Intelligent Data Processing: Theory and Applications, IDP-2016
Barcelona, Spain, October 10–14, 2016

PREDICTION OF STUDENTS' LEARNING RESULTS WITH USAGE OF MIXED DIAGNOSTIC TESTS AND 2-SIMPLEX PRISM

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Introduction (1/1)

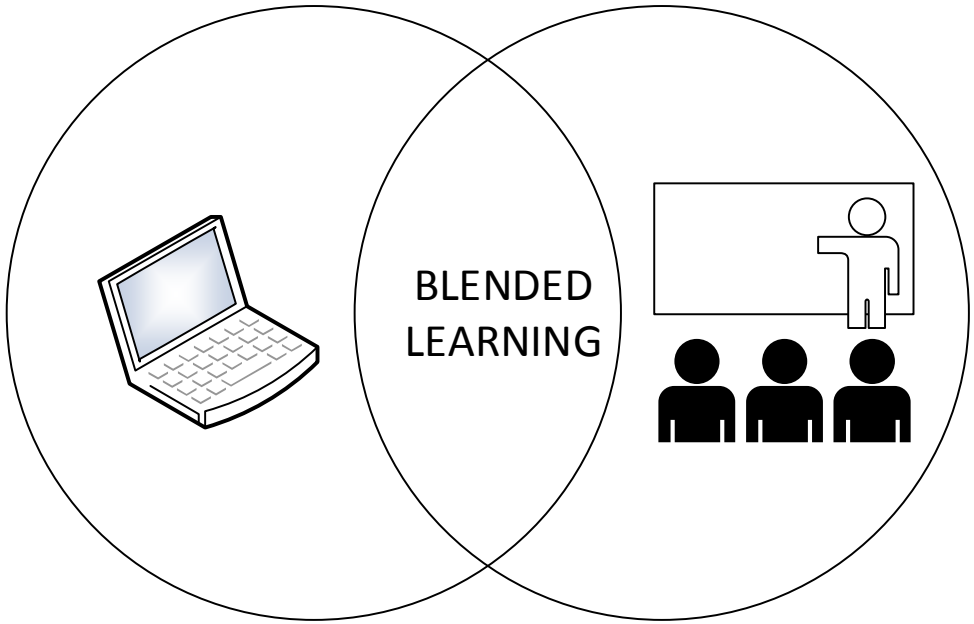

Fig. 1. Blended learning concept

Students' results need to be predicted?!

The concept of blended learning, which combines both education and training, was introduced in [Bliuc et al.]

Blended learning corresponds to an integrated learning environment, using both online learning and traditional classroom teaching [C. Graham]

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Introduction (1/2)

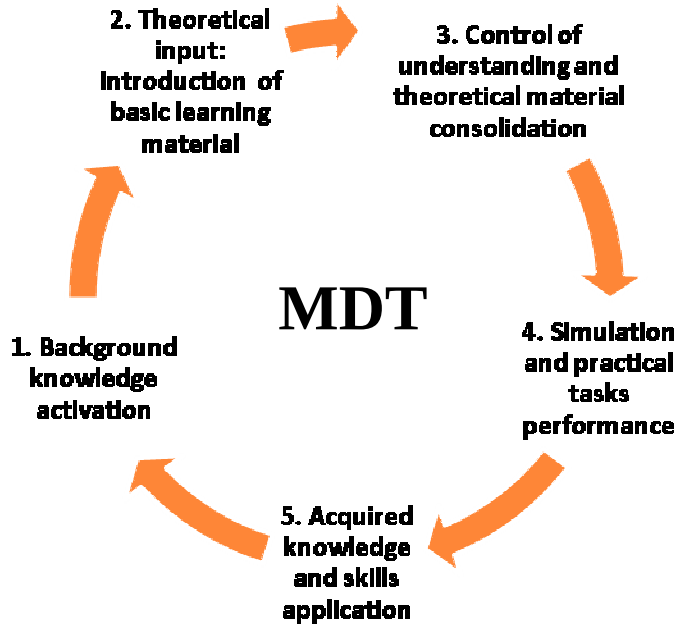

Fig. 2. Reflection cycle (By E. Prokhorec and M. Plehanova)

- We suggest using mixed diagnostic tests (MDTs) to design learning trajectory and predict learning outcomes of each individual
- The originality and relevance of our approach are confirmed by Learning and Testing Intelligent Systems [A. Yankovskaya]
- The term "mixed" was introduced by A. Yankovskaya in 1996

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Introduction (1/3)

http://iyazyki.ru/2013/09/distance-learning/

- The development of learning intelligent systems based on tests is an urgent problem
- Monitoring of students' activities is necessary for predicting student learning outcomes
- Student is a person participating in learning and testing

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Introduction (1/4)

MDTs represent a new paradigm of intelligent systems development based on test methods of pattern recognition
MDTs are a compromise between unconditional and conditional components

- **Unconditional component of the MDT** represents the characteristic features which are introduced to students in a random sequence
- **Conditional component of the MDT** is characterized by sequential presentation of the characteristic features, depending on the answer on the previous feature

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Principal Concepts and Definitions (2/1)

