Third Annual Meeting COST ACTION P10

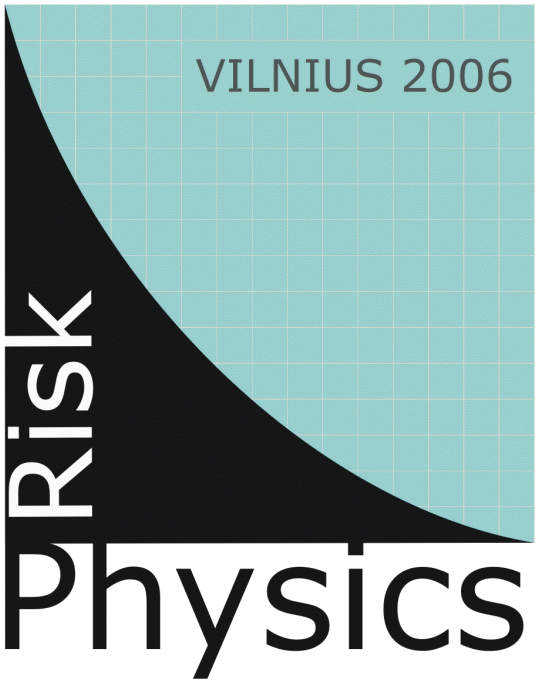
Physics of Risk

& Workshop on

Complex System Science

MC & WG 1-2-3 & Workshop Meetings

Vilnius, Lithuania, 13–16 May 2006



Program & Abstracts

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Program

Saturday, 13 May 2006

00:00–15:00	Arrival
13:00–15:00	Lunch
15:00–15:50	Registration and Coffee
15:50–16:00	**Opening of the Meeting & Workshop**
16:00–17:30	**1st Session: Complex Systems & Risk** Chairpersons Imre KONDOR and Janusz HOŁYST
16:00–16:10	Imre KONDOR, ONCE-CS Action and European Complex Systems Society
16:10–16:40	**Invited talk** Krzysztof KUŁAKOWSKI, Needs and decisions in ghetto
16:40–17:10	**Invited talk** Algimantas JUOZAPAVIČIUS, High performance scientific computations and services on BalticGrid and LitGrid
17:10–17:30	Ingve SIMONSEN, Gain-loss asymmetry in stock markets: empirical facts and model based explanation by I. Simonsen, R. Donangelo, M.H. Jensen and K. Sneppen
17:30–18:00	Coffee
18:00–19:00	**2nd Session: Complex Systems & Networks** Chairpersons Imre KONDOR and Janusz HOŁYST
18:00–18:15	Imre KONDOR, Critical phenomena in portfolio selection
18:15–18:30	Laurynas JUODIS, Self-organized criticality model of the nuclear fuel structure evolution by L. Juodis, I. Petrashenko, G. Trinkunas and V. Remeikis
18:30–18:45	Jevgenijs KAUPUŽS, Critical exponents of 3D Ising model from theory and large-scale MC simulations
18:45–19:00	Dobilas KIRVELIS, Organized complex system as informational closed-loop coding-decoding control system
19:00–20:30	Diner
20:30–21:30	**Working Groups and Private Discussions**

Sunday, 14 May 2006

10:00–11:30	**3rd Session: WG1. Risk** Chairperson Peter RICHMOND
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10:45–11:15	**Invited talk** Rimantas RUDZKIS, Macro-econometric modelling of the Lithuanian economy: from outer experience to data-consistent approach by R. Rudzkis and V. Kvedaras
11:15–11:30	János KERTÉSZ, Some stylized facts of the market revisited and consequences for fluctuation scaling by J. Kertész and Z. Eisler
11:30–12:00	Coffee
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12:15–12:30	Audrius KABAŠINSKAS, Multifractality and self-similarity in the Baltic States market by L. Sakalauskas, I. Belovas and A. Kabašinskas
12:30–12:45	Marco PATRIARCA, Statistical models of social systems by M. Patriarca, E. Heinsalu, and A. Chakraborti
12:45–13:00	Adel SHARKASI, Stock market behaviour for different time intervals with different volatility levels by A. Sharkasi, H. Ruskin and M. Crane
13:00–13:15	Vygintas GONTIS, Modeling long-range trading activity by stochastic differential equations by V. Gontis, B. Kaulakys, M. Alaburda and J. Ruseckas
13:15–13:30	Giulia IORI, Analytical and a microstructure analysis of stock pinning by M. Jeannin, G. Iori and D. Samuel
13:30–15:00	Lunch
15:00–17:00	**5th Session WG3. Networks** Chairperson Geoff. RODGERS
15:00–15:45	**Keynote talk** Ayse ERZAN, From topology to dynamics in generic content based networks
15:45–16:15	**Invited talk** Mauro GALLEGATI, Business fluctuations in a credit-network economy by D. Delli Gatti, M. Gallegati, B. Greenwald, A. Russo and J.E. Stiglitz
16:15–16:30	Alexander HELLERVIK, Distance dependent bond percolation in a geographical network model
16:30–16:45	Jukka-Pekka ONNELA, Weak ties in social networks by J.-P. Onnela, J. Saramäki, J. Hyvönen, K. Kaski, J. Kertész, G. Szabó and A.-L. Barabási
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18:00–19:30	Diner
19:30–21:00	**Private Discussions**

Monday, 15 May 2006

9:00–11:00	**6th Session: WG2 & WG3** Chairperson František Slanina
9:00–9:30	**Invited talk** Šarūnas Raudys, Adaptation of multi-agent populations to environmental changes
9:30–9:45	Marcel Ausloos, Exo- and endo-genous shocks
9:45–10:00	Serge Galam, When sociophysics produces new physical results, by A.O. Sousa, K. Malarz and S. Galam
10:00–10:15	Christophe Deissenberg, The EURACE project: An agent-based software platform for European economic policy design with heterogeneous interacting agents: new insights from a bottom up approach to economic modelling and simulation
10:15–10:30	Andrea De Martino, Multi-asset minority games
10:30–10:45	Jari Saramäki, Characterizing Weighted Complex Networks in Economics and Society by J. Saramäki, J.-P. Onnela, J. Kertész and K. Kaski
10:45–11:00	Mircea Gligor, A moving-average-minimal-path-length method for UE country clustering according to macroeconomic fluctuations by M. Gligor and M. Ausloos
11:00–11:30	Coffee
11:30–13:00	**7th Session: WG2. & CS** Chairperson Marcel Ausloos
11:30–12:00	**Invited talk** Kestutis Staliūnas, Bose-Einstein condensation of financial (profit-seeking) bosons
12:00–12:15	Jürgen. Mimkes, The Nature of Economic Interactions
12:15–12:30	František Slanina, Evolution of imitation structures by F. Slanina and H. Lavika
12:30–12:45	Ihar Miklashevich, The internal structure of socium origins from immanent hazy by I. Miklashevich and V. Barkaline
12:45–13:00	Tomas Rekašius, Context dependent evolution and noninformative biological sequences by M. Radavičus and T. Rekašius
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14:30–16:00	**8th Session: WG3 & CS** Chaiperson Bronius Kaulakys
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14:45–15:00	Stefan Thurner, Dynamical complex networks of rational economical agents by S. Thurner and Ch. Biely
15:00–15:15	Jos Ferreira Mendes, Structural properties of Complex networks
15:15–15:30	Karsten Peters, Disaster spreading in complex networks by K. Peters, L. Buzna and D. Helbing
15:30–15:45	Stanislaw Cebrat, Why does the age structure of the human population change? by Katarzyna Bońkowska, Przemyslaw Biecek and S. Cebrat
15:45–16:00	Josu Takala, Subcontracting risks in electronics manufacturing industry in China, by P. Ollinkoski and J. Takala
16:00–16:30	Coffee
16:30–18:15	**9th Session: Complex Systems & Risk.** Chaiperson Vygintas Gontis
16:30–17:00	**Invited talk** Zdzislaw Burda, Random matrices and risk management
17:00–17:15	Reinhard Mahnke, About the risk to stick in a traffic jam

17:15–17:30	Yurij Holovatch, Public transport networks: scaling and vulnerability by C. von Ferber, T. Holovatch, Yu. Holovatch and V. Palchykov
17:35–17:45	Eriks Klotins, Critical dynamics in nanoscale
17:45–18:00	Arvydas Tamulis, Measure of complexity in the artificial living organisms by A. Tamulis and V. Tamulis
18:00–18:15	Ionut Relu Andrei, EOM control of the LFF chaotic behavior in an ECSL- m:n phase synchronization by M. Bulinski, C. Costea, and C.M. Ticos
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20:00–23:00	Conference Diner

Tuesday, 16 May 2006

9:00–10:00	**MC Meeting**
10:00–10:30	**WGs Meetings**
10:30–11:00	Coffee
9:30–11:00	**10^{th} Session: Poster Session**
11:00–12:30	**11^{th} Session: All WGs & CS General Session** Chairperson Peter Richmond
11:00–11:30	**Invited talk** Igor Mandel, Statistical and Physical paradigms (Econophysics, Sociophysics), Mediaphysics by I. Mandel and D. Kuznetcov
11:30–11:45	Serge Galam, Can Sociophysics becomes a predictive social tool? The example of the recent French referendum
11:45–12:30	Peter Richmond, Janusz Hołyst, János Kertész, Piotr Swiatek, Reinhard Folk *et al*, Meeting and discussions about Physics of Risk with the Lithuania government agencies that are responsible for science planning and funding, with the representatives of Lithuania Academy of Sciences, Lithuanian Science Council and journalists
12:30–12:40	Peter Richmond, Closing Remarks. General Discussions
12:00–14:00	Lunch

Posters

1. Bosiljka Tadic, Dynamic processes on complex networks: structuredynamics interdependences
2. Riitta Toivonen, A Model for Social Networks by R. Toivonen, J.P. Onnela, J. Saramäki, J.Hyvönen and K. Kaski
3. Johannes Feist, Nano-wire with one-sided surface roughness as a complex system by J. Feist, A. Backer, R. Ketzmerick, S. Rotter, B. Huckestein and J. Burgdorfer
4. P. Repetowicz, Modeling distributions of personal income as Markov processes by P. Repetowicz and P. Richmond
5. Viatcheslav Barkaline, Semantic information concept in sociodynamic modelling by V. Barkaline and I. Miklashevich
6. Carmen Costea, Alternatives for the European educational system—the knowledge based economic applied research
7. Jelena Tamulienė, Quantum mechanical investigations of large supramolecules by J. Tamuliene, R. Vainoras and M.L. Balevičius
8. Dalia Šatkovskienė, Additivity based method for conformational analysis of large molecular systems by D. Šatkovskienė, P. Pipiraitė and R. Jankauskas
9. Petras Serapinas, Application of correlative characteristics of individual samples in multi element spectrometric pattern recognition by P. Serapinas and Ž. Ežerinskis
10. Josu Takala, Integration of the environmental management system into other business operations systems by J. Lintala and J. Takala
11. Tauno Kekäle, Power-law knowledge distribution in small software specialist teams, by T. Kekäle, Sara Cervai and Ana Gomez
12. Juozas Justinas Blynas, Wastewater sludge and ASH as risk construction materials by J.J. Blynas and V. Pranaitytė
13. Albert Díaz-Guilera, Dynamics and communities by A. Diaz-Guilera and A. Arenas

Contents

ONCE-CS Action and European Complex Systems Society

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A short description of the European Complex Systems Society and of the open ONCE-CS Coordination Action will be given.

The purpose of the European Complex Systems Society [1] is to promote the development of all aspects of complex systems science in the countries of Europe, in relation with the whole international scientific community. The Society aims to promote complex systems research (pure and applied), assist and advise on problems of complex systems education, concern itself with the broader relations of complex systems to society, foster the interaction between complex systems scientists of different countries, establish a sense of identity amongst European complexity scientists, and represent the European complexity community at all international levels.

The purpose of ONCE-CS [2] is to strengthen European research in complex systems, and to assist people in business and public services to use the new science with various activities. ONCE-CS stands for Open Network of Centers of Excellence in Complex Systems and is funded by the European Commission via the Future and Emerging technology unit of the Information Society Technology priority of Framework 6. It will continue the work of the Complex Systems Network of Excellence "Exystence".

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[1] http://www.open.ac.uk/ecss

[2] http://complexsystems.lri.fr/Portal

Needs and decisions in ghetto

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We consider ghetto as a community of people ruled against their will by an external power. Members of the community feel that their laws are broken. However, attempts to leave ghetto makes their situation worse. We discuss the relation of the ghetto inhabitants to the ruling power in context of their needs, organized according to the Maslow hierarchy. Decisions how to satisfy successive needs are undertaken in cooperation with or defection the ruling power. This issue allows to construct the tree of decisions and to adopt the pruning technique from the game theory. Dynamics of decisions can be described within the formalism of fundamental equations. The result is that the strategy of defection is stabilized by the estimated payoff.

