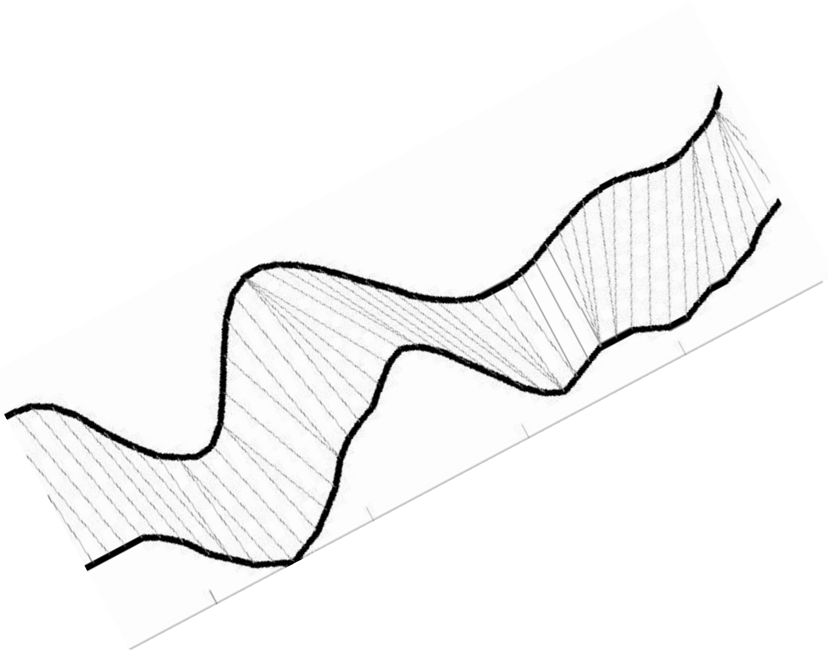
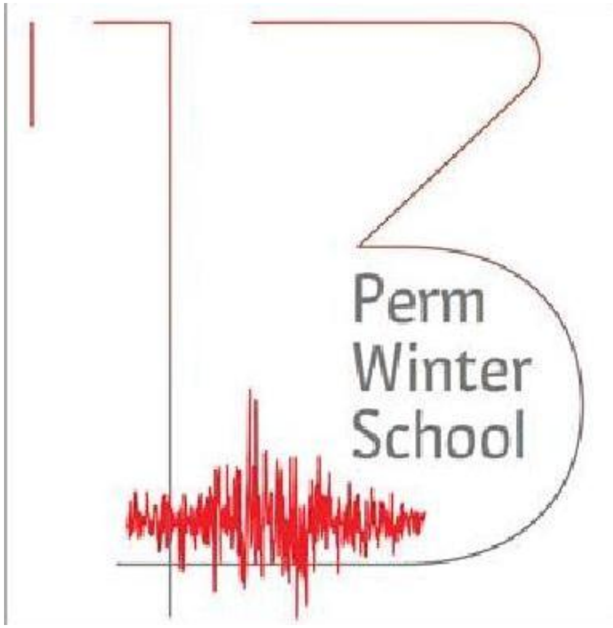
Risk scenarios based on the time series time warped longest common subsequence (T-WLCS) temporality test (Rogov-causality test)





ERM – FRM Convergence.

Consider
- the interaction of different risks,
- **business cycle,**
- **human factor and other global risk factors**

More accessible for SME (crowdsourcing etc,)

Analysis of operational and strategic risks on the basis of modern financial risk management approaches (Global risk factor - space weather**)**

More external statistical data (Risk indices, KRI**)**

Risk management effectiveness evaluation technologies should result in quantitative estimation of risk (ROV)

Management value (RORAC etc.)

ERM standards are harmonized with the sustainable development standard Requirements (GRI)

Financial Risk Management (FRM) and Enterprise Risk-Management (ERM) Convergence[1] (Manifesto)

Nowadays, there is an urgent need in **updating ERM standards with present-day FRM technology advancements** based on financial and actuarial mathematics. Besides, risk assessment techniques should better than ever **consider the interaction of different risks, business cycle, human factor and other global risk factors**. Finally, modern risk management technologies **should become even more accessible for application in small and medium-sized enterprises** where risk management is currently too expensive for efficient application.

In this regard, we should identify a number of innovations requiring more attention while developing the ERM standards, including ISO 31004 Risk Management — Guidance for the implementation of ISO 31000, etc.