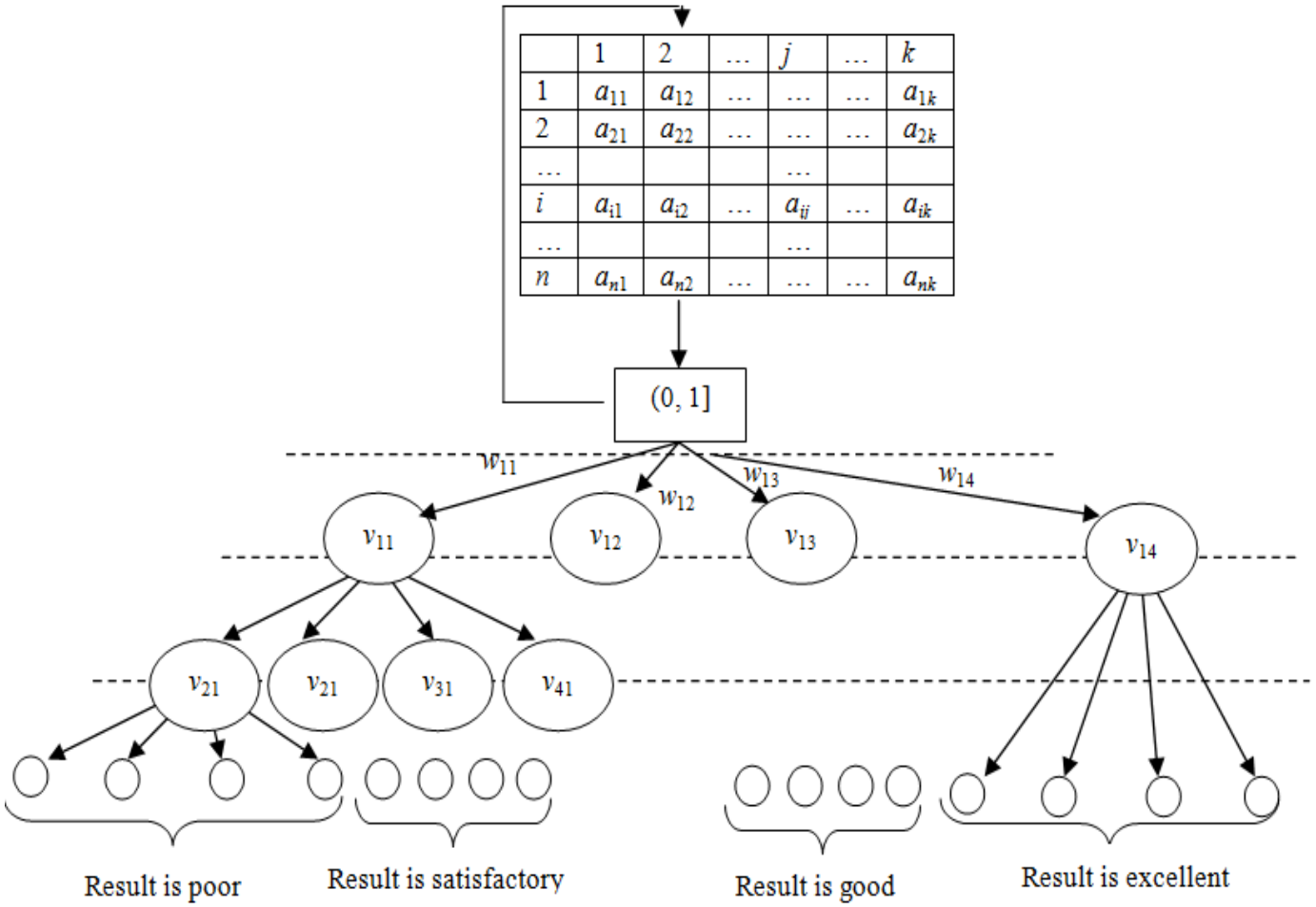

Fig. 3. A block diagram of the MDTs construction algorithm

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Principal Concepts and Definitions (2/2)

- MDT tree is the structure to display relationships between the different elements of MDT
- The root node is necessarily correlated with the unconditional component of MDT
- Each of the remaining nodes is associated with either unconditional or conditional component of MDT
- Edges are set between nodes, i.e. between the different components of MDT

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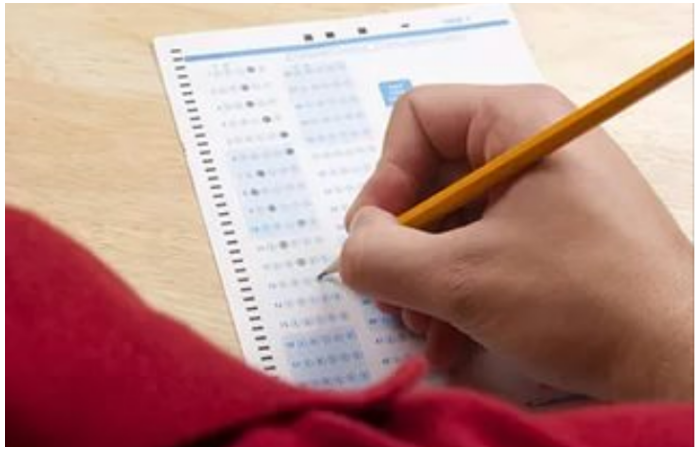
Principal Concepts and Definitions (2/3)



http://ru.depositphotos.com/6552285/stock-photo-taking-a-test.html

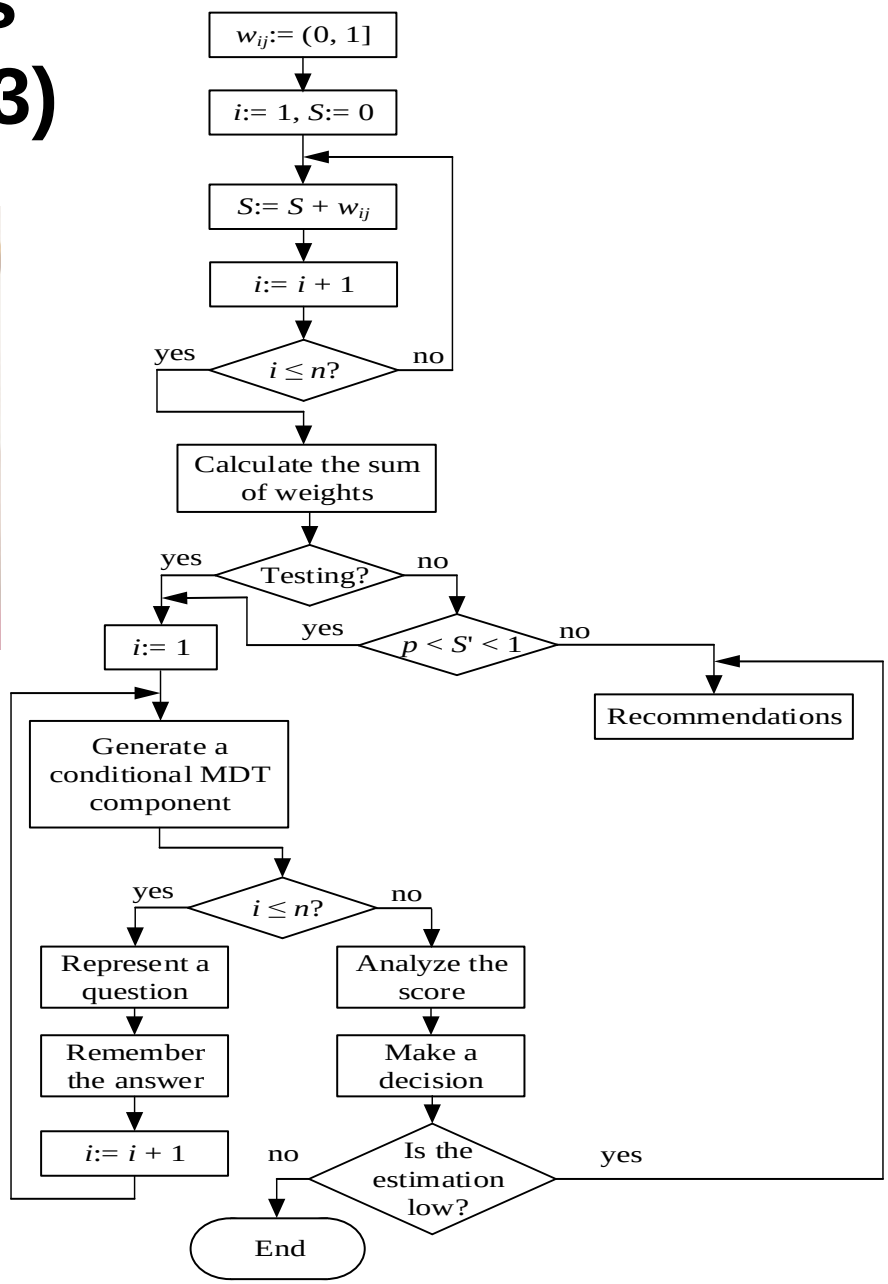


Fig. 4. A block diagram of the MDTs construction algorithm

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Principal Concepts and Definitions (2/4)

Consider the course “Selected Chapters of Electronics”, which is the 1st part of “Power Electronics" discipline.

