

Book of Abstracts

**Sixth Polish Symposium on Econo and
Sociophysics**

Book of Abstracts: Sixth Polish Symposium on Econo and Sociophysics

Published April 2012, ISBN 83-89585-33-2

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Revision: 54.0.13, 2012-04-10 21:36 GMT

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Welcome

On behalf of the organizers and scientific committee welcome to the *Sixth Polish Symposium on Econo and Sociophysics!* This multidisciplinary scientific event is focused on the use of contemporary developments in physics and mathematics in a very widely understood social sciences.

Explaining the aspects of several disciplines such as economics, sociology or psychology may be based on mathematical models derived from many different branches of physics, including statistical physics, the theory of complex systems or even the mechanics of fluids, therefore forming a modern, elegant language designed to describe the whole range of economic and sociological issues. This language, being the foundation of a new science - *econophysics* - is used in forecasting financial and economic time series, the analysis of the exchange, risk assessment, decision making and many other activities.

Econophysics, being an object of intensified research, seems to be particularly important in view of the growing problems of the world economy. We hope that this year's conference will be a significant contribution to the development of this successful, yet still young discipline of science.

We wish you a fruitful participation in the conference and a pleasant stay in Gdańsk.

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- Faculty of Applied Physics and Mathematics, Gdańsk University of Technology
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Programme

Thursday, 19 April

LECTURE

Thursday afternoon, 19 April, 14:15
aula 3

Chair: Prof. Hołyst

14:15

Invited oral

'The bumpy road to criticality'

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Critical slowing down characterises an approaching catastrophic bifurcation in a variety of complex systems, including financial systems. Increased correlations, increased variance and skewness are among the characteristics of this critical slowing down. However, in some systems an additional oscillatory component emerges on the system's road to criticality', giving rise to so-called 'log-periodic' oscillations.

In the talk, I will look into the possible origins of such emergent oscillatory behaviour during the approach to a critical point.

14:50

Oral

Current world markets development from log-periodic perspective

Stanisław Drożdż^{1,2}, Jarosław Kwapien¹, Paweł Oświęcimka¹

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Detecting imprints of deterministic patterns in the financial dynamics and identifying their origin is a great intellectual as well as a practical challenge. In this context the suggestion that financial dynamics may be governed by phenomena analogous to criticality in the statistical physics sense and, especially, the related subtle concept of log-periodicity proves promising but at the same time it still appears somewhat controversial. Based on our related "finance-prediction-oriented" methodology [1] which involves such elements as log-periodic self-similarity [2], the universal preferred scaling factor, and allows a phenomenon of the "super-bubble" [3] we analyze the leading world stock markets (represented by the S&P500, Nasdaq, DAX, WIG and some Asian markets) and the commodity - especially oil [4] and precious metal - markets development over the past several years. This analysis involves both the bull as well as the bear markets phases. We emphasize the subtleties of the related methodology and summarize our predictions as documented on the public fora [5] and/or placed at [6]. Some publicly documented ex-

amples of our previous successful predictions include the oil trend reversal in early July 2008 and its further development until 2012 as well as some local trend reversals in the gold market (December 2009, May 2010 and November 2011). In the present contribution we elaborate on the related description and on the current world market status. We also present some further forecasting scenarios for the world stock market, for the oil and for the precious metals markets.

Bibliography

[1] S. Drożdż, F. Gruemmer, F. Ruf, J. Speth, *Prediction oriented variant of financial log-periodicity and speculating about the stock market development until 2010*, in *Practical Fruits of Econophysics*, Ed. H. Takayasu, Springer-Verlag, Tokyo, 2006

[2] S. Drożdż, F. Ruf, J. Speth, M. Wójcik, *Imprints of log-periodic self-similarity in the stock market*, *Eur. Phys. J. B* 10 (1999) 589

[3] S. Drożdż, F. Gruemmer, F. Ruf, J. Speth, *Log-periodic self-similarity: an emerging financial law?*, *Physica A* 324 (2003) 174

[4] S. Drożdż, J. Kwapien, P. Oświęcimka, *Criticality characteristics of current oil price dynamics*, *Acta Phys. Pol. A* 114 (2008) 702

[5] <http://wojciechbialek.blox.pl/html> (in Polish)

[6] <http://picasaweb.google.com/finpredict>

15:25

Invited oral

Catastrophic bifurcations on financial markets

Marzena Kozłowska¹, Tomasz Gubiec¹, Mateusz Denys¹, Adam Sienkiewicz¹, Tomasz R. Werner², Zbigniew R. Struzik³, Ryszard Kutner¹

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The question of whether the early-warning signals are present in financial markets continues to fascinate both the research community and the general public. Interestingly, such early-warning signals have recently been identified and explained to be a consequence of a catastrophic bifurcation phenomenon observed in multiple physical systems, e.g. in ecosystems, climate dynamics and in medicine (epileptic seizure and asthma attack). In the present work we provide an analogical, positive identification of such a phenomenon by examining its several indicators in the context of a well-defined daily bubble; this bubble was induced by the recent worldwide financial crisis on typical financial markets of small and middle to large capitalizations.

COFFEE

Thursday afternoon, 19 April, 16:00
sala Rady Wydziału Mat. Fiz. Inf.