High performance scientific computations and services on BalticGrid and LitGrid

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The grid computing projects BalticGrid and LitGrid aim to i) develop and integrate the research, education computing and communication infrastructure in Lithuania and the Baltic States into the emerging European Grid infrastructure, ii) bring the knowledge in Grid technologies and use of Grids in the Baltic States to a level comparable to that in EU members states with a longer experience in the development, deployment and operation of Grids, and iii) further engage the Baltic States in policy and standards setting activities. The integration of Lithuania and the Baltic States into the European Grid infrastructure will primarily focus on EGEE software and application solutions, thus automatically enabling our scientists to use suitable research software. Nevertheless, experiences and developments in other Grid efforts, such as DEISA, CoreGrid, CrossGrid, NextGrid and SIMDAT will also be considered.

The BalticGrid deployment and its ability to foster enhanced research collaborations will be validated through supporting and implementing scientific computing applications from high-energy physics (including statistical data analysis, production of Monte Carlo samples and distributed data analysis, nuclear and sub-nuclear physics, and many-body problems), material sciences (including atomic and molecular structures, modelling of advanced technological materials) and bioinformatics. The LitGrid applications will include in addition computing tasks for astrophysics, for atom and molecule level computations, modelling of self-formation processes, computational geometry of free and two-sided surfaces, modelling of hydro-ecological processes and wave impact in shallow waters, some other tasks. Such decisions will support the collaborative efforts of scientists in this highly distributed community with needs to share data from many sources and a diverse set of tools.

The relatively new idea for grid applications, expressed as "Special Interest Groups", emphasizes services on grid infrastructure and is designed to improve communication among many separate research groups, having similar or related R&D interests. Research areas under consideration are: Baltic sea eco-system modelling, Text annotation service, Text-to-speech service, Stellar spectra computation, Atomic and nuclear computations, Computational modelling of heterogeneous processes. These applications will be designed and implemented as high level e-services, providing to scientists and other Grid users: wide variety of data sources of interest; description of processes; description of explicitly recorded knowledge; explicit knowledge-processing services; understanding and description of networks that exist between scientific practitioners; knowledge descriptions that can be asserted or generated in their own right so that they can be found, linked and reused.

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[1] http://www.balticgrid.org.

[2] http://www.litgrid.lt.

Gain-loss asymmetry in stock markets: Empirical facts and model based explanation

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It is well known and documented that asset prices varies from day to day, both relative to each other, but also due to collective movements of the overall market. In theoretical finance, and if market trends can be neglected, such variations are traditionally modelled by (unbiased) geometric Brownian motions, *i.e.* the logarithm of the asset price is consistent with a Brownian process. Under such circumstances, the price process is fully symmetric, and equi-sized gains and losses, in particular, have the same probability of occurring.

It has recently been shown that such symmetry is broken for real markets [1]. One illuminating way to illustrate this fact, is to consider the typical waiting time needed for a price variation to reach a predetermined (return) level [1, 2]. By this so-called inverse statistics, one for real (index) market data, like the DJIA, SP500, NASDAQ *etc.*, observes a pronounced *gain-loss asymmetry* [2]. We stress that this asymmetry is not caused by an overall market growth (trend), that consequently would reduce the waiting times for gains. To the contrary, losses are consistently found to occur faster than the equivalent gains. When considering single stocks of the analyzed index, however, one does surprisingly *not* find any asymmetry between the waiting times of gains and losses. The key problem is thus to understand how an index, can possess a gain-loss asymmetry while the individual stocks making out the index do not.

Our suggestion for a possible explanation for these findings is a *synchronization* mechanism between individual stocks, and we present a basic minimalistic *fear-factor* model to illustrate its consequence. This model consists of a number of randomly fluctuating (symmetric) stocks that occasionally synchronize their short term draw-downs as parameterized by a "fear factor". It explains empirical findings, indicating that synchronization (or collective moments) of (symmetric) individual stocks may be an important ingredient in the understanding of the partly asymmetric stock index dynamics. In particular, it demonstrates that local single stock symmetry and global asymmetry in the index can be explained by occasional (and shortly lived) synchronous draw-downs of the stocks of the index.

[1] I. Simonsen. M. H. Jensen and A. Johansen, Eur. Phys. J. **27**, 583 (2002).

[2] M. H. Jensen, A. Johansen and I. Simonsen, Physica A **324**, 338 (2003).

Critical phenomena in portfolio selection

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Rational portfolio selection is seeking a tradeoff between risk and expected return, by optimizing the risk functional over the portfolio weights, given the expected return and other constraints. In real life the risk functional is not given in advance, but has to be estimated from observations on the market. Since the size N of banking portfolios (i.e. the dimension of space in which the minimum is sought) is large and the number of observed data (the lengths T of the time series for the various assets) is always bounded, we never have a sufficient amount of information to reliably reconstruct the underlying stochastic process and estimate the risk functional. Our estimates of risk will, therefore, fluctuate from sample to sample, and the weights of the optimal portfolio will fluctuate along with them. This problem has long been known in finance, and a large number of noise reduction techniques have been developed to deal with it over the past decades, at least in the simple case when the risk functional is chosen to be the variance. Variance is not the only risk measure in use, and in some cases (e.g. for fat tailed distributions) it can even be grossly misleading. Noise reduction techniques for alternative risk measures are either much less developed or nonexisting.

We have performed a comparative study of the noise sensitivity of various risk measures (variance, mean absolute deviation, expected shortfall, and maximal loss) recently. We have found that the noise sensitivity strongly depends on the ratio N/T, and that different risk measures exhibit very different sensitivity to the same noise. We have also observed that there exists a feasibility boundary, a critical value of N/T, for all these risk measures, beyond which the risk functional becomes unbounded, hence the optimization meaningless. This critical ratio is 1 for the variance and mean absolute deviation, 1/2 for maximal loss, and a value, smaller than 1/2 (and depending on the threshold beyond which the conditional average loss is calculated) for expected shortfall. Upon approaching this critical point the fluctuations in the estimation error of risk increase tremendously: the average error diverges, so does also the variance of its distribution. The weights of the optimal portfolio for a given sample also show strong deviations from their ideal values, with the variance and all the higher moments of their distribution diverging as one approaches the critical point.

These critical indices associated with these divergences seem to be universal, i.e. independent of the structure of the market, whereas the prefactors of the scaling laws do depend on the covariance structure (predominantly positive correlations enhancing, negative ones decreasing the strength of the divergence).

When short selling is excluded (or any other constraint is applied that makes the domain over which the optimum is sought finite) sample to sample fluctuations can obviously not diverge. In these cases the instability of portfolio selection manifests itself through some or most of the weights sticking to the boundaries defined by the constraints. In the case of a ban on short selling this leads to a spontaneous reduction of the portfolio size. Clearly, in these cases the solution is determined more by the constraints than by the objective function. These observations are highly relevant for portfolio selection, especially in the cases where no efficient filtering techniques are known.

The observed critical phenomena in portfolio selection ares related to (and represent a simple class of) the critical phenomena discovered in complex optimization problems recently.

This work has been supported by the "Cooperative Center for Communication Networks Data Analysis", a NAP project sponsored by the National Office of Research and Technology under grant No. KCKHA005.

Self-organized criticality model of the nuclear fuel structure evolution

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Nuclear fuel is a unique system where complex processes of nuclei fission by neutrons, release of heat, accumulation and migration of fission products (FPs) occur. Fresh nuclear fuel is a polycrystalline material composed of UO_2 grains changing during the burnup process. FPs are generated during the fuel irradiation in the whole volume of fuel pellets. Some of them, especially noble gasses tend to precipitate into small intra-granular bubbles in UO_2 matrix [1]. They trap migrating FPs and thus hinder their diffusion to grain boundaries. It is realized that increasing porosity of the fuel with the burnup has direct influence to the FP release [1].

Here we suggest exploring the analogy between the nuclear fuel bubbles during fuel burnup and the species in natural evolution due to the self-organized criticality model (SOCM) [2]. According to the SOCM the worst adopted species are subjected to mutation, while in the present model the largest bubble has the highest probability to change as it can simply be destroyed by a fission fragment. Recently 1D model of FPs bubbles evolution in nuclear fuel has been considered in [3]. Here we apply the 2D model for the fuel structure representing it as an array of different size FPs bubbles with periodic boundary conditions. The largest size bubble is selected and undergoes mutation, as well as neighbor bubbles sufficient number of times. In this process the system evolves into critical steady state in which correlations in space and time between events are distributed without any characteristic scale. We get the distribution of bubbles in space generated by the SOC model. For checking the relevance of the proposed model we directly compared the simulated bubble structures to the actual micrographs [4] of UO_2 fuel pellet cross-section surface of various burnup and surface preparations. Particularly, the similarity of the model to the experimental structures at different burnup levels is attained when adjusting the relevant number of the neighboring bubbles undergoing mutation together with the critical bubble. Developing this model we speculate that the microstructure of the nuclear fuel in irradiation conditions is in self-organized critical state and its evolution takes place via local avalanche processes.

[1] R. J. White, J. Nucl. Mater **295**, 133–148 (2001).

[2] P. Bak, K. Sneppen, Phys. Rev. Lett. **71**, 4083–4086 (1993).

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[4] I. Antoniou, E.P. Akishina, V.V. Ivanov, B.F. Kostenko, A.D. Stalios, Chaos, Solitons and Fractals **18**, 1111–1128 (2003).

Critical exponents of 3D Ising model from theory and large–scale MC simulations

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We report the results of Monte Carlo simulations of 3D Ising model near criticality for linear lattice sizes up to $L = 640$. Our aim is to verify the essentially different predictions for the values of the critical exponents made by the perturbative RG theory [1] and our method of grouping of Feynman diagrams [2]. We evaluate pseudocritical couplings which correspond to a given value of the Binder cumulant and estimate the true critical coupling by fitting these data. We look how the effective critical exponents evaluated either at the critical or at the pseudocritical coupling change with the lattice size. It allows us to control visually the systematic deviations in the results depending on the lattice sizes used in simulations and to estimate the asymptotic values of the critical exponents by a suitable fit (extrapolation). The usually reported values of the critical exponents appear to be effective rather than asymptotic. Although the currently simulated effective values come closer to the RG ones, the plots of the effective exponents apparently deviate from the RG values towards those found in [2]. It is best seen in the case of the critical exponent η calculated from the susceptibility data at the critical point. We compare this behaviour with that of the effective exponent ν evaluated in [3] from the known experimental data for the superfluid fraction in liquid helium very close to the λ–transition point.

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[2] J. Kaupužs, Ann. Phys. (Leipzig) **10**, 299–331 (2001).

[3] J. Kaupužs, Eur. Phys. J. B **45**, 459–463 (2005).

Organized complex system as informational closed-loop coding-decoding control system

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The concept of the organized complex systems constructed on the informational closed-loop coding-decoding control (CL-CDC) principles is represented (Fig1). Phenomenon of informational control appeared on the Earth 3–4 billion years ago, when the life originated. Informatics paradigm considers the physical and chemical transformations of energy and matter as flows that are controlled, or as the signals that are means used by purposive informational control programs. The social and technological informational control systems are a latter phenomenon. The information is born in control systems of organized systems. The organized systems are represented as organizationally closed and mater-energy-information open CL-CDC structures. This look to organized systems emerges from concept of modeling relation by R. Rosen and J.L. Casti that was interpreted on base of W. Powers Perceptual Control Theory (PCT) [1,2,3]. The latter development of this interpretation is CL-CDC scheme that expresses more general understanding of organized systems [4-7]. The living and social systems are a kind of organized systems, but the class of organized systems includes some systems developed as pure technical systems (e.g., robots). According CL-CDC scheme the natural system N of real world sphere may be represented by encoding (coding) procedure on the formal (abstract, mathematical, virtual, computer) world sphere F as model of N. Model or formal system F operates with special rules. Coding should be understood as a reflection of a real system (nature or a technological process) in an abstract virtual form on memory structures (DNA, hormones, neural networks, programs, books, etc.) in such a way, that the re-reflection (decoding) from the abstract to real would be possible. The coding procedure corresponds to observations, measurements, analysis, representations or reflections on memory structures. Accordingly, the decoding procedure is de-reflection or synthesis of natural system N under informational control of model in formal system F. The decoding accompanies procedures of interpretation, control, prediction, synthesis and anticipation.