The modules are as follows:

1. Basics of Electrical Engineering
2. The principles of semiconductor devices operation

Unconditional MDT component

3. Energy indicators
4. Rectifiers
5. Filters
6. Inverters

Conditional MDT component

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Principal Concepts and Definitions (2/5)

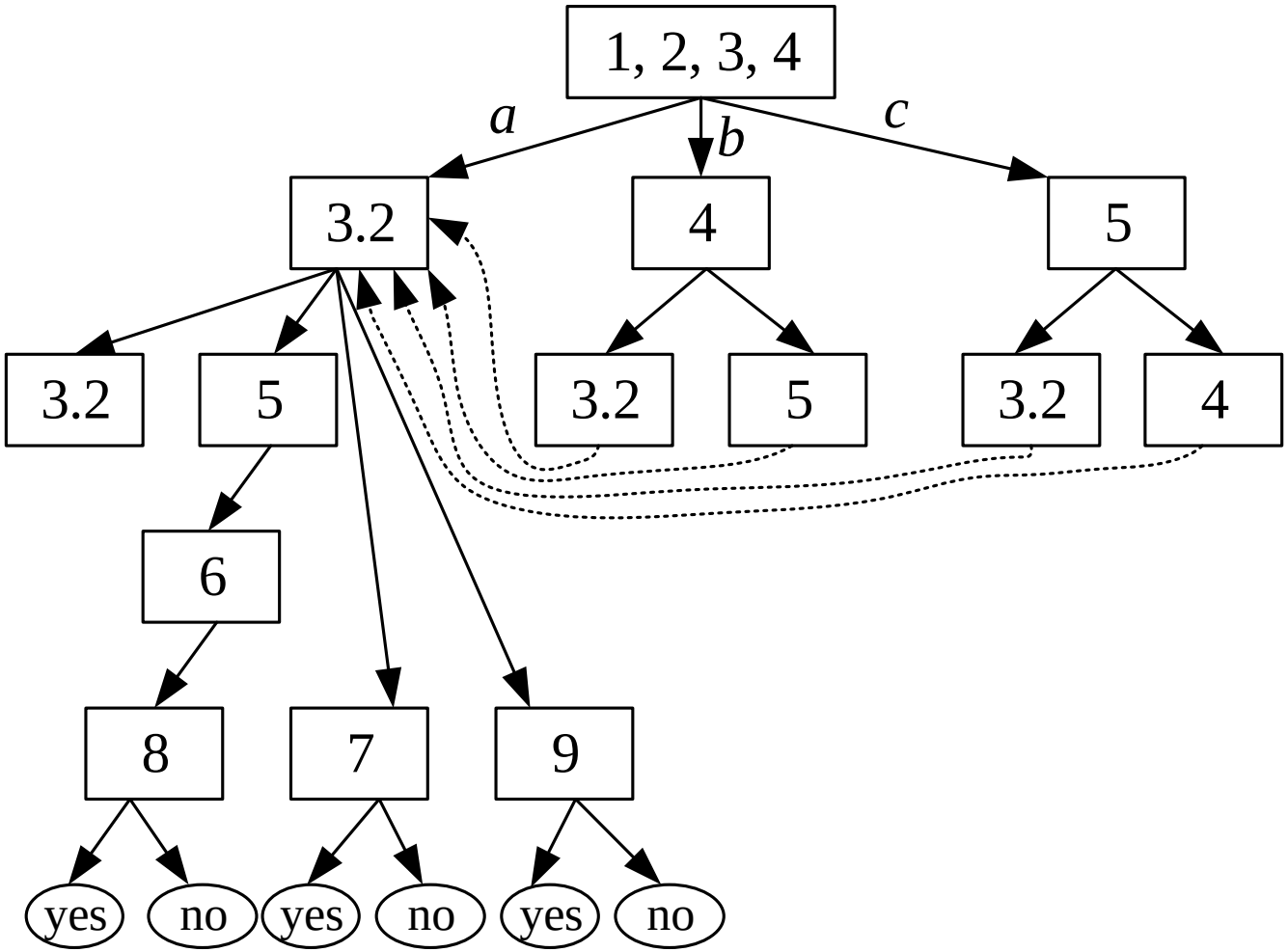

Fig. 5. MDTs Search Tree for the discipline «Informatics»

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Principal Concepts and Definitions (2/6)

- Root node of the search tree is associated with unconditional component of the mixed diagnostic test (sections 1, 2 and 3.1)
- Conditional component of the mixed diagnostic test depends on the previous test task
- Each branch of the tree represents an admissible sequence of test tasks to select the section that leads to a leaf
- Each leaf associates with the result of the test

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Framework of Students' Learning Results Assessment on the Base of MDT (3/1)

We propose:

- Construction of mixed diagnostic tests (MDTs)
- Learning trajectory design
- Prediction of students' learning results

http://belovskaasos.eps74.ru/htmlpages/Show/Obrazovanie/Realizuemye urovniobrazovaniya

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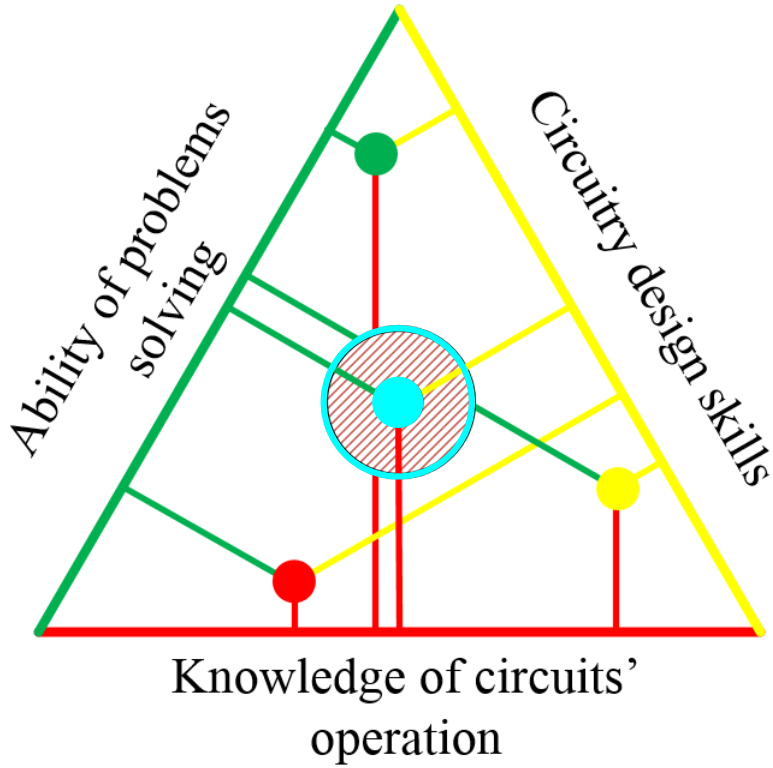
Framework of Students' Learning Results Assessment on the Base of MDT (3/2)