LECTURE

Thursday afternoon, 19 April, 16:30
Chair: Prof. Kamiński

16:30

Oral

More stochastic repulsion in culture dissemination

Małgorzata Krawczyk, Krzysztof Kułakowski

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The order-disorder phase transition in the Axelrod model [1,2] is investigated in the presence of repulsion [3]. Here, the approach of [3] is modified as follows: a) the threshold is removed, and the attractive/repulsive corrections are made with probabilities of finding the same/different symbols in the related codes; b) the initial state of the system is taken as an additional independent variable. We find a new phase diagram with ordered, disordered and non-stationary phases.

[1] R. Axelrod, *J. Conflict Res.* 41 (1997) 203.

[2] C. Castellano, M. Marsili, A. Vespignani, *Phys. Rev. Lett.* 85 (2000) 3536.

[3] A. Radillo-Díaz, L. A. Pérez, M. del Castillo-Mussot, *Phys. Rev. E* 80 (2009) 066107.

17:00

Oral

Entropy-growth-based model of emotionally charged online dialogues

Julian M. Sienkiewicz¹, Marcin Skowron², Georgios Paltoglou³, Janusz A. Hołyst¹

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We analyze emotionally annotated massive data from IRC (Internet Relay Chat) and model the dialogues between its participants by assuming that the driving force for the discussion is the entropy growth of emotional probability distribution. This process is claimed to be responsible for a power-law distribution of the discussion lengths observed in the dialogues. We perform numerical simulations based on the noticed phenomenon obtaining a good agreement with the real data. Finally, we propose a method to artificially prolong the duration of the discussion that relies on inserting into dialogues appropriate comments when the entropy of emotional probability distribution reaches the critical threshold.

17:30

Oral

Equilibrium, stability and turbulence: How physics has shaped and limited economic thinking.

Czesław Mesjasz

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The impact of physics upon social sciences, including also economics, management and finance, has been one of decisive factors of development of the latter. Philip Mirowski in his works the impact of physics upon economics showed that although the influence was sometimes mutual, economics, finance and management to a large extent tried to imitate physics as to prove their quality as scientific disciplines.

The impact of physics onto economic, finance and management has been exerted in four ways. Firstly at the ontological and epistemological level by attempting to make economics in a “scientific” way. Secondly, by applications of physical models in the cases where a sufficient amount of data could be collected. Thirdly, by using models plus their phenomenological interpretations, and fourthly, with the use of analogies and metaphors applied in studies and policy making. It should be added that analogies and metaphors transferred from physics to social sciences have been often simplified, abused and misinterpreted.

The transfer of ideas from physics to economics and other social sciences can be illustrated with applications of five concepts – equilibrium, stability, turbulence, complexity and chaos. Although the above notions are widely used in economics, finance and management yet methods and influence of their applications are not sufficiently deeply analyzed. Their applications may lead to simplifications, sometimes artificial impression of normative “objectivity”, and even to scientism. Advantages and limitations of their limitations seem to be well-known. However, thorough studies show that no deepened analysis of their role in the discourse of theory and practice has been conducted so far bearing in mind two perspectives – relevance of mathematical models to economic/social reality and consequences of their uses in shaping the worldview in economics and finance through semantic and cognitive impact.

The aim of the paper, which includes the first part of results of a broader project, is to show how the ideas of equilibrium, stability and turbulence were transferred from mathematics, physics and control theory to economics, finance and management. The applications of the concepts of complexity and chaos will be only preliminary dealt with in the paper, wherever necessary, since they will be analyzed in detail in the second part of the project – to be presented later.

The research will be based upon a thorough analysis of literature in the areas under study with the use of the author's database. Every concept will be analyzed as follows. Firstly, its origins and applications in physics and, if relevant, other natural sciences and/or control theory will be presented. Then the transfer to economics, finance and management will be described both as direct and indirect applications of mathematical models. Subsequently the use of the models and analogies and metaphors in the language of theory and policy making will be illustrated with three examples: the role of equilibrium in economic and financial models, definitions of financial stability and the impact of the concept of turbulence on strategic management. Special stress will be put on the impact of mathematical models and metaphors associated with equilibrium, stability and turbulence on the discourse in economic theory and practice, since the incomprehensibility of contemporary economy is often linked with constraints imposed by those ideas on interpretations of phenomena in economics, finance and management.

DINNER

Thursday evening, 19 April, 18:15
barek Wydziału Mat.Fiz.Inf.

Spotkanie Komitetu Naukowego

Thursday evening, 19 April, 20:00

Friday, 20 April**LECTURE**

Friday morning, 20 April, 9:00
aula 3
Chair: Prof. Kutner

9:00 Oral

Complexity: what it is and how it can be identified

Jarosław Kwapien¹, Stanisław Drożdż^{1,2}

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Natural and social systems are often characterized by highly complicated structure and behaviour that cannot be deduced solely from their microscopic description. This means that their properties are emergent and their description must be holistic. The systems which can be qualified into this category are commonly referred to as complex systems. Complexity of such systems can by no means be explained by any single property or event; it rather requires a synergy of processes and long sequence of events that make the systems complex. Such explanation of complexity is obviously vague and offers no discriminating criterion which would allow one to classify any given system into one of the two categories: complex or simple. Since the middle of the 20th century, there have been many attempts to define a quantity which could serve as a measure of complexity, but no such a quantity fully succeeded. Therefore, it seems indispensable to attempt to characterize complex systems by analyzing manifestations of their complexity based on empirical data, in order to find properties of such systems and, possibly, to derive some laws that could be universal or at least common to a large group of complex systems. In this talk, a short introduction to the phenomenon of complexity will be given, together with some examples of identifying complexity of selected systems.