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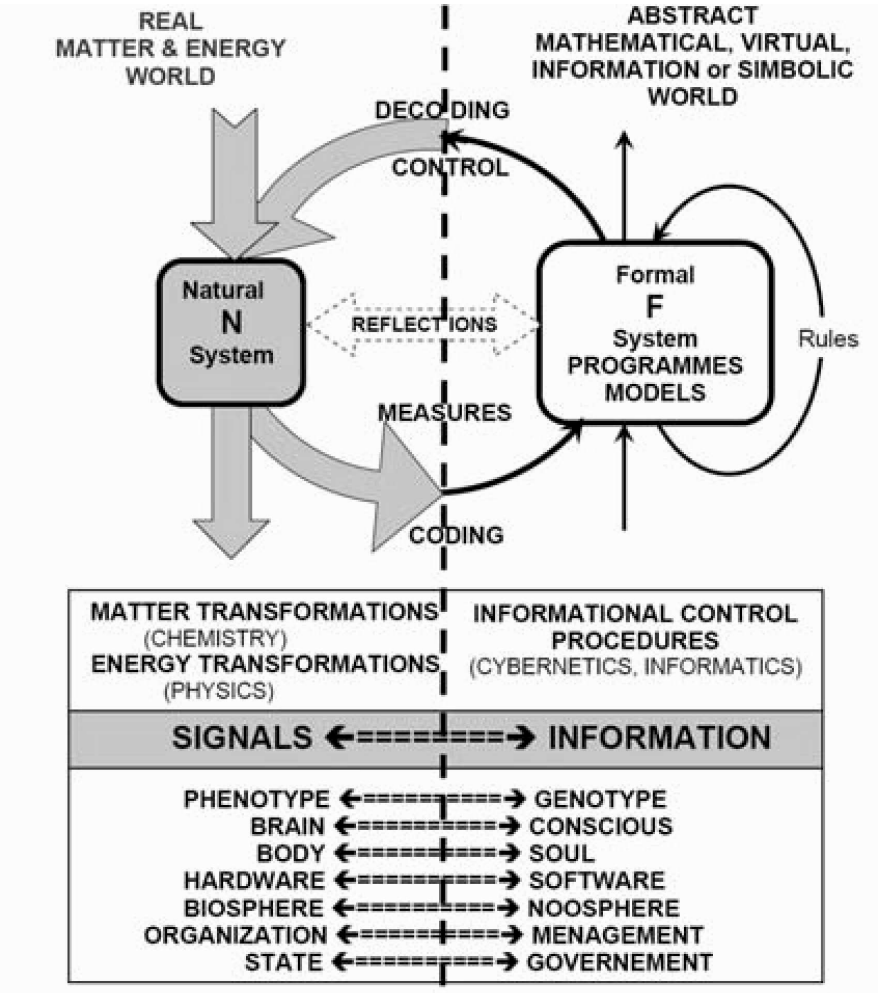

Individual decisions under risk: an investigation of observational economics

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We investigate individual decisons under risk. Our approach is to select a series of conditions occurring in a well defined environment in which individual decisions are taken under risk. The detected outcomes are used to infer about the expected utility function [1] perceived by individuals under different risk conditions. Differently than in typical experiments reported in the economics literature [2, 3] the observed decisions are taken by ordinary people and are involving real money. In some cases, the amount of money can exceed the value of a yearly average income.

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Macro-econometric modelling of the Lithuanian economy: from outer experience to data-consistent approach

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One way to analyse a complex macro-economic structure of a country is to use the macroeconometric modelling, which describes the aggregated relationships of an economic system econometrically, i.e., using a system of parametric regression functions. Differently from high-frequency analyses the macroeconometric modelling in general is related to a very limited number of data available: usually, yearly or quarterly data are used. For instance, due to changes of the national accounting methodology the data in Lithuania are available, at best, since 1995. Therefore modelling here started from adapting/imitating the established models and utilizing the experience gained by other countries without leaning much on the statistical analysis. However, this approach is not necessary consistent with the particular structure of the economy and the actual data and it is furthermore complicated by the transition process-caused instable relationships and various structural breaks (like the Russian crisis, the EU accession), etc.

Recently the macroeconometric modelling activities increased significantly in Lithuania providing new models that were used, e.g., for the pre-accession assessment of the impacts of the EU integration on the Lithuanian economy due to trade liberalization, migration, etc.; to evaluate the effects of alternative use of the EU structural funds. As distinct from the first set of models, the recent ones lean more on modern econometric approach including cointegration theory and stress more the empirical adequacy of the estimated relationships. However, the small number of data available is still the main obstacle that precludes using some widespread econometric techniques, e.g., the maximum likelihood-based Johansen cointegration testing procedure, or, at least, the traditional set-up of the procedures.

The issue here is not only that the limited number of observations imposes restrictions on the number of parameters available to estimate, but also that the asymptotic properties, e.g. superconsistency of the ordinary least squares estimator in the cointegrating relationships, cannot be relied here upon. Therefore one cannot ignore and should utilize any information that helps to avoid potential misspecifications even if asymptotically they were irrelevant.

We review the main developments of the publicly available macroeconometric modelling activities in Lithuania after regaining of independence in 1990 and, leaning on the experience gained in building a set of the Lithuanian macroeconometric models (the LEMM project) and, particularly, by constructing the structural vector error correction model (SVECM) of the main macroeconomic indicators, we discuss the econometric specification issues, including the importance of the lag structure of cointegrating relationships, of the econometric relationships under the constraint of small number of observations.

Size matters: Some stylized facts of the market revisited and consequences for fluctuation scaling

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We reanalyze high resolution data from the New York Stock Exchange and find a monotonous (but not power law) variation of the mean value per trade, the mean number of trades per minute and the mean trading activity with company capitalization. We show that the second moment of the traded value distribution is finite. Consequently, the Hurst exponents for the corresponding time series can be calculated. These are, however, non-universal: The persistence increases with larger capitalization and this results in a logarithmically increasing Hurst exponent. A similar trend is displayed by intertrade time intervals. Finally, we demonstrate that the distribution of the intertrade times is better described by a multiscaling ansatz than by simple gap scaling. The consequences for the recently found fluctuation scaling are discussed.

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Lotka-Volterra like lattice and a 2-D Ising model applications to social systems

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In this talk we briefly summarized the results obtained with a Lotka-Volterra (LV) like lattice of agents interacting among them in collaborative or competitive scenarios, with a "lattice neighbor structure and hierarchy" [1] as well as an Ising model (IM) of interacting agents [2].

In the LV case, we found specific configurations for which agents tend to polarized opinions and contrarians agents appear naturally. Also, higher neighbor structures have been simulated, for which contrarian patterns emerge dynamically. In all cases the initial conditions of the lattice are randomly taken. Hung and conflictive scenarios are discussed.

For the IM we take advantage of the clustering properties of this model, to show how "policies" represented by the external fiel, can modified the agents behavior, in order to move them from "out" to "in" Information and Communications Technologies (ITC).

In both models, the number of interacting neighbor agents lead to different final configurations.

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Wealth distributions: a review of models and empirical data

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We review briefly approaches aimed at understanding the distribution of money in society since the first studies by Pareto at the end of the 19th century. Data for UK income distributions over the period 1992 to 2002 is examined in detail and compared with the log-normal, Boltzmann and generalized Lotka-Volterra distribution functions. We conclude that the Lotka-Volterra model is the superior model giving a good fit to the data over the whole range unlike the Boltzmann and log-normal functions. It is not necessary to invoke different mechanisms to account for data in the low and high income regions as is believed by some researchers.

Multifractality and self-similarity in the Baltic States market

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Foreign financial markets and their challenges were always of top interest for stock brokers. The new investment opportunities emerged after expansion of the European Union in 2004. Undiscovered markets of the Baltic States and other countries of Central and Eastern Europe became very attractive for investors. Unbelievable growth of the gross domestic product (GDP) 3-8% (average of the EU is 1.5-1.8%) and high profitability overcame the risk. But a deep multifractality and self-similarity analysis has not yet been made in those markets. For a long time it has been known that financial series are the source of self-similar and multifractal phenomena and numerous empirical studies support that. In this paper, we focus on the analysis of multifractality and self-similarity of daily stock returns of the Baltic States. Financial series in the Baltic States bear two very important features (compared with the markets of the USA and EU):

1. Series are rather short: 10–12 years (not exceeding 2000 data points), but only recent 1000–1500 data points are relevant for the analysis;

2. A stagnation phenomenon is observed in empirical data (1993–2005). Stagnation effects are characterized by an extremely strong passivity: at some time periods stock prices do not change because there are no transactions at all.

To avoid the short series problem, we use the bootstrap method. The bootstrap is a method for estimating the distribution of an estimator or test statistic by treating the data as if they were the population of interest. In a word, the bootstrap method allows us to "make" long enough series required in multifractality and self-similarity analysis from the short ones.

The second problem, called a "daily zero return" problem, is more serious than it may seem. The Baltic states and other Central and Eastern Europe countries have "young" financial markets and they are still developing, financial instruments are hardly realizable and therefore they are often non-stationary, and any assumptions or conclusions may be inadequate when speaking about long-time series. Stagnation effects are often observed in young markets. In such a case, the number of daily zero returns can reach 89%. A new kind of model should be developed and analyzed, i.e., we have to include one more additional condition into the model, — the daily stock return is equal to zero with a certain (rather high) probability p. Anyway, this problem may be solved by extending a continuous model to the mixed one, where daily returns equal to zero are excluded from the series when estimating the stability parameters. The series of non-zero returns are fitted to the stable distribution. Stable parameters are estimated by the maximal likelihood method. Goodness of fit is verified by the Anderson-Darling distributional adequacy test. The stability is also tested by the homogeneity test, based on the fundamental property of stable laws. The summation scheme is based on the bootstrap method in order to get larger series. Multifractality and self-similarity are investigated through the behaviour of the absolute moments. The Hurst analysis has been made by the R-S method.

Statistical models of social systems

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In the last years, some statistical models of social systems have been introduced, sometimes directly inspired by economic and social theories, which bear a close resemblance to microscopic physical models of many-body systems [1]. In these models the complex interactive nature of an economic system is given a simplified coarse-grained description in terms of agents, defined by a small number of parameters, who exchange e.g. wealth [2]. The challenging and peculiar feature of such models is the ability to reproduce in some respects real economic systems, e.g., in the shape of the wealth distribution [3].

In our contribution we review some features of these models. We then introduce some generalizations, illustrate the corresponding (generalized) mechanical analog and show how they lead to very similar stationary wealth distributions. We suggest a general theoretical formulation for the equilibrium state which provides an analytical expressions for the stationary distribution. Comparison with actual wealth distributions of some European countries is carried out.

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Stock market behaviour for different time intervals with different volatility levels

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Stock markets are traditionally classified into two groups labelled as mature and emerging; the latter of more interest for investors because they offer higher returns for higher risks than the more stable mature markets. Emerging and mature markets exhibit the properties of persistence (long-term memory) and anti-persistence (intermediate memory) respectively [1–3]. In order to ascertain the relevant mechanism to meet conditions of stability, liquidity, efficiency and risk-return balance, the appropriate market aspects for stability and risk must be examined. In general, financial stability is affected by extreme shifts in volatility and we expect major events to demonstrate either gradual shifting over time or catastrophic extremes, depending on the nature of the event.

In order to examine such volatility features, we have developed a new method, based on the discrete wavelet transform (DWT), combined with analysis of fractional Gaussian noise (fGn). This is used to obtain the Hurst exponent, (H), and identify stock market type, classified by memory, (*persistent* or *anti-persistent*) over time periods with crises (high volatility) and without crises (low volatility). We apply this method to the daily return series of eight stock markets, namely Canada, Hong Kong, Ireland, Japan, Portugal, Singapore, the UK and the US, for intervals of three years from 1993 to 2004. The results suggest that different markets show differing degrees of *persistence* and *anti-persistence* (hence memory) depending on the volatility of the period analysed.

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Modeling long-range memory trading activity by stochastic differential equations

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The characteristic feature of the most existing models of the trading activity, trading volume and volatility usually is the short-range memory. Conversely, empirical data of the financial markets exhibit evidence of the long-range memory [1, 2]. Most of proposed models apply generic multiplicative noise responsible for the power-law probability distribution functions (PDF), whereas the long-range memory aspect is not accounted in the widespread models [3] with empirically fitted PDF. The additive-multiplicative stochastic models of the financial mean-reverting processes [4] provide rich spectrum of power-law probability distributions, depending on the model parameters, however, do not describe the long-memory features.

We will present the stochastic model of the trading activity with the long-range correlations. The model is based on the stochastic multiplicative point process model for the flow defined as $I(t) = a\sum_k \delta(t - t_k)$, where a is an average contribution of one transaction at the time moment t_k to the financial data, with the explicit formula for the power spectral density $S(f)$ and PDF $P(I)$ of the flow [5] and is related to the nonlinear stochastic differential equations [6]. The trading activity over time interval τ_d in this model is defined as $N(t) = \int_{t+\tau_d}^{t} I(t)dt$. Preliminary version of the model described by the iterative relation for the interevent time $\tau_k = t_k - t_{k-1}$ was proposed recently [7].

Some new results for the trading activity and power spectral density of the point process models with the interevent time τ_k generated by equations

$$\begin{aligned} \tau_{k+1} &= \tau_k\left(1 + \sigma^2 + \sigma\varepsilon_k\right), \qquad \tau_k < 1, \\ \tau_{k+1} &= \tau_k + \frac{\sigma^2}{\tau_k} + \sigma\varepsilon_k, \qquad \tau_k > 1, \end{aligned} \tag{1}$$

and

$$\tau_{k+1} = \tau_k + \sigma^2\left(\frac{1}{4} + \frac{\tau_k}{1+\tau_k}\right) + \sigma\sqrt{\tau_k}\varepsilon_k, \tag{2}$$

are given in Figure 1. Here ε_k are normally distributed uncorrelated random variables with a zero expectation and unit variance and σ is a standard deviation of this white noise.

In this contribution we will present a more detailed description of the trading activity by the stochastic nonlinear differential equations for different variables reproducing the power spectra and PDF of the financial market characteristics. This enables us to describe the stochastic interevent time as the modulated Poisson process with the slow diffusion of the mean interevent time. Calms and excited stages of the market can be distinguished in our model. This leads to the inefficient market hypothesis with the stochastic dynamics of the interevent time and of the trading activity.

