
Sarmiento, Olga Lucia	MC-40	Schrage, Carola	TA-16	Shah, M E	MG-32
Sasaki, Mihiro	WC-13	Schrempp, Ulrich	WD-06	Shahriar, Kourosh	TE-27
Sass, Jörn	TC-12, MD-36	Schröter, Marcus	TF-43	Shaikh, Arifusalam	WD-13
Sassanelli, Domenico	WC-03, TC-07	Schueller, Sebastian	WC-31	Shakhshneyder, Anastasia	MC-02
Sassi, Renato	TA-30, TC-32	Schuett, Holger	TA-03	Shamsaei, Fahimeh	WD-26
Sato, Kimitoshi	WD-14	Schultmann, Frank	MC-03	Sharafi, Zahra	TC-32
Sato, Yuji	WA-22	Schultz, Rüdiger	WD-12	Sharif Yazdi, Mehdi	TA-19
Sauer, Juergen	TA-02	Schulz, Andreas S.	WC-15	Sharma, Megha	TD-26
Sauer, Nathalie	WC-04	Schulz, Tobias	TC-22	Shawe-Taylor, John	WA-34
Saure, Denis	TE-01	Schulze, Klaas	TE-35	Shchamialiova, Kseniya	MA-17
Sauvey, Christophe	WC-04	Schulze-Cleven, Paul	MD-35	Sheikh Hussin, Siti Aida	WD-32
Savasanel, Secil	WA-14	Schumann, René	TA-02	Shen, Liji	MA-17
Savin, Sergei	MA-37	Schut, Hans	MD-22	Shiau, Tzay An	WC-20
Sawada, Kiyoshi	MC-26	Schutten, Marco	MA-02, MC-04, TF-14	Shikhman, Vladimir	MC-18
Sawaki, Katsushige	TF-04, WD-14	Schwahn, Anne	MC-01	Shim, Yohan	WA-29
Sawicka, Hanna	MG-03, WA-03	Schwanninger, Markus	TF-43	Shimamoto, Hiroshi	WD-07
Sawicki, Piotr	MG-03	Schwarz, Sigrun	MA-21	Shintani, Koichi	MA-27
Sawik, Bartosz	WC-24	Schwarze, Silvia	TG-04, MC-08	Siassiakos, Konstantinos	TF-06
Saxena, Nitin	WE-01	Schweitzer, Marcus	MD-38	Sibbel, Rainer	TC-09
Saydam, Cem	MC-42	Schwientek, Jan	MD-24	Siegbahn, Patrick	WD-15
Sayin, Serpil	WA-06	Schwind, Michael	TG-02	Sillekens, Thomas	MD-22
Sbihi, Abdelkader	MA-26	Schwindt, Christoph	WA-39	Silva Neto, Marco Aurelio	TA-30
Scaparra, Maria Paola	TE-13, MA-14	Schülldorf, Hanno	WD-05, MG-07	Silva, Francisco	MA-14
Schafhauser, Werner	TF-09, TA-10	Schüpbach, Kaspar	MC-08	Silvast, Antti	TE-11
Scheckenbach, Benedikt	MG-10	Schönlein, Michael	TF-08	Sim, Melvyn	MC-28
Scheder, Dominik	TD-21	Scott, Leanne	TE-43	Simeone, Bruno	WD-21
Scheer, Sergio	TA-30	Scrimali, Laura	TD-35	Simon, Hans	WD-21
Schemm, Ralf	MG-29	Searcy, DeWayne	MG-38	Simone, La Spada	TA-07
		Sebastian, Hans-Jürgen	MG-02	Simões, Maria Lurdes	MA-18
		Sedlak, Otilija	TD-36	Singh, Gaurav	MG-44
		Seanner, Florian	TD-08	Singh, Sanjeet	MD-18
		Segerstedt, Anders	TE-04, WD-28	Sinuany-Stern, Zilla	TE-06
		Segura, Baldomero	MG-41	Sipahioglu, Aydin	TD-19, TG-27
				Siskos, Yannis	TG-10
				Skocdoplova, Veronika	WA-39
				Skraba, Andrej	TF-40, TG-40

- Sladky, Karel TD-36  
 Slany, Wolfgang TF-09, TA-10  
 Slastnikov, Aleksandr WD-32  
 Slikker, Marco WC-25  
 Slim, Chokri TD-39  
 Slimani, Hachem TA-37  
 Slowinski, Roman MA-10, WC-11, WC-16, WD-16  
 Smedley, Jo WC-45  
 Smedsrud, Morten WC-02  
 Smeers, Yves WC-18  
 Smirlis, Yannis MG-20, WC-20  
 Smit Sibinga, Cees Th. TF-01  
 Smith, Honora MD-40  
 Smola, Alex WA-34  
 Smolira, Kamil WA-05, MG-27  
 Sobral, Marcos Felipe TE-10  
 Sodhi, Manbir TC-22  
 Sodini, Claudio WD-33  
 Sofianopoulou, Stella TF-20  
 Sohn, So Young TG-44  
 Solal, Philippe WC-25  
 Sologub, Roman TD-32  
 Solymosi, Tamás MA-25  
 Sommer-Dittrich, Thomas MC-13, MD-22, MG-38  
 Soner Kara, Selin MA-13  
 Song, Xiang MC-16  
 Sonia, Radjef WC-24  
 Sonmez, Mahmut TD-37  
 Sonmez, Volkan WA-44  
 Soria, Daniele MG-05  
 Souad, Slimani TE-26  
 Sourd, Francis WD-05, TA-08  
 Sousa Santos, Beatriz TG-12  
 Sousa, Aurea TA-27  
 Souyris, Sebastián TE-01  
 Soyler, Hasan MG-43  
 Soyly, Banu TE-14, MG-43  
 Spengler, Thomas TD-22, TA-23, MD-34, TF-44  
 Speranza, M. Grazia TA-15  
 Spieksma, Frits TC-03, WD-15  
 Spoorendonk, Simon MC-02  
 Spott, Martin TE-34  
 Sprenger, Ralf TF-02  
 Spyridakos, Athanasios TF-23, TG-33  
 Spyrou, Thomas WC-23  
 Srinivasan, Gopalan TA-14  
 Staak, Thorsten TF-37  
 Stamati, Lamprini V. MG-20, WC-20  
 Stancu, Andreea Madalina MG-33  
 Stancu-Minasian, Ioan MG-33  
 Stanczuk, Wojciech TF-35  
 Stanisic, Nenad TD-09  