Literatura:

J. Kwapien, S. Drożdż, Phys. Rep. (in print), <http://dx.doi.org/10.1016/j.physrep.2012.01.007>

9:40 Oral

Effect of detrending on multifractal characteristics

Paweł Oświęcimka¹, Stanisław Drożdż^{1,2}, Jarosław Kwapien¹, Andrzej Z. Górski¹

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The Mandelbrot's concept of multifractals gave rise to one of the most dynamically developing theories in recent years. Its versatility allowed the researchers to apply this concept to describe investigated processes in many different domains of science such as physics, biology, chemistry, economics and even music. However, there are still some unanswered questions referring to the multifractal theory. One of them concerns the influence of the commonly used detrending procedures on calculated fractal characteristics. For example, in the MF DFA method, a trend is approximated by a polynomial of an appropriate order. The choice of this order appears to be extremely significant. The use of a too high order can result in suppressing of high-frequency fluctuations. On the other hand, a low order of polynomial does not eliminate the non-stationarity sufficiently. The present analysis shows that these two effects are reflected in the singularity spectrum in which we observe a relation between the width of the spectrum or the Hurst exponent and the order of the polynomial used in the calculations. Furthermore, this relation itself depends on the kind of analysed signal. Therefore, using the polynomial order as a variable in MF DFA could give more complex view on the correlative structure of the investigated signals.

10:00 Oral

Modeling of large claims in a non-life insurance company

Aleksandra Budzowska¹, Ryszard Kutner²

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The large claims, which are difficult to forecast, are a significant part of the financial result of an insurance company. Their influence can be limited by choosing the proper reinsurance program, for which the knowledge of the large claims distribution is needed. The information about this distribution comes from its realisation - that is, from the historical data of claims. In order to improve the quality of the prediction, the separation of claims into attritional and large claims is required. The threshold between attritional and large claims becomes a crucial parameter of the estimation.

In this work we used the plot of empirical complementary cumulative distribution function (CCDF) in the range of attritional claims to find the threshold of large claims. In the process of parameters' estimation of attritional claims distribution, the threshold value was the value of claim, which - when included in the sample of attritional

claims - was giving considerably worse quality of the fit. The second method of finding the threshold of large claims was fitting the global distribution to the empirical CCDF. The global distribution was a combination of different distributions depending on the range of claims - in this work the lognormal distribution was used for small claims and Pareto distribution for average claims. As a distribution for large claims five distributions were considered: gamma distribution, lognormal distribution, generalized Pareto distribution, Weibull distribution and inverse Gaussian distribution.

Having determined the value of the threshold we used two methods of estimation of the remaining parameters - the method of maximising of the likelihood function and the method of minimising of the least squares of the difference between theoretical and empirical cumulative distribution function (CDF). The main challenge was to verify the quality of estimation - the large claims empirical sample consisted of 40 claim values and the ordinary statistical methods were inadequate. Instead, we used the average and standard deviation from the distribution of maximum value in the sample. Those measures were found using Monte Carlo simulation for each of the five fitted distributions of large claims with the assumption that the random sample in Monte Carlo simulation has the same cardinality as the cardinality of empirical sample. These measures were compared with the actual maximum value of the empirical sample. The results of this comparison were thoroughly discussed.

10:20 Oral

Correlations and dependencies in high-frequency stock market data

Tomasz Gubiec, Ryszard Kutner

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The correlation between different quantities, observed in high-frequency financial data, is a commonly used measure of the dependence between them. In some cases, the results obtained by correlation analysis may be misleading, for instance, uncorrelated quantities are not always independent. In our work we give an important example of such a case. This example is significant in the description of the stochastic evolution of a typical share price on a stock exchange within a high-frequency time scale.

The above given example can be approximated by a simple formula, which included in the Continuous-Time Random Walk (CTRW) model with memory makes this model exactly solvable. Our version of the CTRW model is an extension of that presented on the previous FENS 5 conference [1] and published soon after [2]. This version of the CTRW contains memory over two steps in contrast to the one-step memory presented before. Such an extension improves, for instance, agreement of the theoretical velocity autocorrelation function with its empirical counterpart obtained for the continuous quotation or tick-by-tick financial data.

[1] <http://science24.com/paper/23311>

[2] T. Gubiec, R. Kutner: *Backward jump continuous-time random walk: An application to market trading*, Phys. Rev. E 82, 046119 (2010)

10:40 Oral

Modelling of annual European Union household incomes by using an equilibrium solution of the threshold Fokker-Planck equation

Maciej Jagielski, Ryszard Kutner

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We derived, in the frame of the threshold nonlinear Langevin dynamics and its threshold Fokker-Planck counterpart, a unified formula for description of the annual income of households, for instance, for the European Union in 2006 and 2008. Our formula is more generic than the well known that of Yakovenko as it is valid (by varying driving parameters) for all society classes, including the high-income class. This single unified formula well describes known stylised income facts. That is, it gives the Boltzmann-Gibbs income distribution for the low-income society class and the weak Pareto law for the middle-income class as it expected, while it predicts (to satisfactory approximation) the Zipf law, as expected, for the high-income class.

