

# Set of the time series

| Time<br>TS | 1         | 2         | ... | T-3         | T-2         | T-1         | T         |
|------------|-----------|-----------|-----|-------------|-------------|-------------|-----------|
| 1          | $a_{1,1}$ | $a_{1,2}$ | ... | $a_{1,T-3}$ | $a_{1,T-2}$ | $a_{1,T-1}$ | $a_{1,T}$ |
| 2          | $a_{2,1}$ | $a_{2,2}$ | ... | $a_{2,T-3}$ | $a_{2,T-2}$ | $a_{2,T-1}$ | $a_{2,T}$ |
| ...        | ...       | ...       | ... | ...         | ...         | ...         | ...       |
| N          | $a_{N,1}$ | $a_{N,2}$ | ... | $a_{N,T-3}$ | $a_{N,T-2}$ | $a_{N,T-1}$ | $a_{N,T}$ |

N – number of the time series

T – length of the series

$$a_{i,j} \in E_k, i = 1, 2, \dots, N, j = 1, 2, \dots, T$$

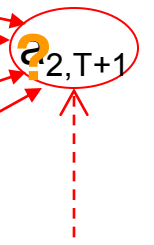
## The set of the time series

# Dependency in the time series

Consider a dependency

$$R = (n, \omega, f)$$

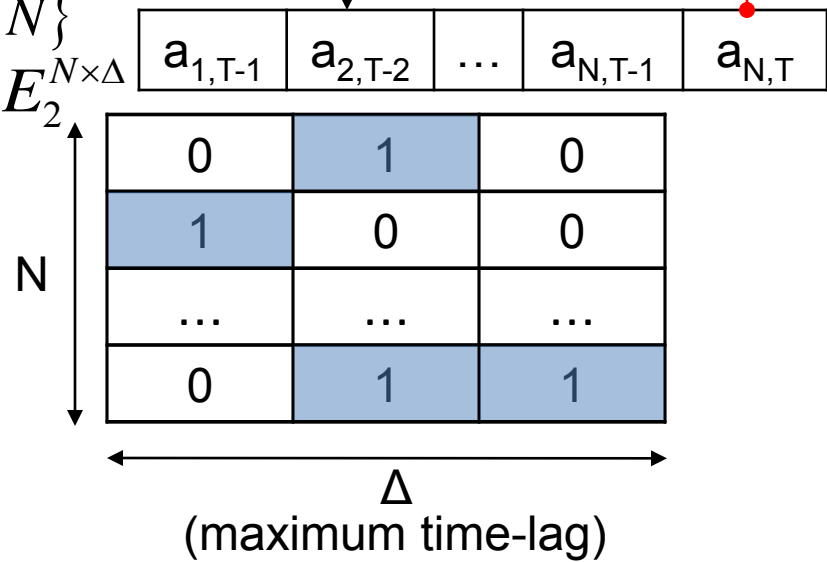
| Time TS | 1         | 2         | ... | T-3         | T-2         | T-1         | T         |
|---------|-----------|-----------|-----|-------------|-------------|-------------|-----------|
| 1       | $a_{1,1}$ | $a_{1,2}$ | ... | $a_{1,T-3}$ | $a_{1,T-2}$ | $a_{1,T-1}$ | $a_{1,T}$ |
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| ...     | ...       | ...       | ... | ...         | ...         | ...         | ...       |
| N       | $a_{N,1}$ | $a_{N,2}$ | ... | $a_{N,T-3}$ | $a_{N,T-2}$ | $a_{N,T-1}$ | $a_{N,T}$ |



- $$R = \begin{cases} 1. n - \text{index of the time series } n \in \{1, 2, \dots, N\} \\ 2. \omega - \text{mask } (\|\omega\| \text{ is number of 1's}), \omega \in E_2^{N \times \Delta} \\ 3. f - \text{partially definite function of } \|\omega\| \text{ variables} \end{cases}$$