 Staub, Roberta MC-20  
 Staupendahl, Kai MC-43  
 Stefanescu, Catalina MA-37  
 Stefani, Silvana TD-29  
 Steffens, Christian M. TF-04  
 Steffensen, Dirk MG-02  
 Stehlik, Petr MC-12  
 Stein, Oliver TA-38  
 Steinborn, Jenny TD-22  
 Steindl, Alois TF-08  
 Steiner neto, Pedro TA-30, TD-43  
 Steiner, Winfried TD-28  
 Steinhardt, Claudius TA-23  
 Stella, Fabio TC-30, TE-31, TF-32  
 Sterle, Claudio WA-03, TC-17  
 Sterna, Malgorzata MG-04, MD-17  
 Sternbeck, Michael TE-28  
 Steven, Marion TF-38  
 Stewart, Theodor WA-12, MA-35, TE-43  
 Stidsen, Thomas TE-19  
 Stiglmayr, Michael TD-05  
 Still, Georg MC-44  
 Stiller, Sebastian MD-01, WC-06, TD-07  
 Stoesslein, Martin TG-14  
 Stojic, Dragan MC-34, TD-36  
 Stolletz, Raik TC-36  
 Stoyan, Yuri TA-17, TF-27  
 Strauss, Arne Karsten MC-37  
 Strijbosch, Leo TE-14  
 Strijov, Vadim TF-32, TA-34  
 Strizhov, Anton TF-32  
 Strohhecker, Jürgen TC-09  
 Strozzi, Fernanda TF-06, TC-45  
 Strömberg, Ann-Brith WA-05  
 Stuber, Martina TD-17  
 Stuber, Matthew MD-24  
 Studniarski, Marcin WA-10  
 Stummer, Christian TA-43  
 Stüber, Gerhard MG-02  
 Stygar, Anna MC-30  
 Stølevik, Martin WA-16  
 Su, Jau-Ming MA-07, MG-08, TD-10  
 Suárez, Rafael WD-13  
 Suarez-Vega, Rafael TC-13  
 Sucha, Premysl WA-09, WC-39  
 Sueyoshi, Toshiyuki MC-20  
 Sufahani, Suliadi Firdaus TG-33  
 Suhl, Leena TA-03, TE-07, MD-22  
 Suhl, Uwe TD-33, TD-42  
 Sukhorukova, Nadezda WD-30  
 Suknovic, Milija WC-23  
 Sun, Xiaoling MG-30  
 Sung, Shao-Chin MG-39  
 Sung, Souk-Kyung MD-06  
 Sunke, Nicole MC-03  
 Supciller, Aliye Ayca MG-19, TD-27  
 Sural, Haldun WA-27  
 Surowiec, Thomas TA-38  
 Suzuki, Kouji MG-39  
 Swann, Julie TC-23  
 Szachniuk, Marta MA-05  
 Szantai, Tamas TF-12, MC-26  
 Szelag, Marcin WC-16, WD-16  
 Szimayer, Alexander MG-28  
 Szorenyi, Balazs WD-21  
 Szpringier, Maciej WC-22
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- Ta, Anh Son WD-42  
 Taghizadeh Kakhki, Hossein MC-14  
 Tajbakhsh, M. Mahdi MA-14  
 Takashima, Ryuta TG-34  
 Talantikite, Hassina WD-31  
 Talbi, El-Ghazali MC-10  
 Talýnlý, Ilhan TF-21  
 Tanaka Filho, Mario MG-18  
 Tanaka, Katsuaki MD-32  
 Tanasescu, Cerasela WC-17  
 Tanfani, Elena MA-21  
 Tanino, Tetsuzo WA-06  
 Tapkan, Pinar TG-19  
 Tarakanov, Alexander TF-30  
 Tas, Duygu WA-02  
 Taschini, Luca MD-29, TC-44  
 Tatsumi, Keiji WA-06  
 Tavares, Gabriel WC-21  
 Taylan, Pakize TE-18, TC-34, WD-37  
 Tchemisova, Tatiana TE-24  
 Tchung-Ming, Stéphane WA-29  
 Teghem, Jacques TD-04, WC-12  
 Tejada, Juan TC-31  
 Tejada, Oriol MA-25  
 Tektas, Arzu MA-23  
 Telhada, Joao TE-09  
 Temath, Christian TE-23  
 Tempelmeier, Horst MD-26  
 Teodorescu, Narcisa MG-42  
 Terlaky, Tamas TA-24, TF-26  
 Tersteegen, Bernd MC-29  
 Tervonen, Tommi TC-06  
 Testi, Angela MA-21  
 Testik, Murat Caner MC-31, WA-44  
 Teunter, Ruud TD-22  
 Teyarachakul, Sunantha MD-30  
 Thanassoulis, Emmanuel WD-20  
 Théníé, Julien TC-44  
 Thiao, Mamadou WA-42  
 Thipwiwatpotjana, Phantipa MC-34  
 Thomaidis, Nikolaos TD-39  
 Thomas, Doreen TD-03, MA-33

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|--------------------------|--------------------------------------|------------------------------|------------------------|---------------------------------------|------------------------|
| Thomas, Lyn              | WA-31, MC-32,<br>TD-34               | Tsai, Ming-Chih              | TG-05, MA-40,<br>MD-41 | Usta, Meriçcan                        | WA-14                  |
| Thonemann, Ulrich        | TD-14                                | Tsang, Wilburn               | TG-38                  | Ustun, Ozden                          | WD-30                  |
| Thonhauser, Stefan       | MC-36                                | Tsantas, Nikolas             | TE-09                  | Utlej, Martin                         | MC-21, MD-40           |