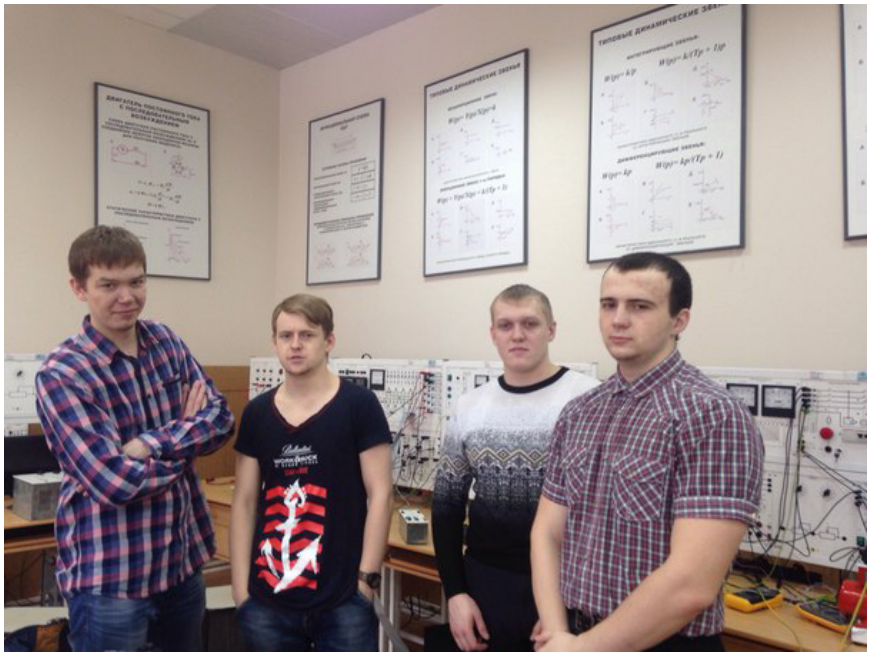


Fig. 6. Using 2-simplex cognitive tool to estimate current level of students' knowledge

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Cognitive Graphic Tools (4/1)

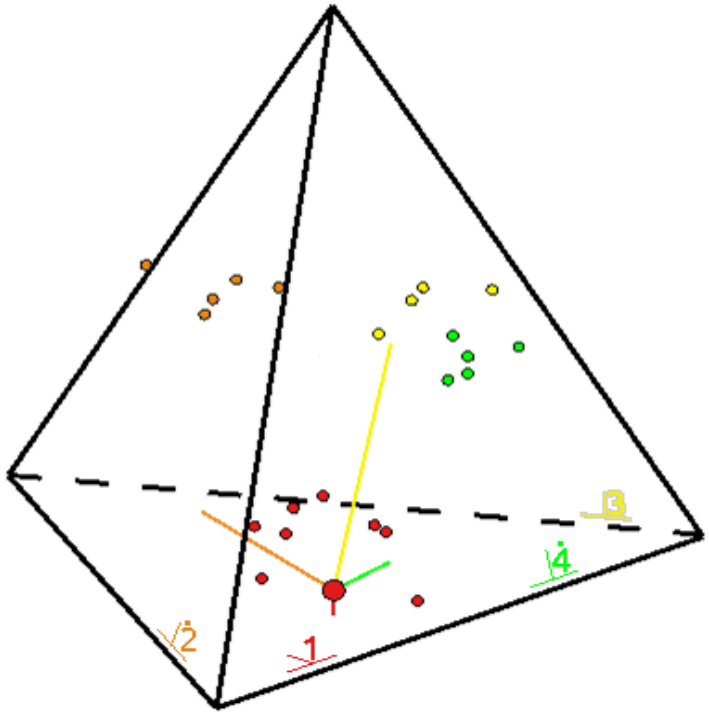

Fig. 7. 3-simplex

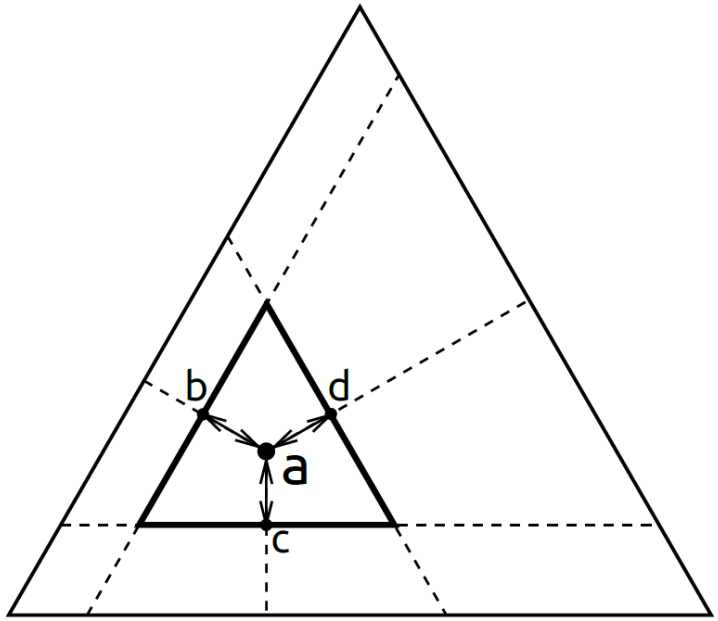

Fig. 8. Calculation of confidence region for prediction in 2-simplex

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Cognitive Graphic Tools (4/2)