COFFEE

Friday morning, 20 April, 11:00
sala Rady Wydziału Mat. Fiz.Inf.

LECTURE

Friday morning, 20 April, 11:30
aula 3
Chair: Prof. Drożdż

11:30 Oral

Mining correlations on the GPW.

Krzysztof Karpio¹, Arkadiusz J. Orłowski^{1,2}, Tomasz Ząbkowski¹, Piotr Łukasiewicz³

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Identification of patterns in the stock market has been an important subject for many years. In the past, a numerous techniques, both technical and econometrics, were used to predict changes in the stock market, but dependency among all the companies listed on a Polish Stock Exchange were considered in a limited extent. Numerous studies confirm that that larger stock items appear to lead smaller ones and that, on global level, most of the world's stock markets are integrated. Therefore, this study implements the association rules as a data mining approach to explore the co-movement between stock items listed on Warsaw Stock Exchange. We believe that to describe and to understand market's behavior, data mining

tools are more flexible to use than for instance the pricing models based on corporate finance theory, because the former seems to be more effective for explaining market behavior without making particular assumptions.

11:50

Oral

On a stress measure in a capital

Daniel J. Kosiorowski

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In this paper we propose a new approach to measure stresses in a capital stored into a certain economic system. Our propositions appeal to statistical theory of shape (STS) and data depth concept. We use among other a pair of thin-plane splines deformation of (proposed by Bookstein) multivariate medians and measures of a shape variability.

We start our considerations with a concept according to which a capital stored in an economic system is connected with an ability of this system to perturb a certain economic space of values (prices, utilities etc.). A flow of the capital between systems is associated with activities of internal and external forces and could be described by an equation similar to the famous Navier–Stokes equation. Stresses in the capital represent the activity of the inner forces and are proportional to the stresses in the space of values.

In this paper we treat companies belonging to sector stock indices as particles of the capital. Using robust methods (functional data depth procedures) we choose a representative particle for each sector index on base of time series of a relative price change to relative volume change ratio analysis. We treat such the representative particle as a landmark – a basic notion of the STS. A set of representative particles considered with respect to change of price and change of volume we treat as a configuration. We apply tools of the STS to analyze configurations of representative companies belonging to the branch indices. In particular we consider changes of a median size-and-shape before and after financial crisis of 2007 year using deformation proposed by Bookstein. We analyze size-and-shape variability before and after the crisis.

We show also certain aspects of the probability distribution of the proposed stress measures for particles behaviors ruled by well known and commonly used in the empirical finance time series models.

References:

Bookstein, F. L. (1989) Principal warps: thin-plate splines and the decompositions of deformations. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 11, 567 – 585.

Kosiorowski, D. (2007). Nonparametric Equity of Two Shapes Test Based on Multivariate Quantile Functional. *Bulletin of the International Statistical Institute*, 56th Session of the ISI – Lisbon.

Lopez–Pintado, S., Romo J. (2009). On the Concept of Depth for Functional Data. *Journal of the American Statistical Association* 104(486), 718 – 734.

Mizera, I., Muller, C. H. (2004). Location – Scale Depth (with Dis-

cussion and Rejoinder). *Journal of the American Statistical Association* 99(4), 981 – 989

12:10

Oral

A Stochastic Non homogeneous Constant Elasticity of Substitution Production Function as an Inverse Problem: A Non Extensive Entropy Estimation Approach

Second Bwanakare

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The document proposes a new entropy- based approach for estimating parameters of non linear and complex models, i.e. those which no transformation renders linear in parameters. Presently, for estimating such class of functions, various iterative technics like the Gauss-Newton algorithm are applied and completed by least square methods approaches. Due to conceptual nature of such methods, definitely estimated functions are different to the original non linear one and estimated values of parameters are in most of cases far from the true values.

The proposed approach, being related to statistical theory of information, is very different from those so far applied for that class of functions. To apply the approach, we select a stochastic non homogeneous constant elasticity of substitution (CES) for aggregated production function of 27 EU countries which we estimate maximizing non extensive entropy function under consistency restrictions related to the CES model plus regular normality conditions. The procedure might be seen as an attempt to generalize recent works (ex. Golan, al. 1996) on entropy econometrics in the case of ergodic systems, related to Gibbs-Shannon maximum entropy principle. Since this non linear CES estimated model contains four parameters in one equation and statistical observations are limited to twelve years, we have to deal with an inverse problem and statistical distribution law of data generating system is unknown. Because of above reason, our approach moves away from normal Gaussian hypothesis to more general Levy instable time (or space) processes characterized by long memory, complex correlation and by convergence, in relative long range, to attraction basin of central theorem limit. In such a case, fractal properties may eventually exist and the *q non extensive parameter* could give us useful information. Thus, as already suggested, we will propose to solve for a stochastic inverse problem through the generalized minimum entropy divergence under the CES model and other normalization factor restrictions.

At the end, inferential confidence interval for parameters is proposed. Output parameters from entropy represent the long-run state of the system in equilibrium, and so, their interpretation is slightly different from the “ceteris per ibis” interpretation of classical econometrical modeling. The approach seems to produce very efficient parameters in comparison to those obtained from classical iterative non-linear method which will be presented too.