| Tiemessen, Harold        | MD-22                                | Tsekouras, Kostas            | MA-20                  | Uyan, Mevlut                          | TG-39                  |
| Tijs, Stef               | TA-25, TC-25, WA-25                  | Tseng, Ching Chih            | TE-41                  | Uzar, M.Furkan                        | WD-08                  |
| Tikkanen, Jukka          | TA-35                                | Tseng, Ke-Wei                | MA-40                  |                                       |                        |
| Timkovsky, Vadim         | WC-32                                | Tseng, Yu-Ning               | MD-08                  | <b>V</b>                              |                        |
| Timm, Ingo J.            | TE-32                                | Tsivtsivadze, Evgeni         | WD-16                  | Vaarmann, Otu                         | WC-12                  |
| Timmer, Judith           | TC-25, WD-25                         | Tsotsolas, Nikos             | TA-09, TG-10           | Vacca, Ilaria                         | MC-15                  |
| Timonina, Elena          | WC-36                                | Tsoukiàs, Alexis             | TG-07, TC-11           | Vacik, Harald                         | TA-35                  |
| Tirado, Gregorio         | MA-01, TD-06                         | Tsujimura, Motoh             | TF-22, TG-34           | Vainiomäki, Pekka                     | TD-17                  |
| Tobin, Patrick           | TC-37                                | Tsutsui, Miki                | TD-20                  | Valente, Jorge                        | TC-04, TD-04           |
| Toczyłowski, Eugeniusz   | WA-05,<br>MG-27, TE-29, 30           | Tuana, Giacomo               | TE-31                  | Vallada, Eva                          | TC-04, TD-04           |
| Toczyłowski, Eugeniusz   | MG-27,<br>TF-35                      | Tumutegyereize, Stephen      | TE-43                  | Vallejos, Reinaldo                    | TE-19                  |
| Todorov, Maxim           | TA-24                                | Tunali, Semra                | TD-27                  | Valls, Vicente                        | MC-06, TF-15,<br>MG-17 |
| Tofallis, Chris          | TC-37                                | Tupmongkol, Thanatas         | MG-40                  | van Anholt, Roel                      | MD-27                  |
| Tokareva, Julia          | TF-25                                | Turcksin, Laurence           | WC-40                  | van Beers, Wim                        | WA-38                  |
| Toledo-Melero, F. Javier | TA-24                                | Turkay, Metin                | TD-05                  | van den Akker, Marjan                 | TA-08                  |
| Tolstad Uggen, Kristin   | TD-30                                | Turkiewicz, Dominika         | TG-40                  | van den Berg, Sander                  | MD-22                  |
| Tomasgard, Asgeir        | MA-12,<br>WA-29                      | Turkiewicz, Kazimierz        | TG-40                  | van den Brink, Rene                   | TD-25,<br>WC-25        |
| Tomazic, Alessandro      | TE-03                                | Turkogullari, Yavuz          | TD-03                  | Van den Schrieck, Jean-<br>Christophe | WC-14                  |
| Toncovich, Adrian        | WA-23                                | Turksen, Burhan              | MD-31                  | van der Heijden, Matthieu             | TF-14                  |
| Tone, Kaoru              | TD-20                                | Turón, Alberto               | WA-23                  | van der Laan, D.a.                    | MD-30                  |