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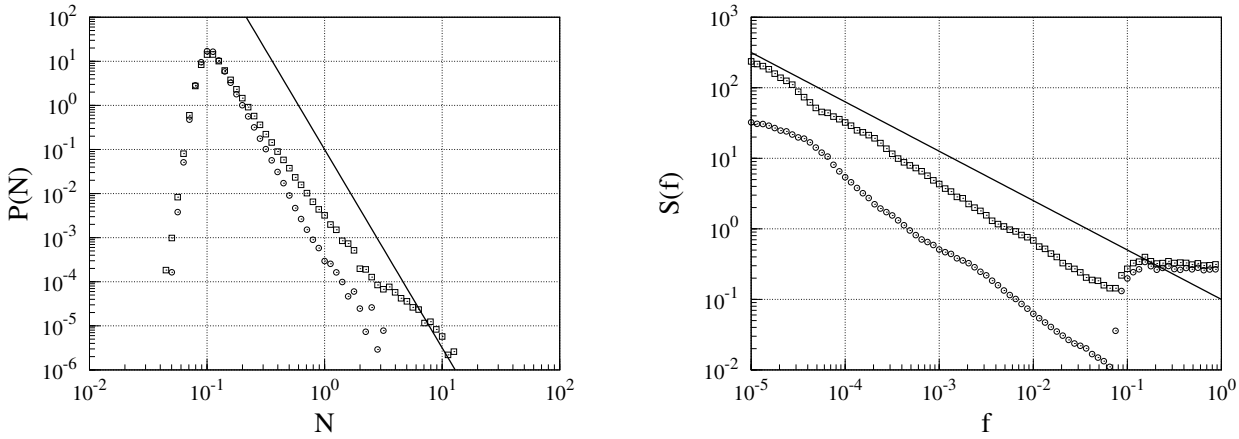

Figure 1: PDF $P(N)$ and the power spectral densities $S(f)$ of the signals generated by Eqs. (1), open circles, and by Eq. (2), open squares, with $\sigma = 0.1$ and $\sigma = 0.02$, respectively. The solid lines indicate the distinctive dependencies observable in the financial markets.

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Analytical and a microstructure analysis of stock pinning

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The paper investigates the effect of hedging strategies on the so called pinning effect, i.e. the tendency of stock's prices to close near the strike price of heavily traded options as the expiration date nears (Ni *et al*, 2005). This effect has been studied by Avellaneda and Lipkin (2003) who propose an explanation of stock pinning in terms of delta hedging strategies for long option positions. We revise the argument of Avellaneda and Lipking in view of the model introduced by Frey and Stremme (1997). We show that pinning is driven by two effects: a hedging dependent drift term that pushes the stock price toward the strike price and a hedging dependent volatility that decreases as the stock price approaches the strike price. In the first part of the paper we calculate the pinning probabilities as a function of the different parameters of the model. In the second part of the paper we study pinning in a simulated microstructure model (Daniels *et al*, 2003) and analyize if pinning is affected by the same mechanisms described in the theoretical models.

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From topology to dynamics in generic content based networks

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Both static and dynamic networks presuppose a certain amount of shared information for the establishment of connections or interactions. A content-based model [1,2] represents the information associated with each node by one or more a Boolean strings. The rule for the formation of a bond between a pair of nodes calls for the matching of a "key" string with a substring of the corresponding "lock." This elementary rule is very generic. By varying the distribution of the information associated with the nodes, one may independently modulate different topological properties of the network[3,4], such as the degree distribution, clustering coefficient or the k-core decomposition[5]. Defining Random Boolean Functions at each node we investigate the interplay between the topology and dynamics[6], which turn out to be more robust than for random scale free networks[7].

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Business fluctuations in a credit-network economy

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We model a network economy with an inside credit (commercial credit) between firms of different productive sectors, and an outside credit (bank credit), which lends credit to industrial sectors (Stiglitz, Greenwald, 2003). Failure of fulfilling debt commitments could lead to bankruptcy chains. If debt commitments are not fulfilled, bad debt increases and the rate of interest may increase as well. The interest rate increase leads to more bankruptcies: "the high rate of bankruptcy is a consequence of the high interest rate as much as a consequence of it" (Stiglitz, Greenwald, 2003: 145).

If future is uncertain, what probability is there that the contract will be fulfilled? Are there major consequences of a small shock? This paper will show in what way a business cycle is linked to company bankruptcies and how a domino effect (a crescendo in terms of bankruptcy) can arise (and as such be avoided). At the same time, the main facts of firm demography (like power law distribution of size and Laplace growth rates of firms) emerge endogenously (and are more resistant to external shocks.) As opposed to previous models of business cycles, in our model, avalanches are due to the interdependence of the output of a firm on supply and payments from other firms. Similarly to the self-organized criticality inventory cycle proposed by Bak et al. (1993), in our model, small shocks fail to cancel at the aggregate level so that large economic fluctuations can occur even without aggregate shocks. According to Bak et al. (1993), we model productive relationships among agents as local interactions (with a different network topology). In addition, we consider firm-bank and firm-firm credit relationships that can amplify the effects of small idiosyncratic shocks on the aggregate.

Heterogeneous agent interaction has a second major implication. We will see that the structure of aggregate behaviour (macro) actually emerges from the interaction among the agents (micro). In other words, statistical regularities emerge as a self-organised process at the aggregate level. Complex patterns of interacting individual behaviour may generate certain regularity at the aggregate level (Delli Gatti et al., 2005). The idea of representing a society by one exemplar (a representative agent) denies the fact that the organizational features of the economy play a crucial role in explaining what happens at the aggregate level (Kirman, 1992). The idea of a snowball phenomenon in which the bankruptcy of one firm somehow affects the financial conditions of the other firms forcing the most vulnerable among them into bankruptcy is not new in economic literature. In this paper the idea is framed in the context of a network of economy in which firms are linked by production and commercial relationship. The bankruptcy of a firm makes banks less willing to extend loans to other firms. A reduction of credit to a firm or an increase in the interest rate charged affects the willingness and ability of that firm to supply commercial credit to its customers. As its customers are adversely affected, they transmit the contraction of credit on to their customers, and so forth around the economy. The higher interest rates charged by suppliers imply higher bankruptcy probabilities for these firms and this in turn induces banks to cut back on their credit.

Our analysis has shown how the decision to provide credit by both banks and firms are interrelated. While the initial impact of monetary policy is on bank behaviour, we showed the interactive play

between the choices made by banks, the choices made by firms in their role as providers of credit, and the choices made by firms in their role as producers.

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Distance dependent bond percolation in a geographical network model

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The robustness of spatial networks is studied by analyzing a simple model of bond percolation on a 1d-lattice. To take into account the increased vulnerability of long-range links, the network is constructed by sequentially connecting random nodes to their nearest unconnected neighbours. It is shown that a giant component never forms in this model. The addition of a proportion of small-world shortcuts, however, leads to another class of percolation behaviour, more similar to that of a random graph. Growing the network by choosing nodes preferentially instead of randomly does not change the results significantly.

Weak ties in social networks

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The social network sets the scene for interpersonal activities but, beyond our visibility, also affects which job offers and flu viruses we may come across. The ubiquity of mobile phones provides an unprecedented opportunity to collect enormous amounts of quantitative data on one-one human communication. We construct a weighted social network from this data and show that link weights, reflecting the strength of interactions, are coupled to the topology of the network. The local structure of the network is compatible with the weak ties hypothesis, i.e. strongly connected communities are weakly connected to other communities. We probe the global organisation of the network by taking out links according to different thresholding schemes, observing phase transitions depending on which links are removed.

Adaptation of multi-agent populations to environmental changes

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Due to non-linear character of processes that are typical in inanimate and animate nature, chaotic phenomena and changes of environments are inherent features of the life. Essential feature of individuals and populations is an ability to adapt to sudden ecological and social changes rapidly, fulfill necessary requirements and to survive. Doubtless, the changeability of the environments and an ability to adapt to changes are among main driving forces of species evolution. Presently the necessity to adapt rapidly becomes one of most important obligations while developing modern robots and intelligent computer programs. In analysis of present-day social, trade and industry problems, one also needs to create mathematical models capable to adapt to unexpected changes rapidly.

In major part of investigations, typically, a single, the static pattern recognition task is used to train decision making algorithm realized by artificial neural network [1]. In a new approach, a large number of different intelligent agents and lengthy sequence of distinct recognition tasks with diverse characteristics are used while training a population of decision making algorithms. This approach is based on a recently discovered fact that while training simple adaptive elements, a nonlinear single layer perceptron connections weights are increasing and slows down ensuing training process [2]. New analysis paradigm was started in [3] where two different recognition tasks model was suggested to analyze aging problems of the intellectual agents, individuals, groups of individuals or social groups. New definition of aging was suggested: *the aging is an inability to adapt rapidly to the changed situation and survive.* Such definition is suitable to characterize the aging in biology and zoology. It fits also for technical systems, including computer software. It could be applied to characterize aging in economics and sociology as well. It was shown that a noise injected to training signals (both to input vectors of the perceptron and desired outputs) prevents excessive growth of the algorithms weights. Thus, it speeds up re-adaptation of the perceptron to solve a new, the changed, pattern recognition task.

We show that while solving two category pattern recognition problem by means of non-linear single layer perceptron, a difference between the desired outputs (target values) of the perceptron (called a stimulation) affects training speed: with an increase in the stimulation strength, training speed increases at first, saturates and then starts decreasing [4]. If a feedback chain is used to control magnitude of the stimulation in neural network training, it could be interpreted as "synthetic emotions" which if correctly determined speed up the adaptation process [5].

In principle, long-lasting sequences of numerous pattern recognition tasks could be considered: the pattern recognition tasks are changing one after another [6]. *Each time, training process starts from previous weight vector.* To help artificial populations to withstand lengthy series of environmental changes (catastrophes), populations with offspring and inheritance of a noise level control parameter have to be created. In artificial population paradigm, different agents possess diverse levels of a noise injected to training signals. It is shown that the optimal values of the noise level follow variations of environmental changes. To improve survivability of offspring, "mothers training" could be introduced. The new analysis paradigm points towards constructive effects of criminality and provided the functional explanations of atypical trends in criminality in East- and Middle European countries in recent years [7].

We also may consider effects of learning parameters that could be interpreted as altruism and collaboration of agents in the population [8]. We demonstrate an influence of environmental changes, their magnitude, period of activity, etc. Utilization of uncomplicated adaptive agents, the single layer perceptrons, allows investigating large multi-agent agents during lengthy time period and obtaining a general look at the adaptation problem in changing environments. We found that even such simple model confirms that division of the agent population into several groups, altruistic behavior of agents inside a group allows the adaptive agent population to overcome more powerful environmental catastrophes. Simulations show that a requirement to accumulate "supplies" are beneficial for survival, as well as moderate altruism level, the number of groups in the agent population and even different number of agents in distinct groups. In sum, the new analysis paradigm allows to analyze positive and negative effects of such "human factors" as stimulation, emotions, variety of value systems, criminal behavior and the group interests.

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Exo- and endo-genous shocks

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The response of music and book sales to an external field and to buyer herding is presented. We distinguish endogenous and exogenous shocks. We focus on some case studies, whose data have been collected from ranking on amazon.com. We show that an ensemble of equivalent systems quantitatively respond in a similar way to a similar "external shock", indicating roads to universality features. We observe that the relaxation process can be seen as an exponential one that saturates toward an asymptotic state, itself different from the pre-shock state. By studying an ensemble of 111 shocks, on books or records, we show that exogenous and endogenous shocks are discriminated by their *short-time* behaviour: the relaxation time seems to be twice shorter in endogenous shocks than in exogenous ones, allowing for a measure of risk. We interpret the finding through a simple agent based - thermodynamic model with a dissipative force.

When sociophysics produces new physical results

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For many years now, my models of local rules driven opinion forming have been perceived by our community as mean field. Its comes from the fact that after each update, agents are reshuffled before new random groups are formed. It thus makes possible in principle for each agent to interact with any other one. That feature has been viewed as the signature of a mean field treatment, against my on going lonely claims.

To settle this basic issue, the problem is taken from the frame of Sociophysics and placed into a pure Statistical Physics context investigating the effect of spins reshuffling on the phase diagram of the two dimensional nearest neighbor Ising ferromagnet. On this basis, using Monte Carlo simulations, gradual reshuffling is studied as function of the probability p of spin reshuffling after each Monte Carlo step. The whole range from no reshuffling (Classical Ising, $p = 0$) to systematic reshuffling (Galam, $p = 1$) is covered.

The variation of the critical temperature T_c as function of p is obtained and exhibits a non-linear behavior. Critical exponents are also found to differ from both, the classical Ising case and the mean field values.The results prove reshuffling does not produce a mean field behavior. Indeed, it does not neither reproduces the classical Ising model but instead create a new universality class for the 2d-Ising model.

To conclude, it is worth to stress that for the first time the solving of a Sociophysics issue has yielded to the discovery of a new unexpected result in pure Physics.