Firstly, this involves the **analysis of operational and strategic risks (prevailing in the real sector activities) on the basis of modern financial risk management approaches.** In particular, when presenting modern approaches to risk assessment it is required to emphasize the importance of time series analysis, the analysis of global risk factors, including the human factor, the space and earth weather, the cyclical nature of the economy, etc. Special attention should also be given to different types of risk relationships in the portfolio (correlation, cointegration and others) to be taken into account in the portfolio approach. The ERM standards should be supplemented with references to such basic risk management methods as portfolio diversification, immunization, securitization and hedging, including those related to business process portfolios.

Secondly, **external statistical data can be much more actively used in risk assessment.** For this purpose, the important role of public data and indices[2] should be highlighted in the ERM standards, and special attention should also be given to the prospects of using crowdsourcing technology via mobile Internet[3] (with a glance to some caution regarding data quality). This is especially important for small and medium-sized companies which either lack evidence or have limited capability to collect and evaluate relevant incident data.

Thirdly, **risk management effectiveness evaluation technologies should result in quantitative estimation of risk management value, and modern assessment method achievements should be taken into account.** For this purpose, the important role of modern approaches to risk budgeting and capital allocation (Capital-at-Risk, Risk adjusted return on risk adjusted capital (RORAROC), and related risk measures[4] should be specified in the ERM standards, as well as the real options theory (ROV) as the base for the effectiveness measure of risk management value[5]. Besides, it is also required to increase emphasis on the importance of ensuring a sufficiently high sensitivity of risk appetite to the changes of the risk context.

Fourthly, it is desirable that **the ERM standards are harmonized with the sustainable development standard requirements**[6].

It would be appropriate to focus efforts in this direction by creating a working group (subcommittee) to handle FRM and ERM convergence issues, if necessary.

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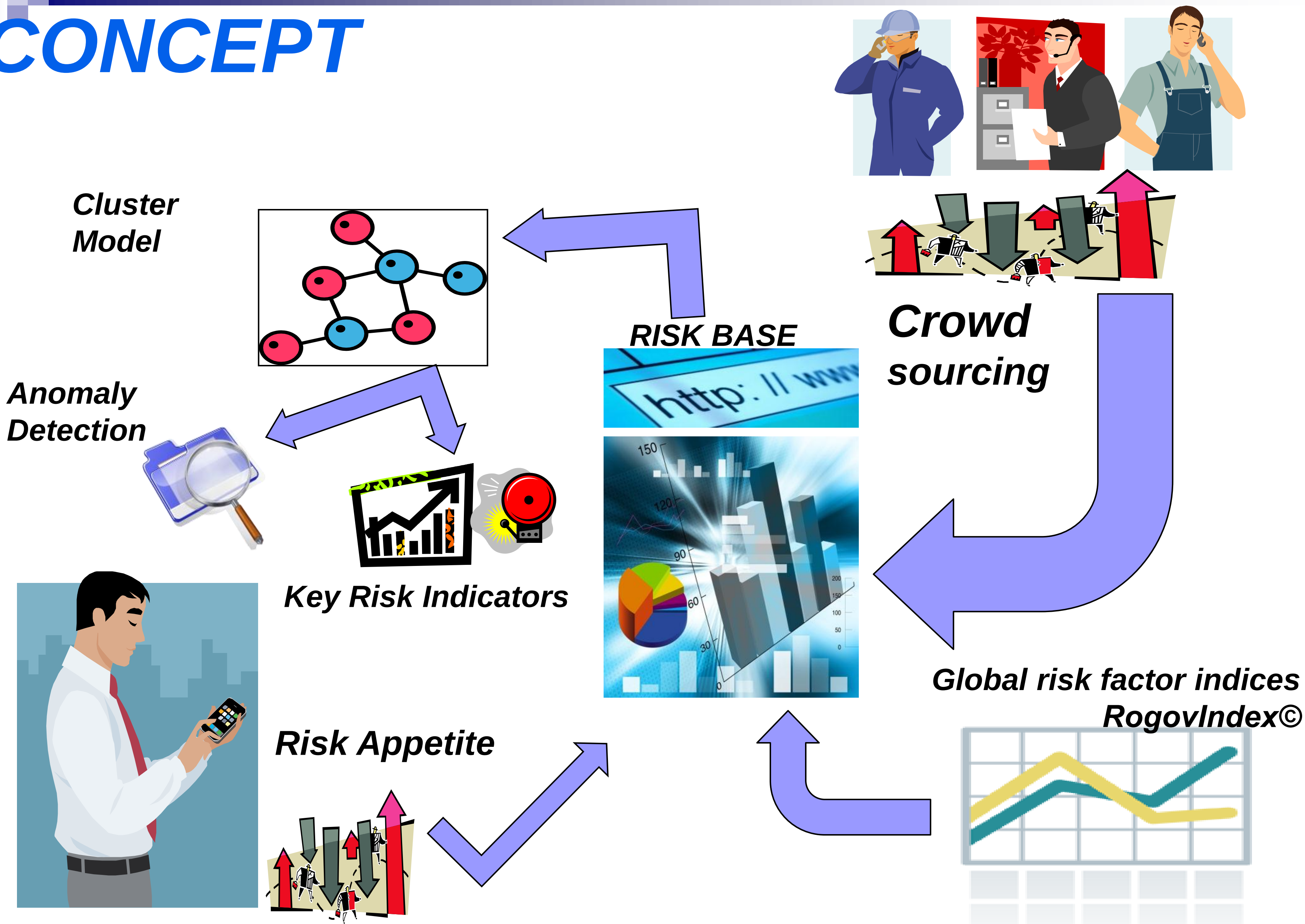
August, 2011, Moscow, Russia