| Topaloglu, Seyda         | TD-27                                | Tuzkaya, Gülfem              | MG-23                  | van der Laan, Erwin                   | TD-22                  |
| Topcu, Y. Ilker          | TA-06, TE-21,<br>MC-23               | Tuzkaya, Umut Rifat          | MD-09                  | van der Sluijs, Jeroen P.             | TD-44                  |
| Toporowski, Waldemar     | TE-28                                | Tuzun Aksu, Dilek            | WA-02                  | van der Sluis, Erik                   | WD-28, TA-36           |
| Toppila, Antti           | TE-11                                | Tuzun, Dilek                 | WA-02                  | Van Der Wal, Jan                      | TF-01                  |
| Topuz, Emel              | TF-21                                | Türker Bayrak, Özlem         | MD-31                  | van der Westhuizen, Magderie          | TC-34                  |
| Tor, Ali Hakan           | WD-24, WA-30                         | Türsel Eliiyi, Deniz         | WA-39                  | van Dijk, Nico                        | TF-01, TA-36           |
| Torres, Antonio          | MG-41                                | Tütüncü, Reha                | WC-28                  | van Dijkum, Cor                       | TD-45                  |
| Torres, Delfim F. M.     | TC-18                                | Tzeng, Gwo-Hshiung           | TG-21                  | van Hoeve, Willem-Jan                 | WD-09                  |
| Torres, Mercedes         | WA-20                                | Törnquist Krasemann, Johanna | MC-07                  | van Houtum, Geert-Jan                 | TF-14                  |
| Toth, Paolo              | MD-01, TF-03,<br>TD-07, MD-15, MG-15 | <b>U</b>                     |                        | Van Nieuwenhuysse, Inneke             | WA-38                  |
| Toth, Sandor             | TA-41                                | Ubeda, Sergio                | MC-06                  | Van Peteghem, Vincent                 | TF-15                  |
| Tous, Michal             | MC-12                                | Udding, Jan Tijmen           | WC-27                  | van Ruijven, Bas                      | TD-44                  |
| Traczyk, Tomasz          | MG-27                                | Uebe-erden, Nadine           | MG-40                  | van Stee, Rob                         | MC-01                  |
| Trafalis, Theodore       | TE-31                                | Ueda, Tohru                  | TA-20, WC-20           | van Vuuren, Detlef                    | TD-44                  |
| Tragler, Gernot          | MA-08, MA-21,<br>MA-42               | Uffinger, Alexander          | TA-22                  | Van Wassenhove, Luk                   | TF-45                  |
| Tramontani, Andrea       | MG-15,<br>TC-15                      | Ugon, Julien                 | WA-30, WD-30           | Van Woensel, Tom                      | TE-02, TA-14           |
| Tran, Angela             | MC-20                                | Ugur, Ömür                   | WD-38                  | Vanberkel, Peter T.                   | MG-21                  |
| Tran, Duc Quynh          | WD-42                                | Uhrig-Homburg, Marliese      | TD-35,<br>MG-36        | Vandaele, Arnaud                      | WD-19                  |
| Tran, Quang Van          | TE-43                                | Ulbrich, Michael             | WD-01                  | Vandaele, Nico                        | TA-22, TA-36           |
| Transchel, Sandra        | TA-14                                | Ulengin, Fusun               | TG-29                  | Vanhoucke, Mario                      | WC-05,<br>WA-09, TF-15 |