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The EURACE project: An agent-based software platform for European economic policy design with heterogeneous interacting agents: new insights from a bottom up approach to economic modelling and simulation

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Macroeconomic policy design plays a fundamental role in social welfare and requires a coordinated application of economic policy measures, e.g., fiscal and monetary strategies, knowledge exchange, R&D incentives etc. Generally speaking, the interplay of such different measures is not completely understood and macroeconomic design follows a classical approach. Conversely, there is considerable interest in the development of an alternative paradigm to the rational representative agent model. The EURACE project (a EU funded FET Proactive Initiative, to start this May) proposes to tackle this complex problem using an innovative approach to macroeconomic modelling and economic policy design within the agent-based computational economics framework. The project objectives are characterized by scientific, technological and societal scopes. From the scientific point of view, the main effort regards the study and the development of multi-agent models that reproduce, at the aggregate economic level, the emergence of global features as a self-organized process from the complex pattern of interactions among heterogeneous individuals. From the technological point of view, the project will develop, with advanced software engineering techniques, a software platform in order to realize a powerful environment for large-scale agent-based economic simulations. Key issues will be the definition of formal languages for modelling and for optimizing code generation, the development of scalable computational simulation tools and the standardization of data with easy to use human-machine interfaces. Finally, from the social point of view, the agent-based software platform for the simulation of the European economy will have an outstanding impact on the economic policy design capabilities of the European Union. It will be a powerful tool, enabling to perform "what-if" analysis, optimizing the impact of regulatory decisions that will be quantitatively based on European economy scenarios.

Multi-asset minority games

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We study analytically and numerically Minority Games in which agents may invest in different assets (or markets), considering both the canonical and the grand-canonical versions. We find that the likelihood of agents trading in a given asset depends on the relative amount of information available in that market. More specifically, in the canonical game players play preferentially in the stock with less information. The same holds in the grand canonical game when agents have positive incentives to trade, whereas when agents payoff are solely related to their speculative ability they display a larger propensity to invest in the information-rich asset. Furthermore, in this model one finds a globally predictable phase with broken ergodicity that is absent in all previously studied Minority Games.

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Characterizing weighted complex networks in economics and society

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The key strength of the networks approach to complex systems is its ability to capture salient features of systems of interacting elements using simple building blocks, vertices and edges, which represent the elements and their interactions. This approach has produced several novel findings, ranging from the ubiquity of high clustering and fat-tailed degree distributions to the relationship between system functionality and topological features such as motifs, modules and communities.

However, in order to understand these interacting systems in detail, it is evident that information about the nature and strength of interactions should be taken into account, in addition to the underlying network structure. In several cases, this is readily accomplished by assigning weights to the edges, such as those provided naturally by fluxes in transportation networks, or communication frequencies in social networks reconstructed from electronic communication records. Likewise, correlation matrices calculated from e.g. stock return time series can be used to depict markets as weighted networks. Naturally, incorporating an additional degree of freedom to the network picture calls for novel methods of network analysis and characterization. We will discuss criteria for extending existing characteristics to take the weights into account, and some novel methods of weighted networks analysis, including characterization of weighted subgraphs and *motifs* [2]. These methods will be applied to economic networks of stock markets and a large social network dataset consisting of mobile communications records of a large number of individuals.

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A moving-average-minimal-path-length method for UE country clustering according to macroeconomic fluctuations

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The moving-average-minimal-path-length (MAMPL) method is developed in order to point out relevant correlations between macroeconomic indicators. The MAMPL is a version of the Minimal Spanning Tree, adapted to extract meaningful sequences from short and noisy macroeconomic time series. The present analysis pertains to the Gross Domestic Product and some of its sources, namely the Final Consumption Expenditure, Gross Capital Formation and Export — Import growth rates. The target group of countries is composed of 15 EU countries, data taken between 1994 and 2004, that is before the last wave of integration. The method leads to a cluster-like structure derived both from the hierarchical organization of countries and from their relative movement inside the hierarchy. The final structure proves to be stable against the fluctuations induced by the moving time window over the scanned time interval.

Bose-Einstein condensation of financial (profit-seeking) bosons

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We describe financial systems as the condensates of profit-seeking bosons, similar to the atomic Bose-Einstein condensates. We calculate equilibrium statistical distributions of the richness of the investors following from our model. The distributions follow the exponentially truncated Pareto distribution, with the power exponents in range , thus corresponding well with the empirical data. In addition we calculated the distribution of the price moves as following from our model. The distribution follows the exponentially truncated Levy distribution, with the power exponent in the range again corresponding well with the empirical observations.

The presentation is based on the recent work [1], where the above distributions are derived analytically. Two essential properties of the behavior of market participants are assumed in the derivation: 1) that the individual market participants tend to cluster, and to behave according to the opinion of majority (herding, or condensation); 2) that the market participants seek for profit. The detailed balance in the system with above two properties (the system of "profit seeking bosons") leads to exponentially truncated Pareto and Levy distributions with power exponents corresponding well to the ones observed in financial markets.

The presentation will also include an extension of the work [1], where the above distributions are checked numerically: 1) by integrating numerically the corresponding master equation for the evolution of the distributions in profit seeking boson system; 2) by Monte-Carlo simulations of the trajectories of individual profit seeking bosons.

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The nature of economic interactions

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Physicists often model economic interactions like collisions of atoms in gases: by interaction one agent gains, the other loses. This leads to a Boltzmann distribution of capital, which has been observed in wealth distributions of different countries. However, economists object: no economic agent will attend a market in which he gets robbed! This conflict may be resolved by writing basic laws of economics into terms of calculus. In these terms the daily struggle for survival of all economic systems turns out to be a Carnot cycle that is driven by energy: heat pumps and economic production depend on oil, GNP and oil consumption run parallel for all countries. Motors and markets are based on the same laws of calculus (macro-economics) and statistics (micro-economics). Economic interactions mean exploiting a third party (nature) and are indeed close to robbing! A baker sells bread to his customers, but the flour comes from nature. Banks sells loans to investors, but the money comes from savers.

Evolution of imitation structures

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We investigate emergence and properties of imitation structures in Society. The Minority Game is used as a testing bed. The agents are placed on a background lattice, which may be either regular or random graph. In the course of the evolution the agents either follow their own strategies or they imitate their more successful neighbours. Gradually, an ensemble of trees, is created, where the imitation goes along the edges. We find that the final state consist always of a single tree, but in a steady but non-equilibrium state the distribution of tree sizes is, depending on the values of the control parameters, either exponential or a power-law. We also find that the number of followers relative to the number of all neighbours increases with the number of neighbours, giving the highly connected agents double advantage. We show that the properties of the imitation structure strongly depend on the cost of the information shared among agents.

The internal structure of socium origins from immanent hazy

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Taking into account the successive acting of hierarchical operators the transition between two different states of the system can be realised by the different way.

$$a_{[4]} = \rho^{+}_{[2]} \to \rho^{\times}_{[2]} \to \rho^{+}_{[1]} \to a_{[1]} \sim \rho^{+}_{[2]}[\rho^{\times}_{[2]}[\rho^{+}_{[1]}]] \to a_{[1]}, \tag{1}$$

$$a_{[4]} = \rho^{+}_{[2]} \to \rho^{+}_{[1]} \to \rho^{\times}_{[1]} \to a_{[1]} \sim \rho^{+}_{[2]}[\rho^{+}_{[1]}[\rho^{\times}_{[1]}]] \to a_{[1]}. \tag{2}$$

It look like normally if this two different ways according to Eqs.(1, 2) give us the system with the same state. For social systems the non-permutability of these operators represents the diachronic aspect of the systems, i.e. the dependence of the system current state from its history, which is fixed in the constructions of the units of the system current level. Namely, when systems evolve by different ways, their units of given level acquire different constructions (genotypes) while their functional activities are the same in the framework of current kind of systems. In other words, to given objective various ways can lead, which produce various organizational realizations (phenotypes).

In any theory any quantity of this theory has to be interpreted as a certain limit of corresponding sequence of empirical approximations:

$$A = \lim_{n\to\infty} a_n, \tag{3}$$

where a_n is a certain statistics of the results of n measurements. In general case we could not consider these measurements as independent ones. Repeating measurements in certain conditions assumed to be unchanged may reduce an uncertainty of A in these conditions only (large numbers law).

In any quantitative theory containing some social dimension, the values such as ${}^{h}A$, where

$$\left(A - \lim_{n\to\tilde{N}} a_n\right) = {}^{h}A. \tag{4}$$

must play the significant role. If $\tilde{N} = \infty$ we obtain the definition of non-standard number.

The full system haziness is the volume of hypersphere with the centre in the exact value of non-standard number because *ver* is infinitesimal of second order. This volume *can't be present as a function of one variables*. Naturally, the full system haziness originate as a intersection of all systems halo:

$$Ver = \sum_{\otimes,\iota} {}^{G}\rho^{\times}_{[\iota]} \otimes {}^{G}\rho^{+}_{[\iota]} \tag{5}$$

and internal structure by the evolution formed according next standartization rule

$$\begin{aligned}\rho^{\times} \otimes \rho^{+} = ({}^{st}\rho^{\times} \boxtimes {}^{h}\rho^{\times}) \otimes ({}^{st}\rho^{+} \boxplus {}^{h}\rho^{+}) = \\ = ({}^{st}\rho^{\times} \otimes {}^{st}\rho^{+}) \boxtimes {}^{h}\rho^{\times} \circledast ({}^{st}\rho^{\times} \otimes {}^{st}\rho^{+}) \boxplus {}^{h}\rho^{+} \circledast {}^{st}\rho^{\times} \boxtimes Ver \circledast {}^{st}\rho^{+} \boxplus Ver.\end{aligned} \tag{6}$$

Context dependent evolution and noninformative biological sequences

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Most of current stochastic models of noncoding DNA sequence evolution assume that neighboring nucleotides evolve independently [1, 2]. However independent evolution implies that distribution of nucleotides in DNA sequences is independent of the rest of the sequence. Therefore the importance of neighbor dependencies in the substitution process has long been recognized, and several models of these dependencies have been proposed [1, 2, 4, 5]. The properties they impose on the sequences (Markovity, reversibility, long range dependence [3], etc.) are rather contradictory [6]. The validity of these properties in noncoding sequences of bacterial genomes is tested by making use of statistical methods. One can assume that mutations in noncoding regions of primitive organisms do not directly affect their vitality and hence nucleotides in these regions evolve entirely under the influence of random factors. Thus the noncoding regions can be treated as *noninformative* DNA sequences or *genetic noise*. Mathematically noninformative distribution of genetic sequences (noise) is defined as a stationary distribution of some evolutionary process of genetic sequences. In view of the statistical analysis of the bacterial genomes a simple context dependent Markov evolutionary process is proposed and properties of its stationary distribution are investigated. In particular, it is shown that in general case the genetic noise produced by this process is non-Markov random sequence. Some results of computer simulations are also presented.

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Ising model on two connected Barabasi-Albert networks

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We investigate analytically the behavior of Ising model on two connected Barabasi-Albert networks. Depending on relative ordering of both networks there are two possible phases corresponding to parallel or antiparallel alingment of spins in both networks. A difference between critical temperatures of both phases disappears in the limit of vanishing inter-network coupling for identical networks. The analytic predictions are confirmed by numerical simulations.

Dynamical complex networks of rational economical agents

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In an attempt to understand the emergence of economical networks, together with well known cyclical phenomena within these networks, we propose a model where agents interact with each other by playing the prisoner's dilemma on a dynamic network. In our model network dynamics arises since agents can not only choose their game-actions (cooperate or defect) but also are free to select their co-players. This leads to a co-evolving system of network structure and strategy patterns of players. Individual decisions are fully (!) rational and are based on local (!) information only. The updating scheme is driven by a profit maximization philosophy: Each agent computes his expected payoff for cooperation or defection, taking the neighboring agents' strategies of the previous time step as a proxy for their next choice. Apart from choosing their game-actions, it may become rational to cancel links and establish ties to new co-players.

We study the model as a function of the payoff matrix structure and re-linking rates: At each time step in the simulation a given fraction of agents re-evaluates her strategies and/or local neighborhoods. In the case of fast re-evaluation where agents re-link at each timestep, the system exhibits oscillatory dynamics: Periods of growing cooperation (and growing total linkage) and periods of increasing defection (and decreasing total linkage). The cyclical behavior disappears and the system is self-stabilized at significant overall cooperation levels when update frequencies are lowered. If update frequencies are decreased further the amount of total cooperation in the system is shown to reduce. At intermediate regions we find a regime where complex hierarchical network structures emerge together with a maximum of total cooperation in the system.

Structural properties of complex networks

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The k-core decomposition was recently applied to a number of real-world networks (the Internet, the WWW, cellular networks, etc and was turned out to be an important tool for visualization of complex networks and interpretation of cooperative processes in them. Rich k-core architectures of real networks were revealed. The k-core is the largest subgraph where vertices have at least k interconnections. We find the structure of k-cores, their sizes, and their birth points — the bootstrap percolation thresholds. I will show a derivation of exact equations describing the k-core organization of a randomly damaged uncorrelated network with an arbitrary degree distribution. This allows us to obtain the sizes and other structural characteristics of k-cores in a variety of damaged and undamaged random networks and find the nature of the k-core percolation in complex networks. These general results will be applied to the classical random graphs and to scale-free networks, in particular, to empirical router-level Internet maps. We find that not only the giant connected components in infinite networks with slowly decreasing degree distributions are resilient against random damage, as was known, but their entire k-core architectures are robust.