[1] For the draft of ISO 31004 standard, etc.
[2] For example, volatility indices, credit spread indices, space weather indices, etc.
[3] For example, the Ushahidi technology
[4] Value-at-Risk, Short Fall, Stress VaR, etc.
[5] When risk management can provide the deviation of the volatile key performance indicators (KPI) within the set of limits based on the risk appetite of an organization, its risk management value can be estimated as the value of the real option portfolio. The underlying asset of the options are relevant KPIs, the spot prices are the planned KPI values , strike prices are the levels of limits on deviations from the KPI target values, the time remaining until expiration of the option is the planning horizon.
[6] In terms of the Global Reporting Initiative (GRI).

CONCEPT



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Mining Time Series Data

Major task considered by the time series data mining community: [Ratanamahatana, Lin, Gunopulos, Keogh, Vlachos, Das].

- **Indexing** (Query by Content): Given a query time series *Q*, and some similarity/dissimilarity measure *D*(*Q;C*), find the most similar time series in database *DB*.

- **Clustering**: Find natural groupings of the time series in database *DB* under some similarity/dissimilarity measure *D*(*Q;C*).

- **Classification**: Given an unlabeled time series *Q*, assign it to one of two or more predefined classes.

- **Prediction** (Forecasting): Given a time series *Q* containing *n* data points, predict the value at time *n* + 1.

Mining Time Series Data

Major task considered by the time series data mining community: [Ratanamahatana, Lin, Gunopulos, Keogh, Vlachos, Das].

- **Summarization**: Given a time series *Q* containing *n* data points where *n* is an extremely large number, create a (possibly graphic) approximation of *Q* which retains its essential features but fits on a single page, computer screen, etc.

- **Anomaly Detection** (Interestingness Detection): Given a time series *Q*, assumed to be normal, and an unannotated time series*R*, find all sections of *R* which contain anomalies or surprising / interesting/ unexpected" occurrences

- **Segmentation**:

(**a**) Given a time series *Q* containing *n* data points, construct a model ^{1}Q, from *K* piecewise segments (*K* << *n*), such that ^{1}Q closely approximates *Q*
(**b**) Given a series Q, partition it into K internally homogenous sections (also known as change detection).

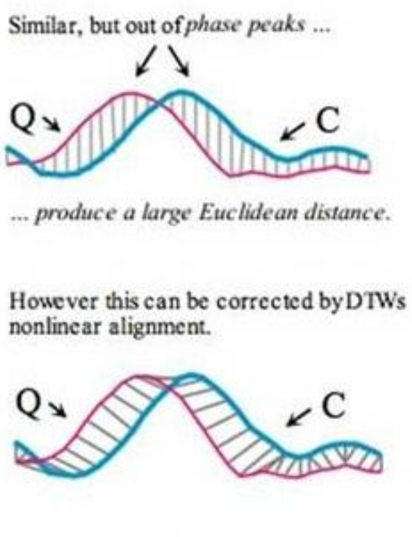
Mining Time Series Data vs. Risk management