| Triantis, Konstantinos   | MA-20,<br>WC-20                      | Ulucan, Aydin                | WA-20, TE-37           | Vanmaele, Michèle                     | WC-38                  |
| Trick, Michael           | WE-02                                | Ulusoy, Gündüz               | TG-29                  | Vasiljevic, Dragan                    | TG-14                  |
| Tricoire, Fabien         | TC-02                                | Ulutas, Berna                | MA-26, MC-31           | Vasin, Alexander                      | MD-39                  |
| Trkman, Peter            | TC-40                                | Unal, Muruvvet               | MC-09                  | Vasquez, Michel                       | MG-01                  |
| Trond, Steihaug          | TA-33                                | Unger, Nils                  | MG-36                  | Vaz, Clara                            | TE-20                  |
| Trubnikova, Olga         | MG-45                                | Uno, Takeaki                 | TA-10, WA-26,<br>MA-31 | Vázquez, Carlos                       | WC-29                  |
| Truemper, Klaus          | TC-21                                | Unuvar, Merve                | TF-12                  | Vázquez, Miguel                       | WC-29                  |
|                          |                                      | Urbanski, Ryszard            | MC-18,<br>MD-19, WC-30 | Vázquez, Pilar                        | WC-29                  |
|                          |                                      | Urlings, Thijs               | TF-04, WD-04           | Veelken, Sonja                        | WD-01                  |
|                          |                                      | Urrutia, Sebastián           | WA-16                  | Veiga Pereira, Mario                  | MG-22                  |
|                          |                                      | Usberti, Fábio               | TG-16                  | Vembu, Shankar                        | TD-31                  |

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|--------------------------------------|--|--|--|
| Veneziano, Thomas                    | MD-11                                    |  |  |
| Ventura, Paolo                       | TA-01                                    |  |  |
| Veraart, Luitgard                    | MA-36                                    |  |  |
| Verastegui, Doroteo                  | TD-07                                    |  |  |
| Vercellis, Carlo                     | TE-31                                    |  |  |
| Verstaen, Jens                       | TE-08                                    |  |  |
| Vespucci, Maria Teresa               | MA-12                                    |  |  |
| Vetschera, Rudolf                    | MC-17                                    |  |  |
| Vianna, William                      | TE-37, TF-37,<br>WC-41, TE-44            |  |  |
| Vicari, Elias                        | WA-35                                    |  |  |
| Vicente Pérez, José                  | MC-24                                    |  |  |
| Vidacic, Stjepan                     | TC-28                                    |  |  |
| Vidic, Tadej                         | TE-40                                    |  |  |
| Vieira Junior, Helcio                | MG-19                                    |  |  |
| Vieira, Luís                         | TE-25                                    |  |  |
| Viejo, Pablo                         | TA-32                                    |  |  |
| Viergutz, Christian                  | WA-04                                    |  |  |
| Villagran de Leon, Claudia Margarita | TG-15                                    |  |  |