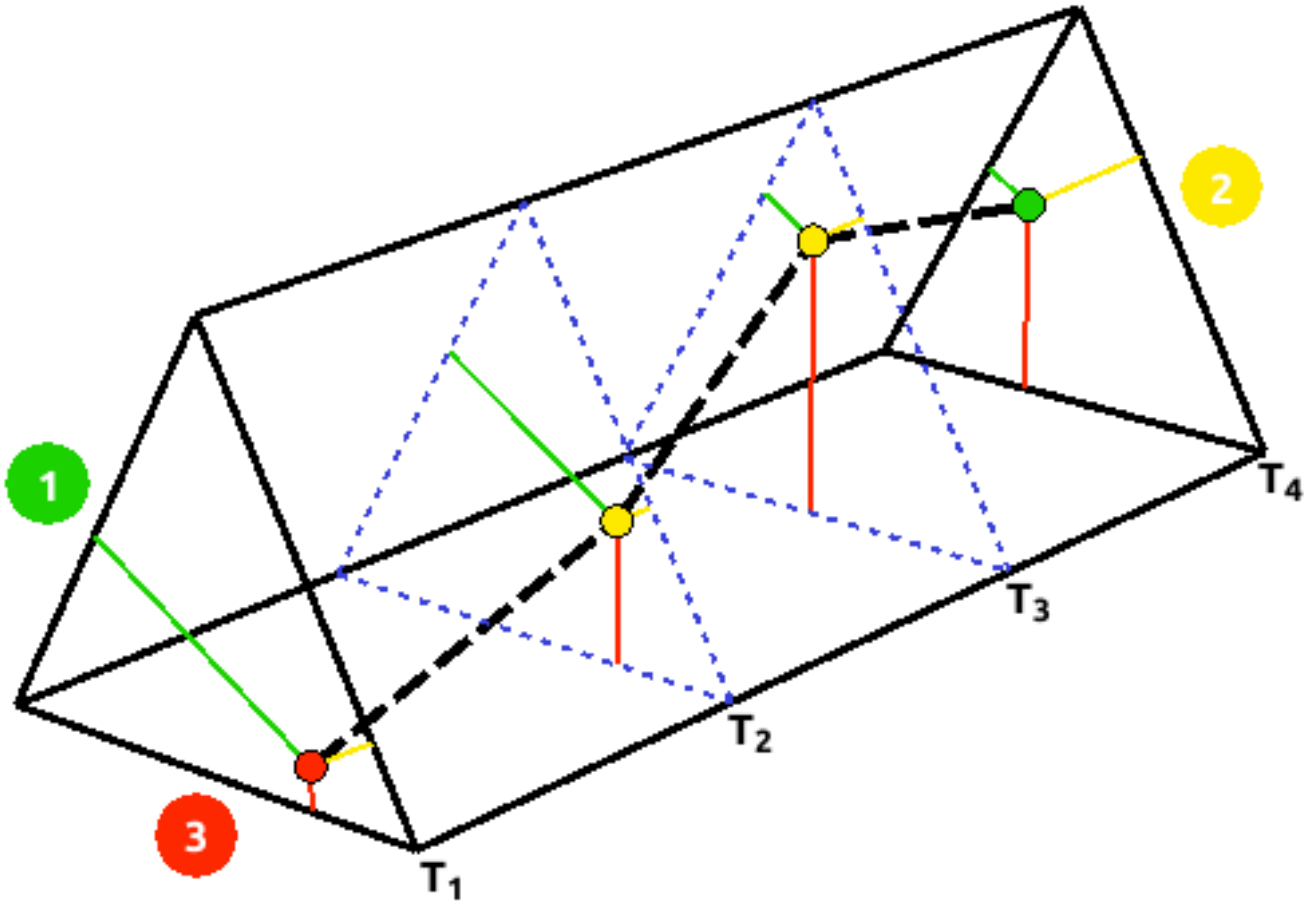

Fig. 9. Learning trajectory construction
using 2-simplex prism cognitive tool

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Prediction of Students' Learning Results and Cognitive Graphic Tools for its Visualization (5/1)

Table 1 Learning Axes Weight Matrix

	Theory (1)	Problems Solving (2)	Electric Circuit Design (3)
1	$w_{1,1}$	$w_{1,2}$	$w_{1,3}$
2	$w_{2,1}$	$w_{2,2}$	$w_{2,3}$
...	...	...	...
i	$w_{i,1}$	$w_{i,2}$	$w_{i,3}$
...	...	...	...
n	$w_{n,1}$	$w_{n,2}$	$w_{n,3}$

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Prediction of Students' Learning Results and Cognitive Graphic Tools for its Visualization (5/2)

$$E_{k,1} = f\left(k, E_{n,1}, E_{n-1,1}, \ldots, E_{n-m+1,1}\right),$$
$$E_{k,2} = f\left(k, E_{n,2}, E_{n-1,2}, \ldots, E_{n-m+1,2}\right),$$
$$\ldots$$
$$E_{k,l} = f\left(k, E_{n,l}, E_{n-1,l}, \ldots, E_{n-m+1,l}\right),$$

- $E_{k,j}$ is a predicted result for the j-th axis;
- $E_{n-1,1}, E_{n-2,1}, \ldots$ is a student's result for the i-th test for the j-th axis;
- $f\left(k, E_{n,1}, \ldots, E_{n-m+1,1}\right)$ is a prediction function;
- k is a number of predicted a step;
- n is an amount of already performed tests;
- m is an amount of tests which is required for a prediction.

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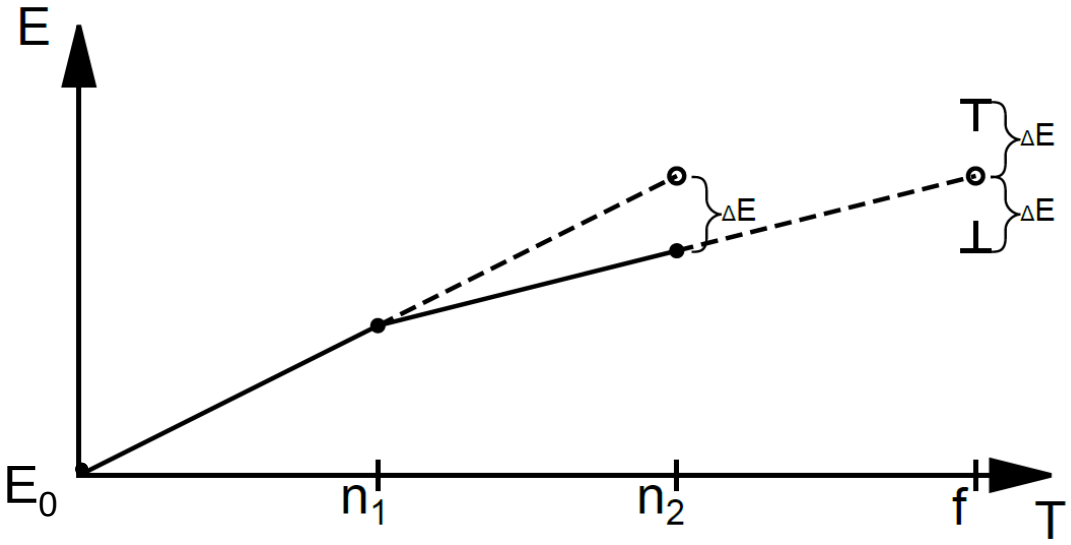
Prediction of Students' Learning Results and Cognitive Graphic Tools for its Visualization (5/3)



http://iyazyki.ru/2012/06/problemstudy-plusmotiv/

Fig. 10. Example of calculation for confidence region prediction

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Prediction of Students' Learning Results and Cognitive Graphic Tools for its Visualization (5/4)