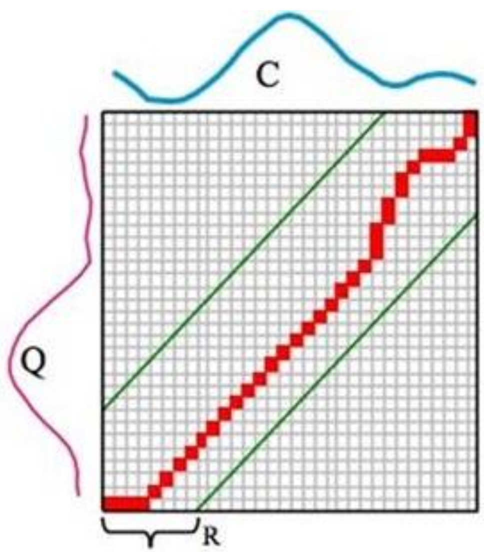
Mining Time Series Data Task	Risk Management Tool
Indexing	Risk Benchmarking
Clustering	Risk Analysis
Classification	Risk Factor Classification
Prediction	Risk Scenario Generation
Summarization	Risk Map
Anomaly Detection	Hidden Risk Identification
Segmentation	Risk Mapping and aggregation Portfolio management

One-to-One vs. One-to-many

Dynamic time warping (DTW) is an algorithm for measuring similarity between two sequences which may vary in time or speed

Source of the figure: http://practicalquant.blogspot.ru/2012/10/mining-time-series-with-trillions-of.html





Given two time sequences C(m), and Q(n), it fills an m by n matrix representing the distances of best possible partial path using a recursive formula:

$$D(i,j) = d(i,j) + min\begin{cases} D(i-1,j), \\ D(i,j-1), \\ D(i-i,j-i) \end{cases}$$

where $1 \leq i \leq m$; $1 \leq j \leq n$, d(i; j) represents the distance between Qi and Cj . D(1; 1) is initialized to d(1; 1). The alignment that results in the minimum distance between the two sequences has value D(m; n).

Longest Common Subsequence Similarity (LCSS)

The basic idea is to match two sequences by allowing some elements to be unmatched or left out. (Kruskal and Sankoff, 1983)
Given a sequence C (m), and a sequence Q (n), find a sequence Z, such that Z is the longest sequence that is both a subsequence of C, and a subsequence of Q . The subsequence is defined as a sequence Z (k), where there exists a strictly increasing sequence i=1,..k of indices of C such that for all j = 1..k; $C_{i_j} = Z_j$.

$$c_{ij} = \begin{cases} 0\,, if\ i = 0\ or\ j = 0; \\ c(i-1, j-1) + 1\,, if\ i,j > 0, Q(i) = C(j) \\ \max\{c(i-1, j), c(j, j-1)\}, if\, i,j > 0, Q(i) \neq C(j) \end{cases}$$

Dissimilarity between *C* and *Q*

$$LCSS(C;Q) = \frac{m+n-2l}{m+n}$$

where *l* is the length of the **longest common subsequence (LCS)**.

Time-Warped Longest Common Subsequence (T-WLCS)

The basic idea is to unite both DTW and LCSS approaches.
(Guo, Siegelmann, 2004)

$$c_{ij} = \begin{cases} 0\,, & if\ i = 0\ or\ j = 0; \\ \max\{c(i-1,j), c(i,j-1), c(i-1,j-1)+1\}\,, & if\ i,j > 0, Q(i) = C(j) \\ \max\{c(i-1,j), c(j,j-1)\}\,, & if\, i,j > 0, Q(i) \neq C(j) \end{cases}$$

Example 1 *C= "41516171", Q = "4567". LCS(C,Q) = 4, T-WLCS(C,Q)=4.*
Example 2 *C = "44556677", Q= "4567". LCS(C,Q) = 4, T-WLCS(C,Q) = 8.*
Example 3 *C="4455661111177", Q= "4567",LCS(C,Q) =4, T-WLCS(C,Q)= 8.*

Stored Sequence \ Query Sequence	*4*	*1*	*5*	*1*	*6*	*1*	*7*	*1*
4	1	1	1	1	1	1	1	1
5	1	1	2	2	2	2	2	2
6	1	1	2	2	3	3	3	3
7	1	1	2	2	3	3	4	4

(a)

Stored Sequence \ Query Sequence	*4*	*4*	*5*	*5*	*6*	*6*	*7*	*7*
4	1	2	2	2	2	2	2	2
5	1	2	3	4	4	4	4	4
6	1	2	3	4	5	6	6	6
7	1	2	3	4	5	6	7	8