| Villar, Jose                         | MA-29                                    |  |  |
| Villwock, Rosangela                  | TA-30                                    |  |  |
| Vilutiene, Tatjana                   | WA-23                                    |  |  |
| Vimont, Yannick                      | MG-01                                    |  |  |
| Virtanen, Kai                        | MA-39                                    |  |  |
| Vis, Iris F.A.                       | MD-27                                    |  |  |
| Visona_Dalla_Pozza, Laura            | MD-42                                    |  |  |
| Vissers, Jan                         | MG-21                                    |  |  |
| Viswanatha, Marc                     | WA-32                                    |  |  |
| Vitoriano, Begoña                    | TD-06                                    |  |  |
| Vizvári, Béla                        | TA-21                                    |  |  |
| Vlach, Milan                         | MD-18                                    |  |  |
| Vlasyuk, Tatyana                     | MG-20                                    |  |  |
| Vliegen, Ingrid                      | TF-14                                    |  |  |
| Voake, Cheryl                        | MD-21                                    |  |  |
| Vogel, Silvia                        | TD-12                                    |  |  |
| Vogt, Bodo                           | MD-34                                    |  |  |
| Voigt, Guido                         | TD-14, TC-22                             |  |  |
| Vola, Maria Chiara                   | TC-17                                    |  |  |
| Volkovich, Zeev (Vladimir)           | WC-36                                    |  |  |
| Volling, Thomas                      | TA-23                                    |  |  |
| Vomlel, Jiří                         | MG-39                                    |  |  |
| von Heusinger, Anna                  | TD-38                                    |  |  |
| von Martens, Tobias                  | TD-23                                    |  |  |
| von Mettenheim, Hans-Jörg            | WA-24, TF-37                             |  |  |
| Voss, Stefan                         | TG-04, WC-31                             |  |  |
| Vossen, Thomas                       | TE-17                                    |  |  |
| Vosvrda, Miloslav                    | TE-43                                    |  |  |
| Vovk, Vladimir                       | MA-37                                    |  |  |
| Vrisagotis, Vassilios                | TF-06                                    |  |  |
| Vryzidis, Lazaros                    | TG-33                                    |  |  |
| Vugdelija, Dragan                    | MC-34                                    |  |  |
| Vujosevic, Mirko                     | MC-26                                    |  |  |
| Vukicevic, Milan                     | TC-30                                    |  |  |
| Vulcano, Gustavo                     | MD-37                                    |  |  |
| Vygen, Jens                          | WE-01                                    |  |  |
| <b>W</b>                             |  |  |  |
| Waegeman, Willem                     | WD-16                                    |  |  |
| Wagner, Dorothea                     | TC-16                                    |  |  |
| Wagner, Stephan                      | TF-08                                    |  |  |
| Wakinaga, Hiroyuki                   | TF-04                                    |  |  |
| Wakolbinger, Lea M.                  | TA-43                                    |  |  |