Disaster spreading in complex networks

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A vast majority of organization, infrastructure and communication systems can be described as complex network whose nodes represent organizations or infrastructure components, and links mimic the interactions between these components. Whereas the theory of complex networks has made considerable progress during the last years not much is known about the dynamics of disastrous events, cascading and avalanche effects in complex networks up to now.

We propose a model for the dynamics of spreading failures in networking systems. By introducing dynamical models of nodes as active elements, we can describe the time dependent spreading of disasters in a quantitative way and investigate critical parameters and topology dependence of robustness and reliability of network structures. Each node is characterized by a bistable dynamics and coupled according to the interaction strength to other nodes in the directed network. Additionally we introduce a function in the dynamic node model which mimics the ability of a node to recover from failures e.g. by repair or other measures within a certain time.

Using this modeling approach we investigated the probability of disaster spreading in extensive simulations for several network topologies and parameter settings. We have evaluated basic mechanisms that may trigger catastrophic events: At first we concentrate on the spreading of breakdowns and failures caused by extreme events external to the investigated system.

In almost all settings a nonequilibrium phase transition can be obtained. In one phase we obtain a dynamic behavior where disasters can be contained and only a relative small number of nodes is affected by an extreme event. In the other phase towards a spreading dynamics more and more nodes are involved in a catastrophic development. The transition takes place at a certain threshold in the parameter space. The critical threshold, however, depends on the connectivity and overall topology of the network as well as on the heterogeneity of the nodes (i.e. the distribution of the characteristic parameters). Beyond external influences and network topology the intrinsic instabilities of components and their internal failures may cause spreading disasters if several unforeseen failures of components coincide randomly. Considering these effects we found interesting interdependencies with respect to the best network structure.

In conclusion, our approach enables a qualitative and quantitative assessment of interaction network and infrastructure topologies with respect to dynamic effects. This allows an optimization in order to improve the robustness of networks. It gives the chance to understand the time dependence of spreading and to identify points in a challenged network or infrastructure where countermeasures in case of spreading disasters must be established within a certain time frame. Therewith it offers promising perspectives and may help to develop and improve methods of disaster management.

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Why does the age structure of the human population change?

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The dynamics of the contemporary human populations are very complicated and vary when comparing ethnic groups, nations, or different periods in populations during profound political and social transformations. Predicting changes in such populations is difficult and risky. There are many approaches used to predict the future age distribution and populations' sizes — extrapolations of trends found in analyses of life tables [1], phenomenological analyses [2], computer simulations using microscopic models [3] or formal descriptions of these microscopic models [4]. Microscopic models can incorporate some biologically justified parameters which help to understand the processes underlying the population dynamics and would also facilitate the formal description of these processes.

In Poland, after the political transformations in the last decade of the twentieth century, the increase in the expected lifespan has been accompanied by very deep decrease in birthrate, much below the minimum necessary for keeping the constant size of the population. In Russia the expected life span during the last decades seems to decrease. We have modified the Penna ageing model to simulate the profound changes in the age structures of populations caused by the changing relations between individuals and environment [5, 6]. Basing on the mutation accumulation theory of ageing we have modeled the observed changes assuming that there was no time for evolution of the genetic pool of human populations during the studied periods of transformations.

Our microscopic model describes the changes in the age structure which have already happened and predicts the future, assuming that our attitudes in respect to life style and social relations will not change. Such predictions could be very important in estimating the risk connected with planning the pension schemes and pricing life insurance instruments as well as funding the social security systems.

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Subcontracting risks in electronics manufacturing industry in China

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Nowadays companies tend to make their activities more effective and efficient by concentrating on their core competencies and by outsourcing everything else. Companies extend their subcontracting acitivities from domestic into global subcontractors when they go international. Low costs play often significant role when choosing subcontractors. In China companies try to benefit from the low cost level and vast market. The benefits provided to the companies there are significant, but partners as well as risks need to be evaluated more carefully than usual. The goal of this research is to evaluate the risks and criteria in choosing chinese subcontractors. The research material was collected by a questionnaire sent to a Finnish company which operates in electronics industry. The company has production facilities in China. The results concerning the most significant criteria for choosing Chinese subcontractor as well as the most likely risks related to that are based on this questionnaire. The results were handled by using Analytic Hierarchy Process (AHP) method. This study presents also the personnels opinions and experiences related to China and Chinese. The interviewees represented several different areas of the company. The research shows that Chinese subcontractor is chosen by evaluating delivery reliability, total costs and the level of production equipment and technology. The most likely risks are related to the quality of products and activities, subcontractors personnel, availability of products and delivery reliability. According to the questionnaire and interviews the most essential topic with Chinese subcontractors is quality. Poor language skills and different cultures cause also problems.

Random matrices and risk management

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The problem of portfolio selection is one of the most fundamental problems in quantitative finance. The risk content of a portfolio which consists of many assets is related to the statistical correlations between the assets. In practice, the information about the correlations is reconstructed from the historical covariance matrix, which involves statistical noise. We shall show how to clean the historical covariance matrix from the noise using random matrix theory.

About the risk to stick in a traffic jam

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A stochastic description of vehicular dynamics, called probabilistic traffic flow theory [1], has been developed.

Based on stochastic dynamics traffic breakdowns are described by a balance equation that models the dynamics of jam formation by two contributions: a discharge rate depending on the length of the congestion, and an adhesion rate mainly depending on the traffic volume of the considered road section. With this balance equation it is feasible to calculate the dynamics of traffic pattern formation especially the first passage time for a transition from free flow condition to congested traffic including the influence of the parameters affecting the discharge and adhesion rates.

Analytical expressions for the breakdown probability $W(q)$ in comparison with survival probability functions like Weibull distribution will be shown coupled together with empirical data points from German freeway A3 (834 breakdown observations within 5–minutes–intervals) near Cologne. First findings are shown in Figure 1.

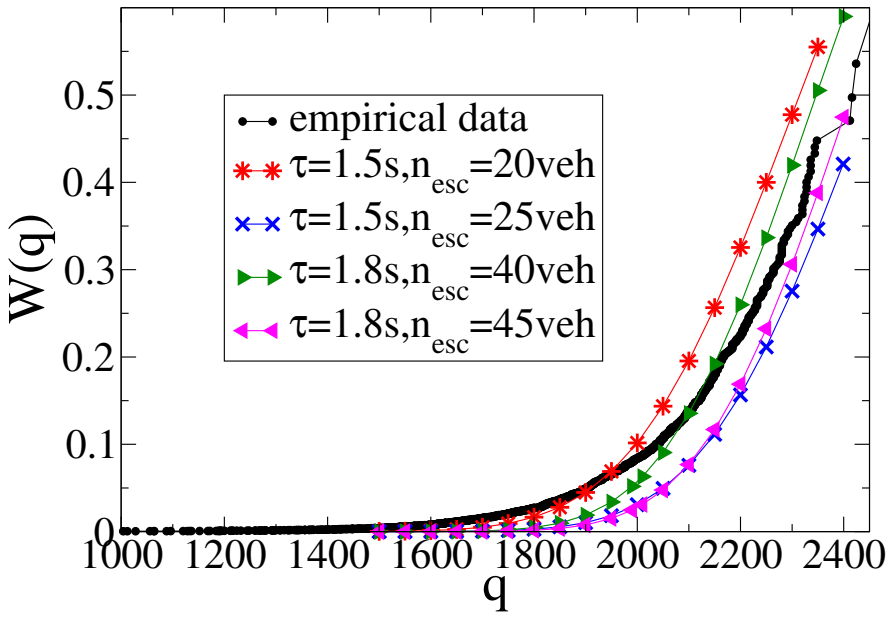

Figure 1: Breakdown probability $W(q)$ as function of flow rate q showing analytical solution from traffic flow dynamics (symbols) in agreement with measured capacity distribution function (data provided by Brilon et al., black dots).

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Public transport networks: scaling and vulnerability

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We analyze the public transport (PT) networks of a number of major cities of the world. While the primary network topology is defined by a set of routes each servicing an ordered series of given stations, a number of different neighborhood relations may be defined both for the routes and the stations. Previous studies of PT have mostly been restricted to much smaller networks and did not observe scale free behavior for which we find clear indications in the larger of the networks that we analyze. Our findings for the statistics as well as for relations between the topology and vulnerability of these networks are supported by simulations of an evolutionary model of PT networks that we propose.

Critical dynamics in nanoscale

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Critical dynamics, formally defined in terms of metastability and ergodicity breaking, is a topic of advanced research and novel applications. Problems in theory basically emerge from the violation of conventional statistics with application to behavior of higher-level object as determined from the lower - level background. Developments, reported in this work, are addressed to (i) nanoscale behavior of ferroelectric polarization and (ii) magnetization in a dot of spins. Dynamics of ferroelectric polarization is modeled in terms of microscopically large/ macroscopically small interacting blocks each of which display metastability and ergodicity breaking implemented by model Hamiltonians of growing complexity. Critical behavior is initiated by attractive interaction between adjacent blocks and the impact of thermal fluctuations. The mathematical technique is supported by symplectic integration [1] so resolving the long standing problem of polarization/electroelastic response at arbitrary driving, finite size, essential boundary conditions. A complementary approach is addressed to structures going beyond the conventional statistics. Example is critical dynamics of magnetic dot involving finite number of spins which undergoes phase transition from the paramagnetic state to the mixture of ferromagnetic states and includes spin-spin and spin-phonon coupling. Whereas the results are addressed to problems of condensed state, the mathematical technique is quite general an applicable to a rich scale of phenomena in complex systems with long-range interactions specified by nonlocal model Hamiltonians.

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Measure of complexity and photoinduced electron tunneling in photosynthetic systems of PNA based self-assembled protocells

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We used quantum mechanical electron correlation time dependent density functional theory (TD DFT) in both the Gaussian 03 and GAMESS-US packages to investigate various bioorganic systems of Los AlamosNational Laboratory (LANL) protocells based on peptide nucleic acid (PNA) in a water and fatty acid (FA) environment [1-3]. New finding from our investigation of the quantum self-assembly of various models of complex photosynthetic centers and functioning of the photosynthetic processes is the critical role played by the nonlinear quantum electron correlated hydrogen bonds and Van der Waals interactions that result from the addition of water and FA molecules. The distances between the separated sensitizer 1,4-bis(N,N-dimethylamino) naphthalene, precursor of FA (pFA) and water molecules are comparable to Van der Waals and hydrogen bonding radii and therefore we may regard the LANL protocells as single electron conjugated supramolecules. These nonlinear quantum interactions compress the overall system resulting in a smaller gap between the HOMO-LUMO and photoexcited electron tunneling from sensitizer to pFA molecules. The result is the possibility of exciting the system with a single photon possessing an energy equal of 2.82 eV (440.0 nm light) (see Figure bellow). Our last two quantum self-assembled models of the photosynthetic systems includes a PNA fragment which is covalently bonded to a [Ru(bipyridine)3]2+ or squarine sensitizer, and two pFA, six FA molecules constituting the micellar container's inner monolayer with water. The small (0.2-10 nm) differences of the experimental absorption spectra peaks in comparison with our TD-DFT calculated it is possible to understand because of more water and FA molecules exist in the real photosynthetic center of LANL protoorganisms and makes possible to search for new sensitizers. The shift of the absorption spectrum to the red for the artificial protocell photosynthetic center might be considered as the measure of the complexity of this system.

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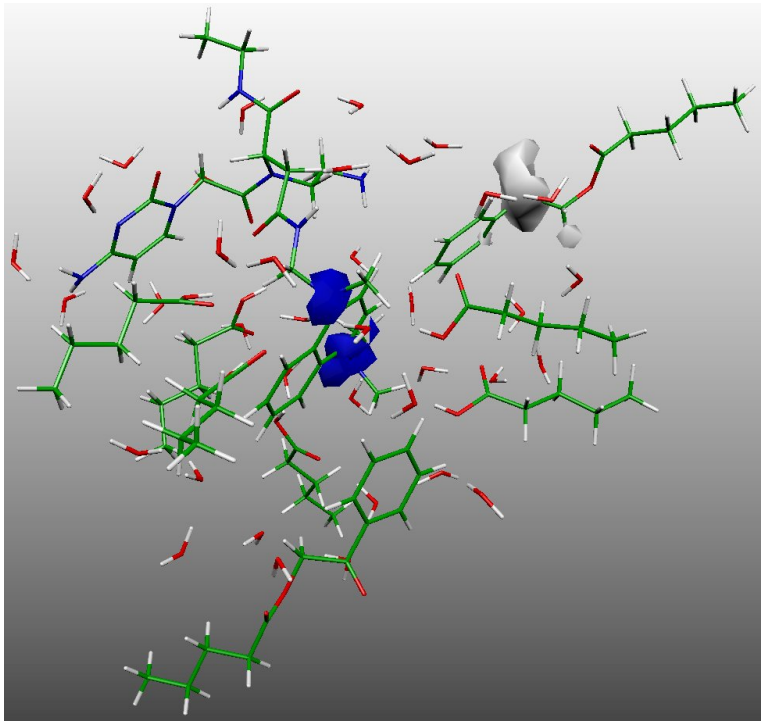

Figure 1: Visualization of the single photoexcited electron charge tunneling in the tenth excited state from the sensitizer 1,4-bis(N,N-dimethylamino)naphthalene molecule to the one of pFA molecules (top-right). Carbon atoms and their associated covalent bonds are shown as green sticks, hydrogens are in grey, oxygens — red, nitrogens — blue. Hydrogen bonds are depicted by dashed lines. The electron cloud hole is indicated by the blue color while the transferred electron cloud location is visualized by the grey color.