12:30

Oral

Spectral analysis of capital marketsAndrzej S. Dyka, Piotr J. Dudojć*Gdansk University of Technology (PG), Narutowicza 11/12, Gdańsk 80-952, Poland**e-mail: Andrzej@Dyka.info.pl*

There is a lot of controversy upon assumption that capital markets show any kind of periodicity. This contribution addresses this problem. In order to identify a periodicity the following procedure has been carried out.

1. Logarithm of the quotation is multiplied by the moving window of the width $4*n$, where n is a natural number. As a result one obtains a number of quotation fragments of the length $4*n$.
2. The said fragments are added (averaged) thus reducing signal-to-noise ratio. Consequently, the mean value from the result is subtracted.
3. For the above result the first harmonic of the triangular Fourier expansion is computed for every value of n .

This procedure has been applied to DJIA index, starting from 1896 to December 30, 2011.

A number of periodicity peaks have been identified, among them the strong one, which corresponds to 10 year cycle.

Extended analysis and cycle validation will be presented at the symposium.

12:50

Oral

Multifractality of nonlinear transformations of monofractal signals with application in financesGrzegorz Pamuła, Dariusz Grech*Wroclaw University, Institute of Theoretical Physics (IFT UWr), pl. Maksa Borna 9, Wroclaw 50-205, Poland**e-mail: dgrech@ift.uni.wroc.pl*

We study the multifractal effects of linear and non-linear transformations for monofractal time series and apply these findings to measure the 'true' unbiased multifractality for volatility series calculated in various ways for different world stock markets. A difference is stressed between the 'naive' multifractal effects calculated directly within MF-DFA as the spread of generalized Hurst exponents $\Delta h = h(q \rightarrow -\infty) - h(q \rightarrow \infty)$ and the unbiased multifractal effect received after subtraction of multifractal residual noise generated as the result of nonlinear transformation of monofractal signal. This way the unbiased multifractal effect of volatility series, caused only by multifractality of price time series, is separated for real financial stocks. Finally, we compare and discuss obtained results from different world stocks.

13:10

Oral

New unbiased measure of multifractality and its application to multifractal asymmetry in financesŁukasz Czarnecki¹, Dariusz Grech²

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New measure of unbiased multifractality in signals of finite length for the generalized Hurst exponent language is introduced. The measure is based on the observation of the whole generalized Hurst exponent $h(q)$ range instead of looking just at the edge behavior $h^{\pm} = h(q \rightarrow \pm \infty)$. Such approach seems to be particularly useful in cases when $h(q)$ is not a monotonic function of the deformation parameter (moment order) q , for instance in non-stationary signals. The method is then applied in finances to search for the existence and properties of multifractal asymmetry between positive and negative returns for various world stock indices. Results are then compared to the usual multifractal analysis within MF-DFA.

LUNCH*barek Mat-Fiz-Inf*

Friday afternoon, 20 April, 13:30

POSTER

Friday afternoon, 20 April, 14:30

hol przy auli 3

14:30

Poster

1

Multidimensional analysis of emotions based on physiological signalsJan Choloniewski, Anna Chmiel, Janusz A. Hołyst*Warsaw University of Technology, Faculty of Physics, Koszykowa 75, Warszawa 00-662, Poland**e-mail: jcholoniewski@gmail.com*

We present an analysis of psychophysiological measurements of emotional states. Data comes from experiments that were performed in the frame of Cyberemotions project [1] and concerned people's emotions observed during discussions on online forums. Each participant saw IAPS pictures, read and wrote posts on an artificial forum while being connected to devices measuring his/her physiological states. Analysis of collected signals (such as EKG, facial muscles activity, skin conductance, etc.) and written responses in emotion questionnaires was the main part of the study. We analyzed an emotional response for a given picture or message, and correlation between the signal and a subjective rating of participants. Our methods combine several different approaches – statistical, based on signal analysis, and elements of information theory.

[1] www.cyberemotions.eu

14:30 Poster 2

Stochastic resonance for information flows on hierarchical networks

Agnieszka Czaplicka, Janusz A. Hołyst

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A simple model of information flows represented by package delivery on networks with hierarchical structures is considered. The packages should be transferred from one network node to another and the delivery process is influenced by two types of noise. The first one is related to a diffusive part in a packet dynamics, i.e. package paths do not follow from completely deterministic rules. The second one is related to partially false knowledge of network topology, i.e. addresses tables in shipping algorithm include a number of errors. In both cases we observe a resonance-like phenomenon for communication efficiency, i.e. the system performance measured as a fraction of packages that are delivered in a certain time period is maximal for an intermediate level of noise. The effect resembles the phenomenon of stochastic resonance existing in many complex systems. The resonance occurs also for a network formed by former Enron Company employees.

14:30 Poster 3

Analysis of leptokurtosis in model distributions and simulated noises

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In this work we considered the threshold model of financial markets, proposed by Paweł Siczka and Janusz Hołyst. The monographic part of our work contains description of this model together with some inspiration of Siczka and Hołyst why they constructed the threshold model. The results obtained by these authors reproduced few stylized facts observed on real markets. However, we additionally presented our results concerning the Siczka-Hołyst model, going one step further. That is, we introduced a useful liquidity coefficient and next we considered violation of central limit theorem. Finally, we studied one of possible modification of the threshold model and its results.