$$f : E_k^{|\omega|} \rightarrow \{0, 1, \dots, k-1, \lambda\}$$

$\lambda$  – the value is not defined



# Markup the time series

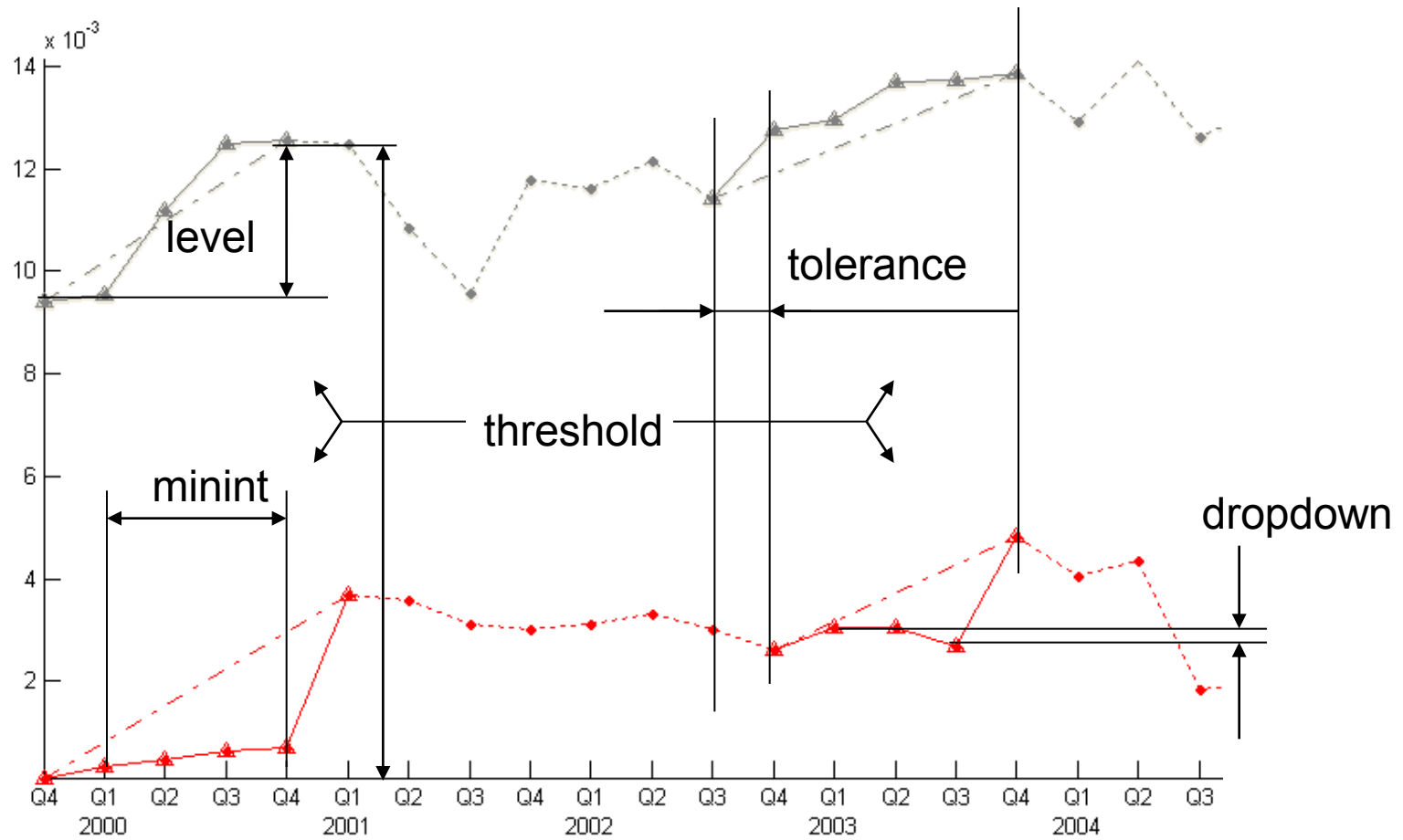
The markup is a sequence of 0s and 1s.

Two types of the marks Up and Down ( the marks could intersect each other on a single time series).

The parameters:

- **dropdown** – maximum overall drop down on the price decay (maximum rise during the fall of the trend), in fractions of the overall price change , in the (0,1) segment: (0 – any dropdown is allowed, 1 – no dropdown is allowed)
- **minint** – minimum number of the consecutive 1s, takes values from 1 to 24.
- **level** – the threshold of the price variation relatively to the average value; the variation below the threshold is not marked as Up/Down.

# Markup, an example



# Similarity and synchronization

- **Interval** is consecutive series of markups in corresponding to the series (quarterly transaction volumes for a given sector or a given stock).
- Intervals are considered to be similar, if the number of non-equal samples is not greater than a given value **tolerance**.
- **Similarity** between time series A and B is the sum of the number of equal Up/Down corresponded pairs of the marks.

An example of similar intervals:

| threshold = 0   | threshold = 2     | threshold = 2   |
|-----------------|-------------------|-----------------|
| 0 0 1 1 1 1 0 0 | 0 0 0 1 1 1 0 1 0 | 0 0 1 1 1 1 1 0 |
| 0 0 1 1 1 1 0 0 | 0 0 0 1 1 1 1 0 0 | 0 1 1 1 1 1 0 0 |

Two time series are considered to be synchronous if the number of the similar intervals is greater than a given value **threshold**.

The parameters:

- **tolerance** refers to the maximum number of non-equal samples in an interval (if the tolerance exceeds then intervals are not similar);
- **threshold** refers to the minimum number of the *similar* intervals in the pair of time series.

# Synchronization of the owners