EOM control of the LFF chaotic behavior in an ECSL - m:n phase synchronization

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The chaotic behavior of on external-cavity semiconductor laser (ECSL) working in a regime of low-frequency fluctuations (LFFs) can be controlled by periodic electro-optical phase modulation (EOM) of light. We show by numerical simulation that for specific modulator/laser parameters the phase of the laser LFFs, which increases after each power drop-out event, can be synchronized with the phase of the modulator in a so called m:n phase synchronization.

The degree of stabilization is determined by calculating Shanon's entropy and by analizing the stability of these synchronized states. The synchronization region in the variables of the modulator, frequency and amplitude, is mapped and also the zones of periodicity, low and high amplitude chaos are identified.

There are also underlinedsome aspects regarding the methods of controlling the chaotic behavior, especially a new confirmation of m:n type phase synchronization emergent in a time delayed feedback control scheme, with numerical applications in laser physics and with potential counterpart in economical behavior.

Dynamic processes on complex networks: structure–dynamics interdependences

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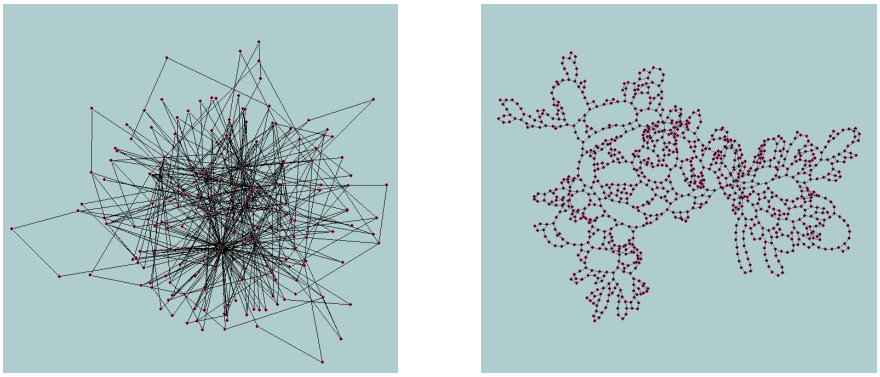
Driven dynamics on graphs represents more closely complex dynamical systems and network's function. In general, the properties of the process depend on the complexity of the underlying network. The network geometry makes severe constraints to the dynamics by restricting the interaction pathways along the inhomogeneous organization of links [1].

In recent years using numerical simulations and data analysis we studied several network topologies (Fig.) and driven dynamic processes on them: Information transport [2], Magnetization reversal in antiferromagnetic spin-networks [3], Gene dynamics of Yeast [4], and Voltage-driven transport of electrons on cellular networks [5]. A detailed statistical analysis reveals that the properties of the processes depend on the underlaying network structure. Often variations in the structural parameters or elements—connectivity, clustering, and higher topological measures as centrality, modules and subclusters—can be connected with statistically recognizable changes in the dynamic properties. Here we highlight several such cases, substantiated with quantitative evidences of structure–dynamics interdependences.



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A model for social networks

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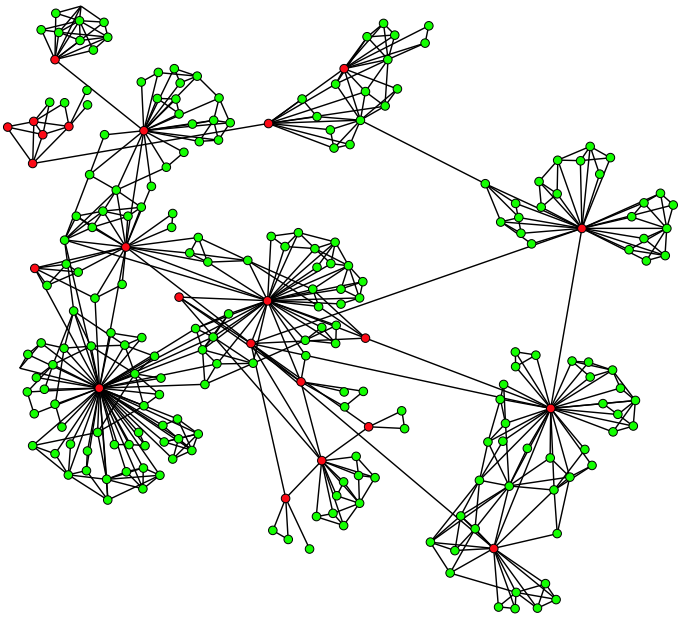
Social networks are organized into communities with dense internal connections, giving rise to high values of the clustering coefficient. In addition, these networks have been observed to be assortative, i.e. highly connected vertices tend to connect to other highly connected vertices, and have broad degree distributions and small average path lengths. We present a model for social networks [1] which reproduces these characteristics. In this growing, undirected network, the community structure arises from random attachment to initial contacts and implicit preferential attachment to their neighbors. The networks generated by the algorithm can be used as substrates for studies of socio-dynamic phenomena. The unweighted model easily allows for weighted extensions. We also discuss the effect of community structure on dynamic processes taking place on the network.



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Nano-wire with one-sided surface roughness as a complex system

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Systems that display classically chaotic behavior have been intensively studied in the past few decades. Because of the chaotic dynamics, the behavior of such systems becomes unpredictable even on relatively short time or length scales. One generic reason for the emergence of chaotic dynamics in a complex system is the presence of disorder, such as impurities in a solid crystal. The transport properties of the system are then largely determined by the disorder. For sufficiently small devices, quantum mechanics has to be employed to describe the properties of the system. It is then necessary to investigate what happens to the classically chaotic dynamics in the quantum regime. Since the Schrödinger equation is linear and should not display chaos, while at the same time, the quantum system should mimic the corresponding classical system for small wavelength, the quantum to classical crossover is of considerable conceptual interest.

The theoretical modelling of classically chaotic systems in quantum mechanics is often performed by employing random matrix theory (RMT). We consider the case of transport through *quantum wires*, 2-dimensional cavities with hard boundaries. RMT is perfectly applicable for quantum wires where a static disorder potential present in the *bulk* of the solid. Reduction of system sizes and improving fabrication methods lead, however, to an increased surface-to-volume ratio in nano-devices, such that *surface roughness* can turn out to be the dominant source of disorder scattering. The application of RMT to systems with surface disorder is however not straightfoward, as transport then depends on the angle (mode number) of the injected particle (wave) [1].

We numerically study electronic quantum transport through extremely long nano-wires in the presence of a one-sided surface roughness and a magnetic field. Classically, such a system has a mixed phase space, consisting of a regular island and a chaotic sea. In the quantum-to-classical limit of $E_F \to \infty$, the quantum dynamics is able to resolve this classical phase space, such that quantum states inside the regular island can traverse the wire without being scattered by the disorder, which leads to exponentially diverging localization lengths.

We demonstrate by an analytical model that this effect can quantitatively be accounted for by tunneling between the regular and the chaotic parts of the underlying mixed classical phase space. We thereby establish a direct link between experimentally accessible transport quantities like the conductance and theoretical concepts on "dynamical tunneling" as well as "directed quantum chaos" [2]. In this sense our model system offers a convenient testing ground for recent theoretical predictions in these fields.

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Modeling distributions of personal income as Markov processes

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In [1, 2] a model for the distribution of personal income has been proposed which, from the mathematical point of view, is a Markov process in a two dimensional Euclidean space with a transition rate matrix:

$$\begin{pmatrix} \lambda + \epsilon\lambda_1 & \epsilon\lambda_1 \\ \epsilon_1\lambda_1 & \lambda + \epsilon_1\lambda_1 \end{pmatrix} \tag{1}$$

where $\lambda \in [0, 1]$ is a real number, $\lambda_1 = 1 - \lambda$ and ϵ is a random number with probability density function $\rho(\epsilon)$ and $\epsilon_1 = 1 - \epsilon$.

In a series of works [3–6] the authors simulated the model on the computer and drew following conclusions on the long time limit distribution function of the process:

1. If $\lambda \neq 0$ is not random the distribution is well fitted by a *Gamma function*:

$$f_1(w)dw = P\left(w < W < w + dw\right) = \frac{n^n}{\Gamma(n)} w^{n-1} \exp(-nw)dw \tag{2}$$

   where $n = 3\lambda/(1 - \lambda)$. In addition it was suggested that this distribution results as an equilibrium distribution of the *kinetic energy* in an ideal gas in the *canonical statistical ensemble*.

2. If λ is a randomly number then the distribution exhibits a power law with index unity in the high end: $f_1(w)dw \simeq 1/w^{1+\alpha}dw$ with $\alpha = 1$. It was suggested that the long time limit distribution is *universal*, ie does not depend in the distribution at time zero.

Basing on our previous studies of that model [7] in this work we show the following:

1. In both cases above the long time limit distribution is a *continuous superposition* of the *time zero distribution* and an *analytic kernel* and *is not* the *Gamma function* found above. We find closed form expressions for the distribution and for all its moments.

2. In both cases above *all moments are finite* and thus the distribution diminishes according to an *exponential* and *not* a *power law* as found above.

We conclude that *numerical simulations* and *intuition* based on *equilibrium statistical physics* and the search for *universal features* in long time limits of stochastic processes are *not* the *proper way* of investigating these complex random processes.

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Semantic information concept in sociodynamic modelling

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In accordance with W.Weidlich's quantitative sociology approach to the description of social systems the current state of socium composed of K competitive populations P_a , a=1 ...K, is characterized by element $\mathbf{v} = \{\mathbf{n}, \mathbf{m}\}$ of certain space of socioconfigurations Ω. Socioconfiguration consist of a set of personal variables $\mathbf{n} = \{\dots n_{ia} \dots\}$, where n_{ia} means the number of members of population P_a having an "attitude" or *modus vivendi* indexed by i, $i = 1 \dots I$, and a set of material variables $\mathbf{m} = \{\dots m_\gamma \dots\}$, where m_γ, $\gamma = 1 \dots \Gamma$, means economic and other objective characteristics of socium .

The dynamics of socium is described as the transitions from given initial state $\mathbf{v}_1$ to neighboring states $\mathbf{v}_2$. Transition rates, i.e. probabilities per unit time to proceed from $\mathbf{v}_1$ to $\mathbf{v}_2$, engender the transition as their "driving forces". They are induces by the activities of the individuals of the socium as

$$w_{2\leftarrow 1}(\mathbf{v}_2; \mathbf{v}_1) = n_1 \cdot p_{2\leftarrow 1}(\mathbf{v}_2; \mathbf{v}_1) \tag{1}$$

where n_1 is the number of individuals initiating the transition $1 \rightarrow 2$ while individual transition rates are determined as

$$p_{2\leftarrow 1}(\mathbf{v}_2; \mathbf{v}_1) = \mu(\mathbf{v}_2, \mathbf{v}_1) \cdot \exp(M_{2\leftarrow 1}(\mathbf{v}_2, \mathbf{v}_1)), \tag{2}$$

with mobility function $\mu(\mathbf{v}_2, \mathbf{v}_1) = \mu(\mathbf{v}_1, \mathbf{v}_2)$ and motivation potential $M_{2\leftarrow 1}(\mathbf{v}_2, \mathbf{v}_1)$ arising from the evaluation and comparing of states $\mathbf{v}_1$ and $\mathbf{v}_2$ by the individuals. Motivation potential is usually defined as difference of the values of dynamic utility function evaluated by individuals for states $\mathbf{v}_1$ and $\mathbf{v}_2$.

At present work we intend to introduce informational mass-media contribution to the motivation potential using the concept the semantic information. We postulated the relation

$$M_{2\leftarrow 1}(\mathbf{v}_2, \mathbf{v}_1) = I_2[\delta(\mathbf{v}_0)] - I_1[\delta(\mathbf{v}_0)], \tag{3}$$

with quantities of semantic information $I_{1,2}[\delta(\mathbf{v}_0)]$ brought by the message δ about desired state $\mathbf{v}_0$ in the scales of conceptual lattices Sc_1 and Sc_2, corresponding to states $\mathbf{v}_1$ and $\mathbf{v}_2$, where

$$I_{1,2}[\delta(\mathbf{v}_0)] = H_{1,2}[\Omega(\mathbf{v}_0)] - H_{1,2}[\delta(\mathbf{v}_0)] \tag{4}$$

and $H_{1,2}[\Omega(\mathbf{v}_0)]$ and $H_{1,2}[\delta(\mathbf{v}_0)]$ are *a priori* and *a posteriori* entropies of desired state before and after message $\delta(\mathbf{v}_0)$ in scales Sc_1 and Sc_2. Since $I_{1,2}$ may be as positive as negative, motivation potential may as increase as decrease the transition rates with respect to spontaneous values described by mobilities. Some modelling results are presented.

Alternatives for the European educational system—the knowledge based economic applied research

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The motivation for this paper comes from conflicting trends occurring at the university teaching level, with regard of the optimizing microeconomic model. Within most tertiary institutions a fast move is required to be done towards a more specialized curricula and a mathematical formalization of the classical theory and approaches derived from it.