14:30 Poster 4

Cycles in DJIA

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The goal of this contribution is to identify possible cycles in DJIA

index. The index quotations from 1896 until December 30, 2011 were transformed into the sequence of returns for various investment horizons. For the maximum value of Pearson's coefficient the first harmonic of Fourier expansion is derived. Primary results indicate that for the horizon of 15 and 20 years a discrimination of relatively strong cycles is possible. An extended analysis and results will be presented at the Symposium.

14:30 Poster 5

Distribution of time lags between pedestrians

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We are interested in the probability distribution $P(\tau)$ of time lags τ between moments when successive pedestrians cross a given line, e. g. a door. Recent simulations [1] within the Social Force Model [2] suggest that this distribution contain a relevant information on the mode of motion, e.g. the desired velocity. Here we report a series of measurements of τ , supplemented by the analysis of related materials from Internet.

[1] P. Gawronski, K. Kulakowski, M. Kampf and J. Kantelhardt, *Acta Phys. Pol. A* (2012), in print (arXiv:1103.0403)

[2] D. Helbing, I. Farkas and T. Vicsek, *Nature* 407 (2000) 487.

14:30 Poster 6

Continuous-Time Random Walk models with memory. An application to description of market dynamics

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The canonical Continuous-Time Random Walk (CTRW) formalism was originally introduced by physicists, Montroll and Weiss, in 1965 as a way to render time continuous in the classical random walk. In both processes mentioned jumps of the process value are random and independent. The difference is in the time dimension. In the classical random walk time intervals between jumps are constant while in Continuous-Time Random Walk intervals are random and independent, just like the jumps of the process value.

Continuous-Time Random Walk models with memory, developed in my thesis, are more general class of the stochastic processes. In those models jumps of the process value are still random but not necessarily independent. In my thesis I analyzed two versions of the CTRW model:

- model with one-step memory - jump of the process value depends on one preceding jump
- model with two-step memory - jump of the process value depends on two preceding jumps

In both models (one and two step memory) dependences of the consecutive jumps were motivated by the negative feedback. The negative feedback is encountered both in nature and in socio-economical systems as a counteraction against some exogenous factors which aim at restoring of the initial conditions of these systems. This effect is well defined for systems in equilibrium or, approximately, in partial equilibrium by the commonly known Le Chatelier-Braun principle of contrariness.

The strong mutual dependence between consecutive jumps of a share price has been observed on financial markets in contrast to its weak statistical dependence on time intervals between consecutive trades. Importantly, this strong dependence originating in the market microstructure can deeper be understood by analysis of the order book. The order book is a deterministic system developed to organize the double auction market, such as stock market. This book contains different kinds of buy and sell orders. The most prominent feature of this auction is the so-called bid-ask spread. This spread is a positive and decisive difference between the lowest available sale offer (ask) price that sellers are willing to accept and the highest purchase (bid) price of an asset that buyers are willing to pay. The existence of the bid-ask spread and intraday dynamics of transaction prices in markets with a moderate liquidity, as is apparently the case of emerging markets (e.g. the Polish market), leads to the phenomenon called bid-ask bounce. The presence of this bounce results in a strong anti-correlation of successive price changes.

The principal aim of my thesis was to describe stochastic evolution of a typical share price on a financial market with a moderate liquidity, on a high-frequency time scale. This evolution is a short-term anti-correlated stochastic process, which I described in the frame of the CTRW model with memory. The model was mainly validated by satisfactory agreement of theoretical velocity autocorrelation function with its empirical counterpart obtained for the continuous quotation or tick-by-tick data.

14:30 Poster 7

Reputation-based cooperation – what if errors?

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We explore the model of cooperation in the Prisoner’s Dilemma, based on reputation [1]. Here, for altruisms equal zero, the probability $P(W(k,i))$ that agent k cooperates with agent i is assumed as $P(W(k,i),a)=\{1+\text{th}[a(W(k,i)-1/2)]\}/2$, where $W(k,i)\in(0,1)$ is the reputation of agent i in eyes of k and $1/a$ is a measure of errors of the players. In the limit of infinite a , the game is deterministic. Then, the game has three possible outcomes: a) both cooperate (probability 0.25), b) both defect (probability 0.25) and c) a cyclic series of games where either k cooperates and i defects, or the opposite, exchanging the strategies at each time step. Then, the distribution of $W(i,k)+W(k,i)$ consists of three sharp peaks. For finite values of a , the probability of c) decreases exponentially in time. For small values of a , a crossover is observed from the state where only options a) and b) appear ($a = 5$) to a homogeneous distribution of $W(i,k)$ at

the most fuzzy case $a=0$.

[1] K. Kułakowski, P. Gawroński, Physica A, 388 (2009) 3581.

14:30 Poster 8

The role of driving parameters of the three-state Ising model on the stability of the reconstruction of financial market phenomena

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The three-state G. Iori model of heteroagents placed in sites of a planar square lattice in the version has been modified. We model the increase of herding behaviour by simulating the altering trust of an agent to neighbour one: the trust increases if the price change has been foreseen by the neighbour correctly and decreases - if foreseen incorrectly. The agents base their decisions on looking at both their neighbours’ advice and the fundamental price of the asset. The fundamental behaviour switches on periodically. The model reconstructs the following real market phenomena (stylized facts): volatility clustering, fat tail log return distribution and the power law decay of the volatility (absolute value of log returns) autocorrelation function over time. The latter corresponds to the real market empirical data supplied with high accuracy.