| Waligora, Grzegorz                   | WA-17                                    |  |  |
| Walkowski, Slawomir                  | MD-17                                    |  |  |
| Wallace, James                       | TA-34                                    |  |  |
| Wallner, Klaus                       | MD-43                                    |  |  |
| Walter, Matthias                     | MG-38                                    |  |  |
| Walther, Grit                        | TD-22, TF-44                             |  |  |
| Walther, Ursula                      | WD-43                                    |  |  |
| Walukiewicz, Stanislaw               | TF-41                                    |  |  |
| Wang, Guei- Jhih                     | MG-08                                    |  |  |
| Wang, Hui-Xuan                       | WD-08                                    |  |  |
| Wang, Jian-Cai                       | WA-08                                    |  |  |
| Wang, Linda                          | MG-19                                    |  |  |
| Wang, Mei                            | MD-29                                    |  |  |
| Wang, Sheng-Pen                      | TF-42                                    |  |  |
| Wang, Shuoyu                         | TF-38                                    |  |  |
| Wang, Xiao-Ying                      | TA-05                                    |  |  |
| Wang, Xin                            | MD-02                                    |  |  |
| Wasik, Szymon                        | TE-05                                    |  |  |
| Wassan, Niaz                         | MA-15                                    |  |  |
| Wauae, Veronika                      | TD-42                                    |  |  |
| Weber, Christian                     | WD-05, TA-08                             |  |  |
| Weber, Gerhard-Wilhelm               | WC-12, MA-13, TE-18, MC-31, TA-34, WD-37 |  |  |
| Weber, Richard                       | TF-31, TD-34                             |  |  |
| Wechselberger, Peter                 | TD-28                                    |  |  |
| Weglarz, Jan                         | WA-17                                    |  |  |
| Wei, Shang-Ling                      | MD-23                                    |  |  |
| Wei, Ying                            | WC-14                                    |  |  |
| Weider, Steffen                      | MC-08                                    |  |  |
| Weigert, Gerald                      | MA-06                                    |  |  |
| Weintraub, Andrés                    | TE-01                                    |  |  |
| Weiskircher, Rene                    | MG-44                                    |  |  |
| Weismantel, Robert                   | TC-21                                    |  |  |
| Weiss, Gideon                        | WB-03                                    |  |  |
| Weiss, Thomas                        | WD-23                                    |  |  |
| Weitzman, Ron                        | TE-06                                    |  |  |
| Wen, Min                             | TE-19                                    |  |  |
| Wendell, Richard E.                  | MD-20                                    |  |  |
| Wensing, Thomas                      | TE-14                                    |  |  |
| Wenstøp, Fred                        | TF-45                                    |  |  |
| Werner, Frank                        | MC-01                                    |  |  |
| Werner, Kerstin                      | WC-26                                    |  |  |
| Werner, Ralf                         | MC-24                                    |  |  |
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