Table 2 Source Data for visualization

Student #	Theory				Problems Solving				Electric Circuits Design			
	Input Test	Test 1	Test 2	Pass-Fail Test	Input Test	Test 1	Test 2	Pass-Fail Test	Input Test	Test 1	Test 2	Pass-Fail Test
1	63	72	80	83	70	80	85	84	75	77	85	90
2	54	56	60	68	60	56	65	67	59	65	70	75
3	53	56	60	63	52	60	55	61	60	64	70	68
4	58	63	65	67	65	62	70	76	68	71	75	82
5	51	50	54	52	52	56	57	55	54	53	56	60
6	65	63	68	75	73	75	72	75	76	73	78	84
7	60	65	63	68	65	68	75	74	72	76	76	82
8	55	58	54	55	53	60	62	66	60	62	60	65
9	72	76	68	75	76	68	63	70	80	72	83	85

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Prediction of Students' Learning Results and Cognitive Graphic Tools for its Visualization (5/5)

Table 2 Source Data for visualization

Student #	Theory				Problems Solving				Electric Circuits Design			
	Input Test	Test 1	Test 2	Pass-Fail Test	Input Test	Test 1	Test 2	Pass-Fail Test	Input Test	Test 1	Test 2	Pass-Fail Test
10	51	51	53	54	51	56	58	55	51	55	53	54
11	52	55	53	64	62	70	68	75	60	56	72	73
12	68	64	69	75	70	75	76	80	75	68	74	80
13	52	55	54	60	51	52	60	60	60	65	72	68
14	56	58	54	56	75	79	82	84	68	75	81	75
15	82	86	81	86	75	76	72	70	75	78	69	70
16	64	67	67	72	55	54	60	65	52	58	70	68
17	51	52	51	52	55	62	61	60	54	66	68	72
18	60	65	68	67	56	58	52	54	62	60	64	62
19	51	52	51	52	51	51	53	52	51	55	60	65
20	65	67	65	68	60	65	62	66	72	76	78	80
21	60	62	66	65	56	65	72	75	52	55	56	59

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Prediction of Students' Learning Results and Cognitive Graphic Tools for its Visualization (5/6)

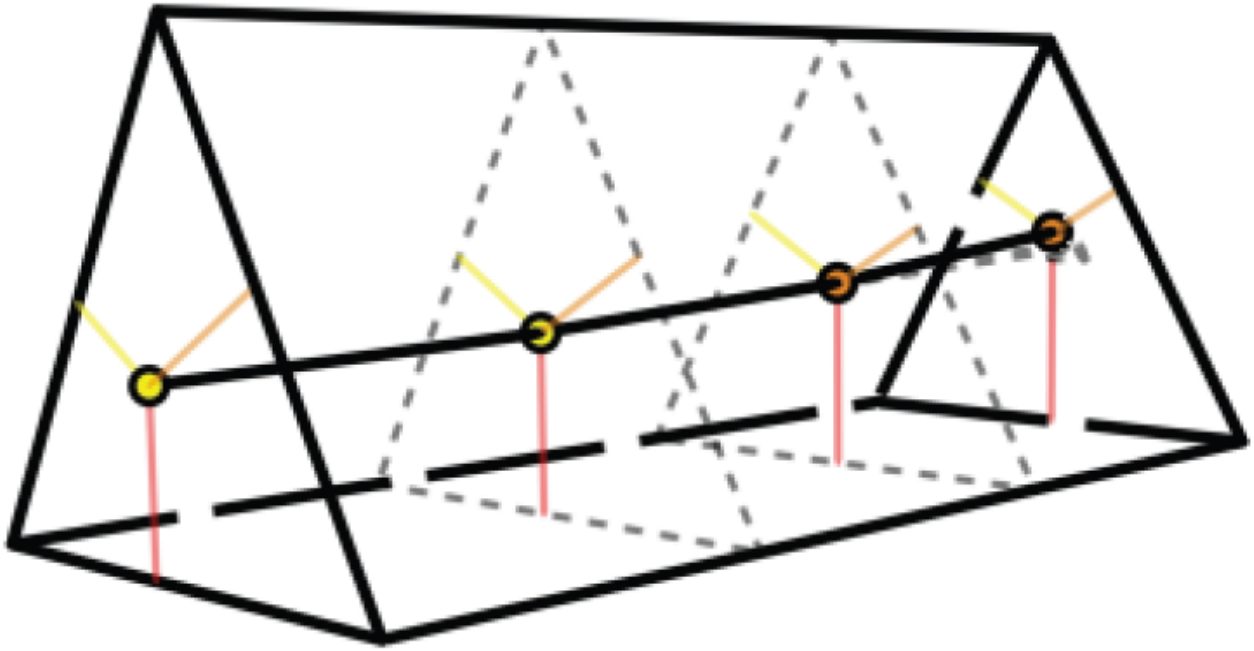

Fig. 11. 2-simplex prism application for prediction of students' learning results

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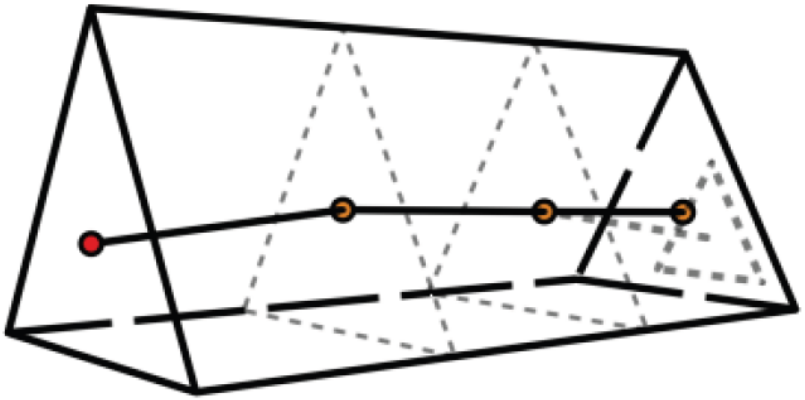
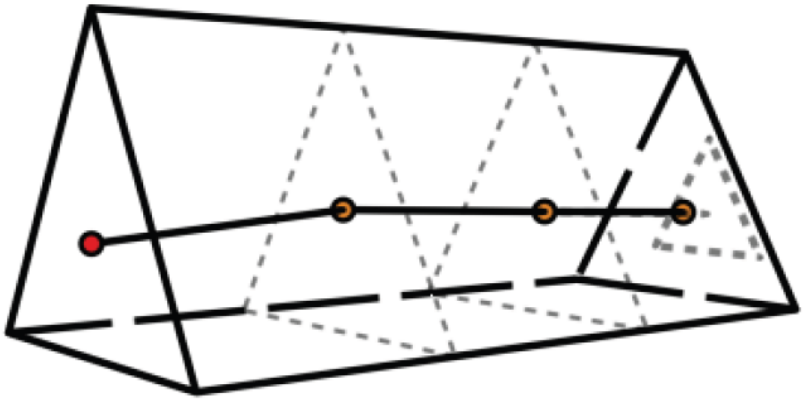
Prediction of Students' Learning Results and Cognitive Graphic Tools for its Visualization (5/7)



a) square polynome



b) linear polynome

Fig. 12. Polynome degree influence on prediction quality

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Specificity of Software Implementation of Cognitive Graphics Tools and Their Integration (6/1)