(b)

Stored Sequence \ Query Sequence	*4*	*4*	*5*	*5*	*6*	*6*	*1*	*1*	*1*	*1*	*1*	*7*	*7*
4	1	2	2	2	2	2	2	2	2	2	2	2	2
5	1	2	3	4	4	4	4	4	4	4	4	4	4
6	1	2	3	4	5	6	6	6	6	6	6	6	6
7	1	2	3	4	5	6	6	6	6	6	6	7	8

(c)

Time Series Temporality: Granger Causality

The Granger causality test is a statistical hypothesis test for determining whether one time series is useful in forecasting another. (Granger, 1969)

Let *y* and *x* be stationary time series. To test the null hypothesis that *x* does not Granger-cause *y*, one first finds the proper lagged values of *y* to include in a univariate autoreression of *y*:.

$$y_t = a_0 + a_1 y_{t-1} + a_2 y_{t-2} + .. + a_m y_{t-m} + residual_t$$

Next, the autoregression is augmented by including lagged values of *x*:

$$y_t = a_0 + a_1 y_{t-1} + a_2 y_{t-2} + .. + a_m y_{t-m} + b_p x_{t-P} + .. + b_q x_{t-q} + residual_t$$

One retains in this regression all lagged values of *x* that are individually significant according to their t-statistics, provided that collectively they add explanatory power to the regression according to an F-test (whose null hypothesis is no explanatory power jointly added by the *x'*s).

The null hypothesis that *x* does not Granger-cause *y* is accepted if and only if no lagged values of *x* are retained in the regression.

Time Series Temporality: Rogov Causality

Rogov Causality test

Given Z =T-WLCS (X,Y), such that $Z_i = X_{t_i} = Y_{t_i - time\ lag_i}$

The null hypothesis that *X* does not Rogov-cause Y is not accepted if and only if both LCSS and the time lag's CDS(0)* are high enough.

Scenario generation on Rogov causality test:

$Y_t = X_{t+Time\ lag}$ where $\boldsymbol{Time\ lag_{min}} \leq \boldsymbol{Time\ lag} \leq \boldsymbol{Time\ lag_{max}}$

----

*CDS – cumulative distribution function, CDS(0) = P(Lag$\leq$ 0)

EXAMPLE:

Let X_{t_i} – list of dates and places of visits of the spy X
and $Y_{t_i+time\ lag}$ – list of dates and places of visits of the spy Y…

Time Series Temporality: Rogov Causality

Unknown. Woman officers practice at shooting range-Fire arms inspection-Girls with Guns. 08.10.1968. Gelatin silver print. Courtesy Fototeka Los Angeles