14:30 Poster 9

Critical slowing down in strategy selection in crowd

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Thermal noise in order-disorder phase transitions has been generalized [1] to a wide class of phase transitions parametrized by rates of probability flows between discrete states. The rates depend on the states of neighbors of a node in a medium network. Here we apply the new parameterization to strategies selected by people in crowd, represented by a square lattice of nodes. The crossover in the scaling relation of the DFA fluctuation function [2, 3] is investigated for the time dependence of the mean strategy. The data show the critical slowing down effect near the phase transition. The obtained dynamic critical exponent z is close to 2.0, in agreement with recent literature [4].

[1] K. Malarz, R. Korff and K. Kułakowski, Int. J. Mod. Phys. C **22**, 719 (2011)

[2] C.-K. Peng, S.V. Buldyrev, S. Havlin, M. Simons, H.E. Stanley, and A.L. Goldberger, Phys. Rev. E **49** 1685 (1994)

[3] A. Bashan, R. Bartsch, J. W. Kantelhardt, and S. Havlin, Physica A **387**, 5080 (2008)

[4] M. J. Dunlavy and D. Venus, Phys. Rev. B **71**, 144406 (2005)

14:30 Poster 10

Sentiment and activity analysis of Manchester United football forum.

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We present an analysis of dynamics of discussions on web forums related to football. The data are users' text comments from various forums threads. We collected them and classified as positive (1), negative (-1) and objective (0). After averaging in time windows we received two kinds of time series describing average emotional value and number of comments in a time interval (intensity of discussion). The data set was extracted from an unofficial Manchester United forum, where club's fans can discuss topics dealing with sport, football and their favourite Premier League club. We concentrated on one part of forum called Matchday Forum, where Match Threads exist. Every thread is devoted to another MU match. We studied how a goal during the match affects the forum dynamics. A large increase of intensity of discussion is observed after goals scored or lost and a decrease average emotional value - after lost goals. We show that relaxations relative changes of these observables can be described by power law functions.

14:30 Poster 11

Emotional clusters observed in Internet communities

Tomasz Ryczkowski, Anna Chmiel, Janusz A. Hołyst

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We present an analysis of Internet users' behaviour based on the study of a set of four million comments from two services: BBC Forum and DIGG. Each of the comments was processed using sentiment analysis classifiers to determine its emotional valence (positive, negative or neutral). We propose two new versions of emotional clusters which are an extension of the definition introduced in the paper [1] to quantify the collective character of expressed emotions. The new clusters take into account the existence of noisy comments with mistakenly classified emotional valence. The presence of noise changes distributions of cluster lengths. Additionally, we suggest a simple analytical model describing emergence of noisy clusters.

[1] A. Chmiel, J. Sienkiewicz, M. Thelwall, G. Paltoglou, K. Buckley, A. Kappas, J. A. Hołyst *Collective emotions online and their influence on community life*, PLoS ONE 0022207 (2011)

14:30 Poster 12

Application of the MST technique to the analysis of cross-correlations in the Warsaw Stock Exchange.

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After publication by Rosario N. Mantegna the paper entitled "Hierarchical structure in financial markets" in The European Physical Journal, the avalanche of scientists have used MST (Minimum Spanning Tree) technique to examine financial markets. In our work we applied this method to analysis of the Warsaw Stock Exchange before, during and after its crisis in 2008. We used daily data to compute cross-correlations and build MST. Then we focused on three typical elements of the analysis: characteristics of a single graph built within wide period of time (almost two years), time dependence of the graph and on the distribution of vertex degree. We found distinct difference between graph built in 'crisis' and 'non-crisis' times. Furthermore, we found that the distributions fit well with the power law and that this law is better fulfilled in the 'non-crisis' periods. Besides, this distribution seems to be robust on selecting subsets of considered stocks. We also tested random synthetic data and found that Pareto power law behaviour is not an artefact but comes from some real significant market properties.

14:30 Poster 13

Observations and analysis of the origins of lognormal distributions of user post lengths in Internet discussions

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This paper presents an analysis of the length of comments posted in Internet discussion fora, based on a collection of large datasets from diverse environments. We found that despite differences in language, discussed topics and emotions, the distributions are very regular and well described by lognormal distribution, despite differences in topics, language and emotions of writers. We discuss possible origins of this regularity and suggest the existence of a universal mechanism deciding the length of single topic communication. We suggest that the observed logarithmic dependence may be due to a normal distribution of comment length measured in a non-linear, logarithmic-like mental space of each user, in accordance with Weber's law. We present also results of experiment measuring the accuracy of measuring the text length, strongly supporting the hypothesis of logarithmic mental representation.

14:30	Poster	14
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Superextreme Events and Their Impact on Characteristics of Time Series

Tomasz R. Werner¹, Ryszard Kutner², Tomasz Gubiec²

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Super-extreme events in the form of sustained drifts and abrupt shocks are analysed both numerically and analytically; in particular their impact on velocity autocorrelation function is discussed. Our theoretical model is based on the hierarchical Weierstrass-Mandelbrot Continuous-Time Random Walk formalism. We also discuss the possibility of an unambiguous distinction between the super-extreme "dragon-kings" and "normal" "black swans" in real empirical time series.