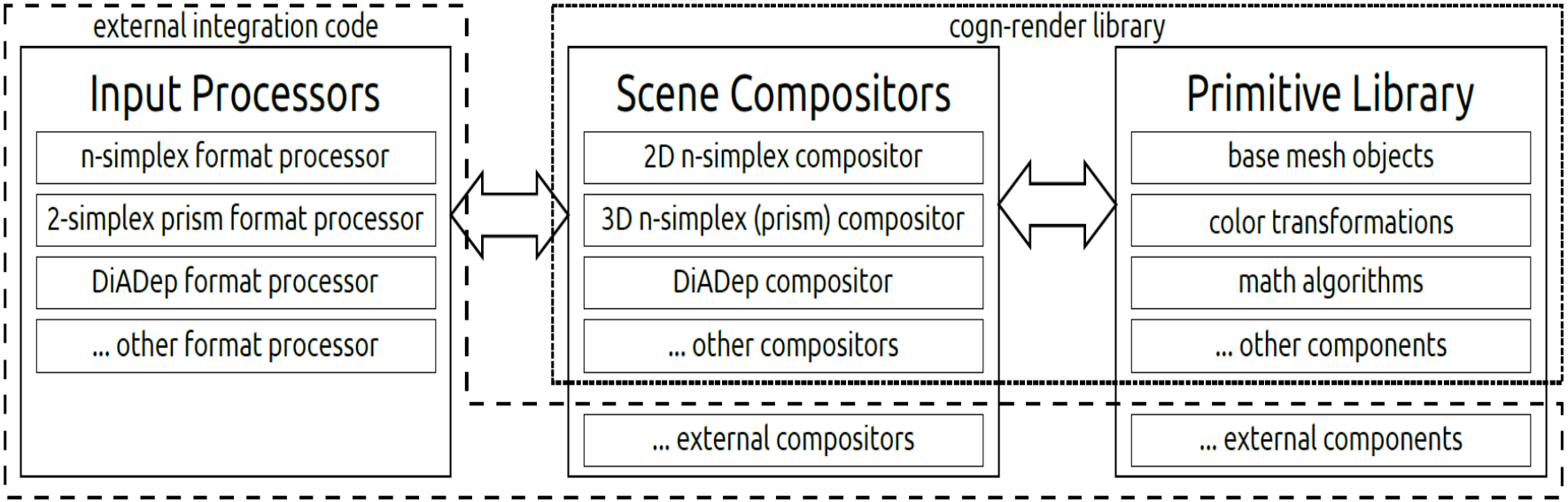

Fig. 13. Architecture of Library for Cognitive Tools Visualization

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Concluding Remarks (7/1)

1. Current state of research in e-learning area is discussed:
   - survey of individual learning trajectory construction
   - monitoring of students' learning trajectory
   - its prediction
2. Following new components for developed intelligent learning technology are proposed:
   - approach to assessment of students' learning results, based on MDT
   - approach to prediction of students' learning results, based on MDT and 2-simplex prism
3. Proposed approaches allow to construct individual learning trajectory for every student and help to determine weak points, which should be considered in more detail

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REFERENCES (8/1)

[1] Brusilovsky, Peter and Knapp, Judith and Gamper, Johann Supporting teachers as content authors in intelligent educational systems. International Journal of Knowledge and Learning 2(3/4), 2006, pp. 191–215. doi:http://dx.doi.org/10.1504/IJKL.2006.010992.

[2] V. Uskov, A. Uskov, Welcome Address: Computers and Advanced Technology in Education–Perspectives for 2010-2015. Proc. of the 13th IASTED International Conference on Computers and Advanced Technology in Education, Maui, Hawaii, USA, 2010. doi: http://dx.doi.org/10.2316/P.2010.709-067.

[3] A. Yankovskaya Logical tests and means of cognitive graphics. LAP LAMBERT Academic Publishing, 2011, (in Russian).

[4] A. Yankovskaya, N. Yevtushenko, Finite State Machine (FSM) – Based Knowledge Representation in a Computer Tutoring System. New Media and Telematic Technologies for Education in Eastern European Countries, 1997, pp. 67–74.

[5] Singer, Florence Mihaela and Stoicescu, Daniela Using Blended Learning as a Tool to Strengthen Teaching Competences. Procedia Computer Science, 3, 2011, pp. 1527–1531. doi: http://dx.doi.org/10.1016/j.procs.2011.01.043.

[6] Curtis J. Bonk, Charles R. Graham, Handbook of Blended Learning: Global Perspectives, Local Designs. John Wiley & Sons.

[7] Stan Maria Magdalena, The Relationship of Learning Styles, Learning Behaviour and Learning Outcomes at the Romanian Students. Procedia – Social and Behavioral Sciences 180 (2015) pp. 1667–1672. doi: http://dx.doi.org/10.1016/j.sbspro.2015.05.062.

REFERENCES (8/2)

[8] Shaidullin R.N., Safiullin L.N., Gafurov I.R., Safiullin N.Z. Blended Learning: Leading Modern Educational Technologies. Procedia – Social and Behavioral Sciences 131 (2014) pp. 105–110. doi: http://dx.doi.org/10.1016/j.sbspro.2014.04.087.

[9] Trends, E-Learning Market Forecast 2014-2016 Report. A report by Docebo. Available at: http://www.docebo.com/landing/contactform/elearning-market-trends-and-forecast-2014-2016-docebo-report.pdf (accessed June 01, 2015).

[10] Hattie, John and Yates, Gregory CR Visible Learning and the science of how we learn. Routledge, P. 368.

[11] Barana, Alice and Marchisio, Marina Ten good reasons to adopt an automated formative assessment model for learning and teaching Mathematics and scientific disciplines. Procedia – Social and Behavioral Sciences (2016) pp. 608–613. doi:http://dx.doi.org/10.1016/j.sbspro.354 2016.07.093.

[12] Samigulina, Galina and Samigulina, Zarina Intelligent System of Distance Education of Engineers, based on Modern Innovative Technologies. Procedia – Social and Behavioral Sciences (2016) pp. 229–236. doi: http://dx.doi.org/10.1016/j.sbspro.2016.07.034.

[13] Harandi, Safiyeh Rajaee Effects of e-learning on Students' Motivation. Procedia – Social and Behavioral Sciences (2015) pp. 423–430. doi:http://dx.doi.org/10.1016/j.sbspro.2015.04.905.

REFERENCES (8/3)

[14] Dzandu, Michael Dzigbordi and Tang, Yinshan Beneath a learning management system Understanding the human information interaction in information systems. Procedia Manufacturing 3 (2015) pp. 1946-1952. doi:http://dx.doi.org/10.1016/j.promfg.2015.07.239.

[15] Andreicheva, Liliya and Latypov, Rustam Design of E-Learning System: M-Learning Component. Procedia – Social and Behavioral Sciences 191 (2015) pp. 628—633. doi: http://dx.doi.org/10.1016/j.sbspro.2015.04.580.