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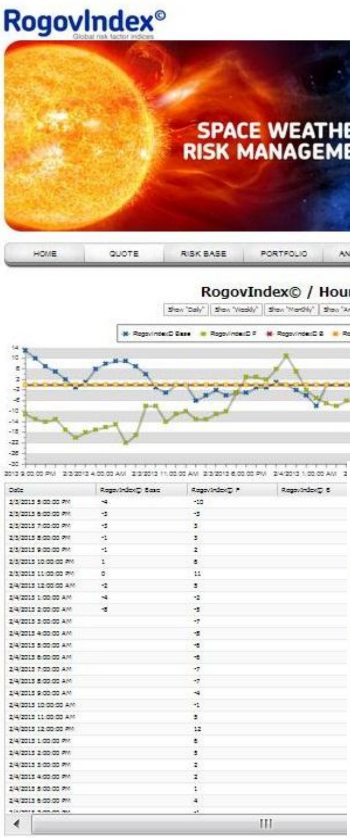
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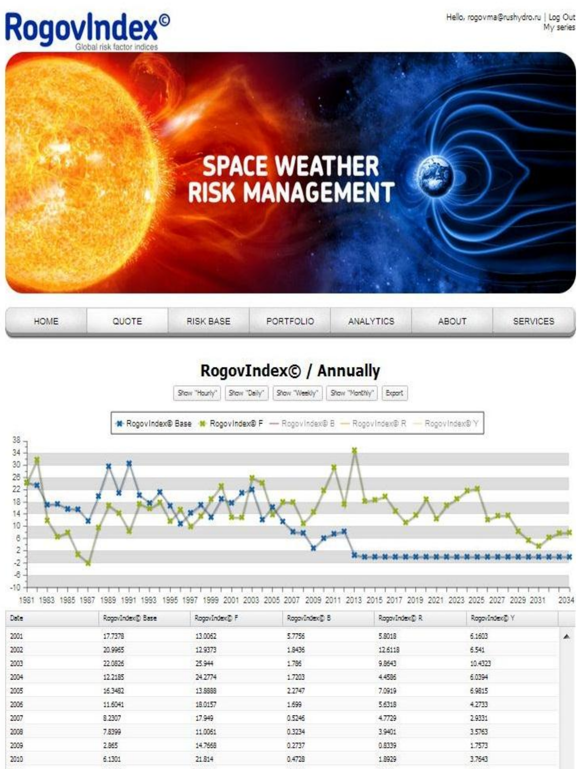
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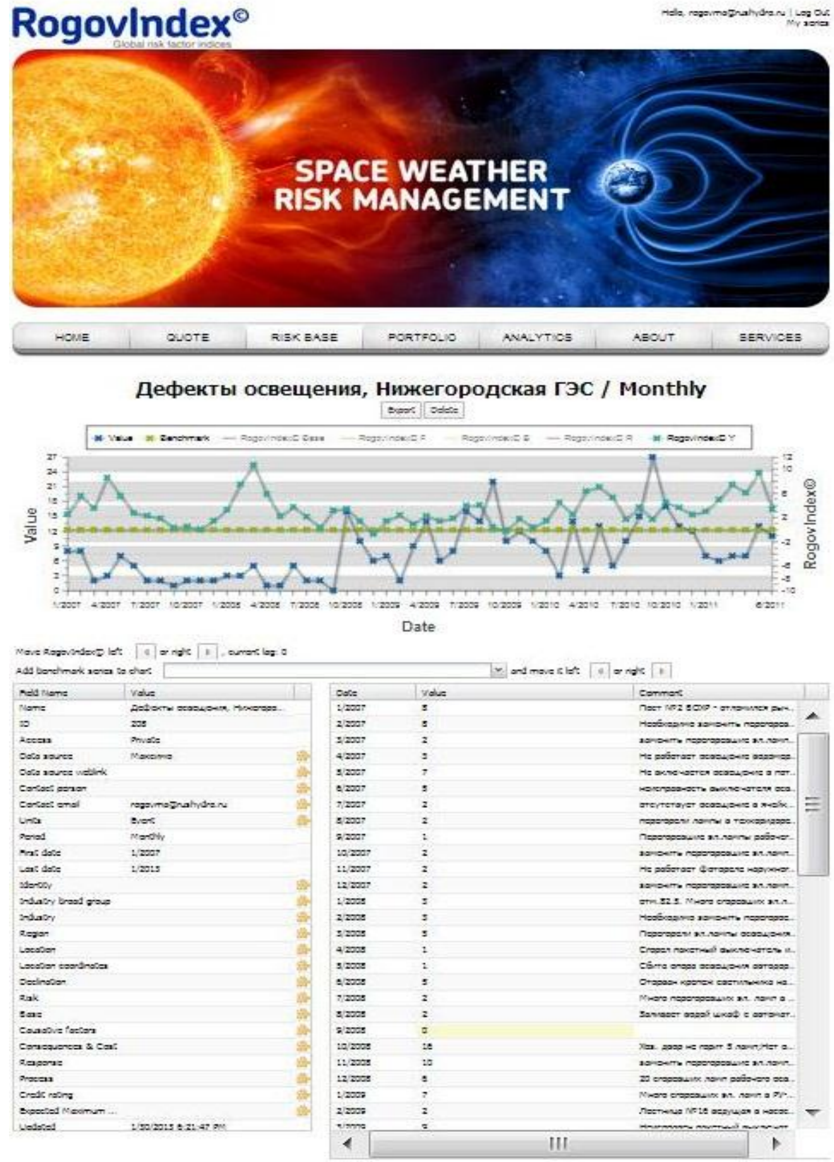
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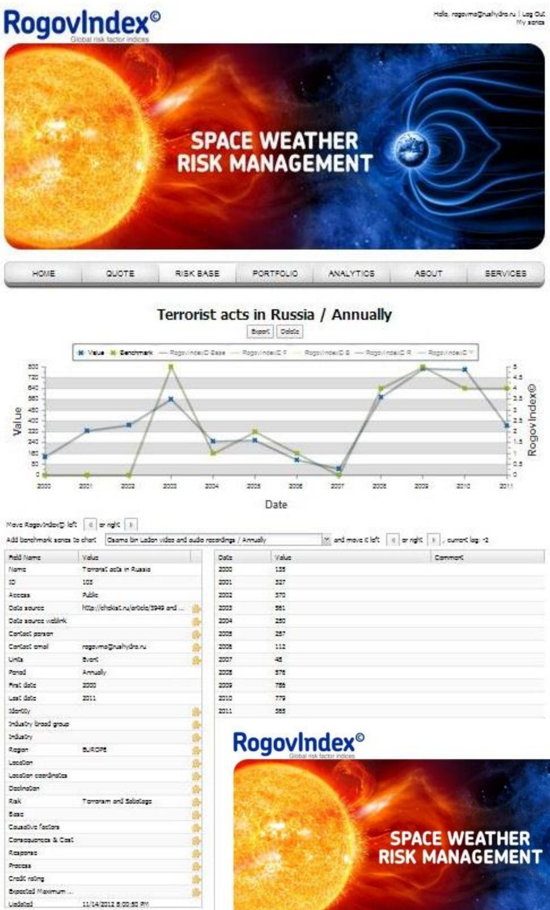