The basic idea is to improve the application of new methods oriented to shorten the pathway from theoretic ideas to the real implementation in the market.

The essence is to find out what new educational products and services should be created to set up a more adequate system of teaching, based more on coaching than learning, more on scientific application than theoretical approach.

The deviation from the classical way has to be in the favor of the durable partnership between schools, research institutes and business owners.

Re-branding the academic system could become compulsory in our days society; the stain of love-mark bringing a farther added value in teaching.

The presentation is aimed at raising the awareness of lecturers and practitioners of the limited way in which research is integrated into teaching and the right moment to transform it into a sustainable coaching.

This way the course of knowledge will lead us to think that together we have discovered the findings influencing our thinking.

Quantum mechanical investigations of large supramolecules

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Dendrimers are perfectly branched synthetic supramolecules having numerous chain ends all emanating from a single core. The isolated molecules of dendrimer consist of 1000 or even more atoms. From physical and chemical point the studies of the above molecules are very excited due to the promising future. The dendrimers could be used for the design of single-layer multichromophoric light-emitting diodes, sensors, fluorescent labeling of biological molecules, variety of photonic devices, and nanosized carriers for diagnostic or therapeutic applications. Good knowledge of the geometrical characteristics of dendrimers and hyperbranched polymers is an important prerequisite to understanding and using the great potential of this novel class of material. At present, the theoretical investigations of large derivatives are performed applying Molecular dynamic or Monte Carlo simulations. The molecular dynamics simulation method is based on Newton's second law or the equation of motion. The method serves to go up systematically into the macroscopic properties such as thermodynamic or transport characteristics through the microstructure of the material. The simulation necessitates a potential function of the power field, as well as modeling the crystal structure of the material, and this crucially influences on the accuracy and the reliability of the computation. The Monte Carlo method can be loosely described as statistical simulation method, where statistical simulation is defined in quite general terms as any other method that uses sequences of random numbers to perform the simulation. Neither Molecular dynamics nor Monte Carlo methods include explicitly the interactions that are presented in quantum physic, i.e. the adapted approximation in these methods does not allow to investigate the phenomena that are quantum effect depended. Hence, the problem to investigate giant polimer molecules is an open question. Recently, new approach by using X-ray diffraction and the atomic pair distribution function technique has been successfully applied to study the structure of polymer macromolecules of few nanometers in size [1]. Our performed investigations indicate that it is possible to design molecular structures that possess the properties of the real macromolecules. Our obtained ab initio performances indicate that using several different modeled structures it is possible to calculate the geometrical structure and to foresee the main electronic properties of investigated supramolecules. It is emphasized, that our obtained results coincide well with the experimental one.

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Additivity based method for conformational analysis of large molecular systems

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It is known [1] that the conformations play an extremely important role in macromolecular processes. For example, the character of interactions and structure of the products in a plenty of biochemical reactions essentially depends on the conformations of the interacting compounds. The communication gives the overview on experimental and theoretical investigations which showed that the determination of the relative arrangement of conformational energies for large compounds both experimentally as well as using quantum mechanical calculations is the complicated problem. The present study aims to work out the practically useful method allowing solving the problem using the additivity rule of conformational energies, quantum mechanically justified in [2]. For this, applying the quantum mechanical methods, we studied simple saturated hydrocarbons modeling substitutes by halogen atoms. The investigation showed that it is possible to find a certain number of the most important increments corresponding to the energies of separate conformational segments and their sequences allowing determining the relative arrangement of conformational energies on the energetic scale with appropriate accuracy. It was also demonstrated that the mentioned increments are transferable to the more complex molecular systems. The results obtained leads to the conclusion that the proposed method can be used as a simple practical tool for design of new materials having the predicted conformational properties.

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Application of correlative characteristics of individual samples in multi element spectrometric pattern recognition

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Multi element concentration measurements are widely used for recognition and classification of samples. Number of characteristic elements and chemical compounds especially increases for materials of complex chemical composition, e.g., in analysis of plants and plant products for recognition of their countries of origin. Multivariate pattern recognition techniques, such as Principal Component Analysis, Linear Discriminant Analysis and other mathematical techniques are used to analyze the numerous data usually being applied in description of such complex systems. Correlative description, enabling to reveal additional information of physical interest, is also one of the statistical tools and can be used to characterize a system if large enough number of samples was studied.

Modern multi element analytical measurement methods, such as Inductively Coupled Plasma Mass Spectrometry, Neutron Activation Analysis and others, enable to increase the number of analytes being measured, and at present data for 50 and more elements and other analytes are often presented in the studies. In the present report a method is proposed that due to such high numbers of analytes enables to use the correlative description for characterization not of the whole batch only but of the individual samples as well.

If n analytes are measured, covariation matrix includes $n(n-1)/2$ independent numbers and, as an example, for $n = 30$ measured elements provides more than 400 parameters on correlative relations between analytes for that batch of samples. If even the highest positive and highest negative correlations are selected two sets of correlating and anti correlating pairs of analytes can be formed. Deviations of the individual data from the mean values for each component of the correlating or anti correlating pair can be used as input data to calculate the mean correlation coefficient for each group of pairs for individual samples. Illustrations of application of the method for classification of the food products according to their country of origin will be presented in the report.

Integration of the environmental management system into other business operations systems

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The core goal of the case study in heavy process industry was to define how to create an effective and efficient integration in the business operations systems including quality, environmental and safety operations. A great challenge was to find out the basis for the integration and to help to decide the actions needed. A company can have only one management system for all the business operations.

By the interviews information was gathered both about the current situation and the viewpoints for integration. The aim of Analytic Hierarchy Process (AHP) method was to depict the basic principles in the integration and the conditions for its implementation. By benchmarking it was concentrated on analyzing how the integration has been carried out earlier, and on analyzing Best Practices based on CARMAN -operation model striving for developing working processes. The purpose was to find knowledge, advice and ideas to carry out the integration and to make it possible to take it into use. Finally, the operational model developed was verified by the weak market test which belongs to a constructive research approach in business sciences.

When evaluating effects of organizational cultures it is important to understand deeply the differences between them. The company has to achieve benefits from the business with the common customer and still to ensure good quality in operations. The importance of continuous improvement in the change process was found out. It was also important to observe different interest groups e.g. in communications. The continuous improvement makes a good progress thanks to certification of the operational systems. It is remarkable that the personnel and management have to commit to the change process. For the commitment and secure communications the solution is training remarkable factor in the integration in our case, too. By the help of that we can diminish conflicts and reduce resistance to the changes needed.

Power-law knowledge distribution in small software specialist teams

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In big companies, managerial activities and organizational boundaries will over time hide most distribution patterns; studying the organizations with the means of modern applied physics is thus quite difficult. People are forced to communicate along the organizational lines, and their personal preferences that could affect the communication networks are often dampened to nearly obsolete. In small companies, however, as well as other less structured non-business organizations (e.g. the group self-organizing activities studied and reported by the Tavistock Institute since the 1950s), many network patterns exist, based on the preferred cooperation and communication behaviour of human beings, and are observable in various real-life situations.

Our example is from a small software development team. In startup companies, many of the software developers are recruited directly from school; their main source of learning is thus through solving real-life problems that turn up when coding. Given their free choice of either to solve the problem themselves or go to one of the colleagues to ask for help, and a preference based on the transactive memory of the organization (a word-of-mouth "reputation" information about who has the skill needed to solve the problem, or who solved the previous one with some similarity) will over time lead to most difficult problems always being solved by one or two key individuals.

We have illustrated this with a agent model, presented in the paper. Furthermore, we are currently conducting interviews in a 40-person software solution company. It seems the knowledge is on its way to become distributed according to power law also in the reality of this company, even if there are not enough interactions in the five-year history of the company to prove this in a statistically significant way.

So, where's the risk in such a case? For management of knowledge in a company serving bigger companies with software development, as is the case of the company we are studying, the probability of the company losing the one or two key employees with the wide variety of problem-solving skills - and also historical knowledge of the company's earlier software products - to competitors or customers increases with every problem-solving transaction. So, managerial action and organizational design should take place to share the problem-solving load more evenly, to "break" the power-law distribution of experience. The research will continue by comparing the findings to other software companies.

Wastewater sludge and ASH as risk construction materials

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The vast quantity of wastewater sludge generated throughout the world is creating problems of disposal. Sludge disposal by landfilling may no longer be appropriate owing to land scarcity and increasingly stringent environmental control. Problems arising from sludge diposal will be drastically reduced if sludge or its incinerated ash can be put to large-scale economic applications. This is a review of current studies by researchers in Lithuania and abroad in using sludge as novel construction materials. Properties of innovative materials derived from sludge, the production process, decress of risks, and the suitibility of the products for construction purposes are discussed.

Dynamics and communities

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The science of complex network has been a subject of attention of the physicists' community in the recent years. These complex networks are found in fields as diverse as the Internet, the World-Wide-Web, food-webs, and biological and social organizations. Although the main characteristics of complex networks have been properly described at the microscale level (node properties) and also at the macroscale level (whole network properties) some of the characteristics of the mesoscale are still elusive. In particular, the community detection problem concerning the determination of mesoscopic structures that have functional, relational or even social entity is still controversial starting from the 'a priori' definition of what a community is [1].

The community detection problem consists in finding a 'good' partition of the network in subgraphs that represent communities according to a given definition. However, in many complex networks the organization of nodes is not completely represented by a unique partition but by a set of nested communities that appear at different topological scales. Let us consider as a naive example the network formed by all human acquaintances. Thus, at some topological scale we can expect to find many communities formed by families, friends and soon, beyond this scale the expected partitions into cities will come up, beyond this regions, after that countries, and finally probably continental areas. Our goal is to determine these different topological scales based on the time evolution of some dynamical properties. [2]

We also analyze the role of communities in a problem of search and congestion recently introduced by us. [3] Again we can discuss this dynamical problem and how the community structure of the network affects and can be used for better performance of the search and congestion problem.

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Statistical and Physical paradigms (Econophysics, Sociophysics, Mediaphysics)

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A history of interactions between statistics and physics is full of many mutual influences and misinterpretations. Very rarely the same person worked in two areas; usually specialists were unaware about results in an alien field. Gibbs's and Boltzman's creation of statistical physics more than a hundred years ago, merging two terms together, did not do much for recognition of deep relations between those sciences. Publication of a book "Physique sociale" by A. Quetelet (1835), practically unknown for physicists, but widely recognized by statisticians a pioneering book, also didn't spark an interest to that topic (the content of that book was really about new views of statistics, but the title and interpretation of it were far ahead of its time). Statistics for a couple of hundred years was treated as a social discipline; in the last hundred years it was considered rather in mathematical terms, as a special universal science about mass phenomena, regardless on its nature. However, the social roots of statistics are still seen there, particularly, in a fact that for social sciences statistics is the only tool relating theoretical concepts and real life. Physics, in essence, has not change its subject since inception, even being marred with other disciplines (biophysics, astrophysics, geophysics and so on). In all those interdisciplinary sciences the special question about statistical and physical paradigms was not of particular interest, because the distinction in subject matters were (or seemed to be) quite obvious.

The problem became an actual one, in our opinion, with the introduction of econophysics and sociophysics during last 30 years. The main reason is a mentioned fact that for social sciences statistics is irreplaceable, whereas for other more "natural" sciences, it is just one of the tools. Anatomy or studies of planetary orbits do not need statistics by itself. That's why the invasion of physics in those disciplines did not change their core business — physics remained physics, just applied to new, yet physical objects. But cohabitation of physics and social sciences is a much more complicated phenomenon, because the objects are not physical anymore (people instead of particles, human interactions instead of molecules' collisions, etc.). Physics is used there only as an analogy, i.e. becomes only a methodological tool, and in that role openly competes with already existing and very well developed statistics.

This presentation is about the main problems regarding those issues. We consider historical and methodological aspects of sociophysics and econophysics. A deep difference between two approaches is studied. It is shown, that physics may indeed change traditional "over statitistized" view on society and enrich it. A mediaphysics, proposed recently by the authors as a concept of analyzing communicational phenomena in societies, is also briefly considered as possible way to bridge two different and mutually supplementary paradigms. A concrete example of using mediaphysical principles on marketing material of one large company is presented.

Can Sociophysics becomes a predictive social tool? The example of the recent french referendum

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In 2005, for the first time, a highly improbable political vote outcome was predicted using a model of sociophysics. Moreover the prediction was made several months ahead of the actual vote against all polls and analyses predictions.

The model deals with the dynamics of spreading of a minority opinion in public debates using a two sate variable system. It applies to a large spectrum of issues including national votes like the recent French vote, behavior changes like smoking versus non-smoking, support or opposition to a military action like the war in Iraq, rumors like the French hoax about September eleven, and reform proposals.

The dynamics articulated around successive local opinion updates combining majority rule rationality and the existence of doubt. In case of a local doubt, collective beliefs are activated to make a choice. The emergence of a stable collective opinion is found to obey a threshold dynamic. It is the degree of heterogeneity in the distribution of common beliefs which determines the current value of the threshold which may well vary from ten percents to ninety percents.

Accordingly the expected democratic character of a free public debate may turn onto a dictatorial machine to propagate the opinion of a tiny minority against the initial opinion of the overwhelming majority. Extensions and limits of the approach are discussed.

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