[16] Urh, Marko and Vukovic, Goran and Jereb, Eva and others The model for introduction of gamification into e-learning in higher education. Procedia – Social and Behavioral Sciences 197 (2015) pp. 388 — 397. doi: http://dx.doi.org/10.1016/j.sbspro.2015.07.154.

[17] Yankovskaya, A.E. Design of optimal mixed diagnostic test with reference to the problems of evolutionary computation. Proceedings of the First International Conference on Evolutionary Computation and Its Applications, Moscow, pp. 292–297, 1996.

[18] Yankovskaya, A.E. and Semenov, M.E. Intelligent System for Knowledge Estimation on the Base of Mixed Diagnostic Tests and Elements of Fuzzy Logic. Proceedings of IASTED International Conference on Technology for Education (TE 2011), Dallas, USA, pp. 108–113, December 14-16, 2011. doi: http://dx.doi.org/10.2316/P.2011.754-001.

REFERENCES (8/4)

[19] Yankovskaya, A.E. and Semenov, M.E. Decision making in intelligent training-testing systems based on mixed diagnostic texts. Scientific and Technical Information Processing, 2013, Vol. 40, No 6, pp. 329–336. doi: http://dx.doi.org/10.3103/s0147688213060087.

[20] Yankovskaya, A.E. and Semenov, M.E. Foundation of the Construction of Mixed Diagnostic Tests in Systems for Quality Control of Education. Proceedings of 13th IASTED International Conference Computers and Advanced Technology in Education (CATE 2010), Maui, Hawaii, USA, pp. 142–145, August 23-25, 2010.

[21] Yankovskaya, A.E Mixed Diagnostic Tests are a New Paradigm of Construction of Intelligent Learning and Training Systems. Proceedings of the New quality of education in the new conditions, Tomsk, Russia, V.1., pp. 195–203, 2011, (in Russian).

[22] Yankovskaya, A.E. and Semenov, M.E. Application Mixed Diagnostic Tests in Blended Education and Training. Proceedings of the IASTED International Conference Web-based Education (WBE 2013), Innsbruck, Austria, pp. 935–939. February 13 - 15, 2013. doi: http://dx.doi.org/10.2316/P.2013.792-037.

[23] Yankovskaya, A.E., Fuks I.L., and Dementyev Y.N. Mixed Diagnostic Tests in Construction Technology of the Training and Testing Systems. International Journal of Engineering and Innovative Technology, V.3, Issue 5, pp. 169–174, 2013.

REFERENCES (8/5)

[24] A. Yankovskaya, Y. Dementyev, D. Lyapunov, A. Yamshanov Intelligent Information Technology in Education. Information Technologies in Science, Management, Social Sphere and Medicine (ITSMSSM 2016). doi: http://dx.doi.org/10.2991/itsmssm-16.2016.11.

[25] Yankovskaya Anna, Razin Vladimir Learning management system based on Mixed Diagnostic Tests and Semantic Web technology. Tomsk State University Journal,Issue 2(35), pp 78–98, 2016, (in Russian). doi: http://dx.doi.org/10.17223/19988605/35/9.

[26] Anna Yankovskaya, Yury Dementyev, Danil Lyapunov, Artem Yamshanov Design of Individual Learning Trajectory Based on Mixed Diagnostic Tests and Cognitive Graphic Tools. Proceedings of the 35th IASTED International Conference Modelling, Identification and Control (MIC 2016) February 15 – 16, 2016 Innsbruck, Austria. – 2016, pp. 59–65.

[27] Anna Yankovskaya, Artem Yamshanov, Natalia Krivdyuk Application of Cognitive Graphics Tools in Intelligent Systems. IJEIT, Vol.3, Issue 7, January 2014, pp. 58–65.

[28] Yankovskaya, Anna and Yamshanov, Artyom Development of Cross-Platform Cognitive Tools Invariant to Problem Areas and their Integration into Intelligent Systems. Key Engineering Materials, Vol.683, 2016, pp. 609–616. doi: http://dx.doi.org/10.4028/www.scientific.net/KEM.683.609.

REFERENCES (8/6)

[29] Yankovskaya A.E., Yamshanov A.V. Application of 2-simplex Prism for Researching and Modelling of Processes in Different Problem Areas Proceedings of the Seventh International Conference on Cognitive Science, Svetlogorsk, Russia, 2016. pp. 655–657, (in Russian).

[30] A. Yankovskaya, A. Yamshanov Family of 2-simplex cognitive tools and their applications for decision-making and its justification. Computer Science & Information Technology (CS & IT), 2016, 63–76. doi: http://dx.doi.org/10.5121/csit.2016.60107.

[31] Yankovskaya, 416 A., Levin I., and Fuks, I. Assessment of teaching and learning by mixed diagnostic testing. Proceedings of the Frontiers in Mathematics and Science Education Research Conference (FISER'14), Famagusta, North Cyprus, pp. 86–93, May 1-3, 2014.

[32] Yankovskaya, A.E. and Semenov, M.E. Construction of the Mixed Tests of the Quality System of Education. Proceedings of the International Scientific Conference (Modern IT& (e-) Training), Astrakhan, Russia, pp. 125–129, 2009, (in Russian).

[33] A.E. Yankovskaya, M.E. Semenov, A.V. Yamshanov, D.E. Semenov Cognitive Tools in Learning and Testing Systems Based on Mixed Diagnostic Tests. Artificial Intelligence and Decision Making, 4, 2015, pp. 51–61, (in Russian).

[34] Yu. I. Zhuravlev, I. B. Gurevitch Pattern recognition and image analysis. Artificial Intelligence in 3 Books, Book 2: Models and Methods: Reference Book, Ed. by D. A. Pospelov (Radio and Comm., Moscow, 1990), pp.149–191 (in Russian).

REFERENCES (8/7)

[35] A.E. Yankovskaya Transformation of features space in patterns space on the base of the logical combinatorial methods and properties of some geometric figures. Proceedings of the International Conference Pattern Recognition and Image Analysis: New Information, Abstracts of the I All-Union Conference, Part II, pp. 178-181, Minsk, 1991, (in Russian).

[36] S.V. Kondratenko, A.E. Yankovskaya System of visualization TRIANG for decision-making justification with cognitive graphics usage. Proceedings of the Third Conference on Artificial Intelligence. Vol. I. - Tver, 1992. - pp. 152-155, (in Russian).

[37] Demo for Developed Cognitive Tool. Available at: http://cogntool.tsuab.ru/demos/2-simplex-prediction/ (accessed August 25, 2015).

[38] Source Code of Cognitive Tools Prototype Visualization Library. Available at: https://github.com/zZLOiz/cogn-proto (accessed June 01, 2015).

[39] Source Code of Cognitive Tools Visualization Library. Available at: https://github.com/zZLOiz/cogn-render (accessed June 01, 2015).

THANKS A LOT
FOR YOUR ATTENTION

Fig. 14. Any Questions???

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