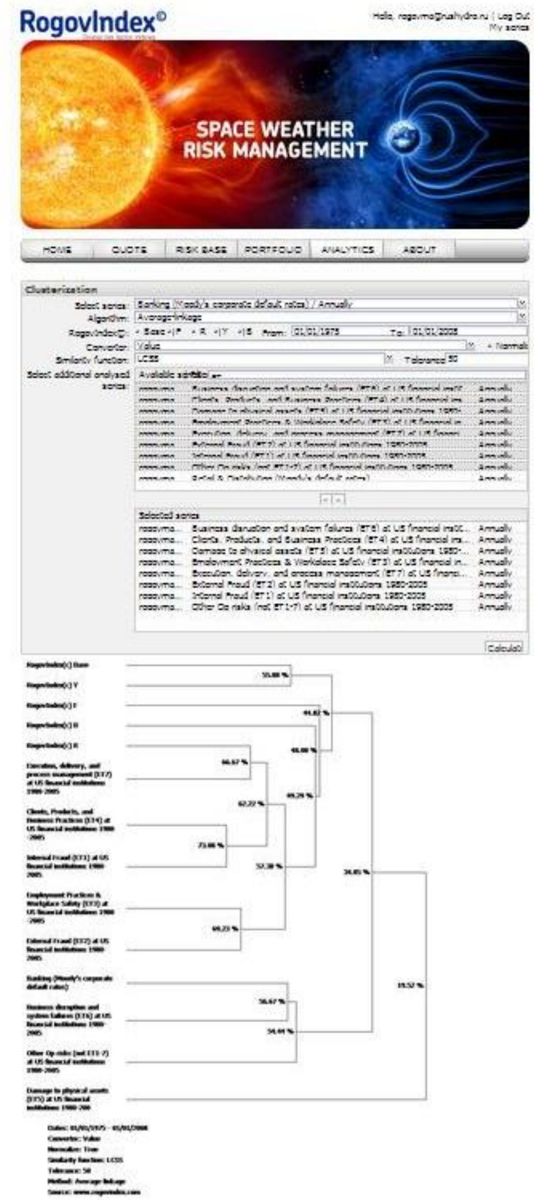

Mikhail A. Rogov


РОССИЙСКАЯ ФЕДЕРАЦИЯ

ПАТЕНТ

НА ИЗОБРЕТЕНИЕ

№ 2250495

СПОСОБ ФОРМИРОВАНИЯ КОНТРАКТОВ УПРАВЛЕНИЯ РИСКАМИ ЧЕРЕЗ КОМПЬЮТЕРНУЮ СИСТЕМУ

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StrategicRISK

Dear Mikhail Rogov,

I am delighted to confirm that JSC Rushydro has been shortlisted in the 2012 StrategicRISK European Risk Management Awards.

As a shortlisted finalist, the company is entitled to a free place at the StrategicRISK European Risk Management Awards ceremony on 8th May 2012 and we would be pleased if you could attend.

The Awards ceremony will be held at The Grand Connaught Rooms, 61-65 Great Queen Street, London, WC2B 5DA.

Many thanks and best wishes,

Katherine Ball
StrategicRISK
+44 (0)20 7618 3492