14:30	Poster	15
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Diffusion equation and Wigner's surmise

Ryszard Wojnar

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Non-Gaussian distributions occur in systems that do not follow the prescriptions of standard statistics. Prominent example of non-Gaussian statistics is Wigner's surmise distribution giving a remarkably good description of the level repulsion observed in neutron scattering. Wigner's distribution appears in computation of the large zeros of Riemann's zeta function on the critical line, which according to the Montgomery-Odlyzko law have the same statistical properties as the distribution of eigenvalue spacings in a Gaussian unitary ensemble. Wigner's distribution is also found in social sciences, e.g. the bus system in Cuernavaca, Mexico, is subject to this distribution.

Most non equilibrium systems do not have analytical solutions for the distribution and correlation functions. In this contribution the evolution of Wigner's statistics is studied and a diffusion type equation with source term is proposed for this aim. The solution of this equation is the Wigner distribution of the type $f(x,t) = a(t) \times \exp[-b(t) x^2]$, where $a = a(t)$ and $b = b(t)$ are functions of time t only, and x is the space variable.

1. Eugene P. Wigner, On the statistical distribution of the widths and spacings of nuclear resonance levels, *Mathematical Proceedings of the Cambridge Philosophical Society* Vol. 47, Iss. 04, 790-798 (1951).

2. H.L. Montgomery, The pair correlation of zeros of the Riemann zeta-function on the critical line, *Proc. Symp. Pure Math.* Providence 24, 181-193 (1973).

3. A.M. Odlyzko, The 10^{20} th zero of the Riemann zeta-function

and 70 million of its neighbors, in 'Dynamical, spectral, and arithmetic zeta functions' (San Antonio, TX, 1999), 139-144, *Contemp. Math.* 290, Amer. Math. Soc., Providence 2001.

4. N.M. Katz, P. Sarnak, Zeros of the zeta function and symmetry, *Bulletin of The AMS* Vol. 36, Number 1, January 1999, Pages 1-26.

5. Jinho Baik, Alexei Borodin, Percy Deift, Toufic Suidan, A model for the bus system in Cuernavaca (Mexico), *Journal of Physics A: Mathematical and General*, Vol. 39, Iss. 28, pp. 8965-8975 (2006).

6. Milan Krbálek and Petr Šeba, Spectral rigidity of vehicular streams (random matrix theory approach), *J. Phys. A: Math. Theor.* 42 (2009) 345001 (10pp).

14:30	Poster	16
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Diffusion processes on coupled complex networks

Grzegorz Siudem, Janusz A. Hołyst

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We consider a diffusion process on a graph consisting of two weakly connected complex networks. Our diffusion model takes into account attractiveness of individual nodes in both graphs but neglects interactions between moving particles. Using a time scale separation for intra- and inter-network dynamics we found an effective equation for inter-network migration that is similar to the Fick's First Law. We estimated diffusion constants for a large class of complex networks and we derived an analytical formula for the entropy production in such systems.

COFFEE

sala Rady Wydziału Mat. Fiz. Inf.
Friday afternoon, 20 April, 15:30

LECTURE

Friday afternoon, 20 April, 16:00
aula 3
Chair: Prof. Mesjasz

16:00	Oral	
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Real estate market under catastrophic change.

Mirosław Belej¹, Sławomir Kulesza²

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The dynamics of the development of the real estate market is found unprecedentedly unstable within the last decade considering changes of real estate prices. The essential problem concerns the need for establishing the limits, and re-defining the meaning of stable and unstable periods of the real estate market development, paying special

attention to discontinuous changes. The research aims at explaining the sources of abrupt real estate price changes using scientific methods which are new in this subject. The research would make it possible to model the hardly explored field of sudden changes in the real estate market in order to reveal the edge of discontinuity.

In general, the main goal is to verify the statement that the observed fluctuations in property prices are insignificant adjustments to the trend. The scientific hypothesis is that the periods of sudden price changes reflect an crucial feature of the real estate market, and they constitute the turning points of its development. The evolution path of the real estate market under the influence of the control parameters runs mostly over the areas of long-term stability, and occasionally enters into the instability area.

According to authors, the proper way to model abrupt price changes in the real estate markets influenced by external circumstances (control variables) is to make use of the theory of discontinuous change, also known as the theory of morphogenesis, or the catastrophe theory. The catastrophe theory provides a qualitative mathematical framework for reasoning about how control parameters affect the system behavior.

16:15 Oral

Fluid mechanics vs phonographic and financial markets. Power laws and correlations.

Andrzej Buda

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In fully developed turbulence, velocity fluctuations are characterized by an intermittent behaviour, which is reflected in the leptokurtic nature of the pdf of velocity increments. Experimentalists usually measure the velocity $v(t)$ as a function of time. The velocity changes are anticorrelated while S&P 500 changes are essentially uncorrelated. On the other hand, the peaks of record sales caused by new releases displays analogy to turbulence in the fluid mechanics rather than the financial markets. The Hurst exponent, the DCCA methods and hierarchical structure in phonographic and financial markets are also discussed.

16:30 Oral

Hurst exponent as a tool of technical analysis in the foreign exchange market

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Technical analysis gives us a class of investment strategies based on the analysis of trends of price time series and a multitude of indicators. There are economical theories which claim that these strategies cannot be profitable. However technical traders exist and they oper-

ate on different time scales. Why are they effective? The answer was given in 1990 by Lars Twede in "The Psychology of Finance" and is known as the idea of self-fulfilling prophecy. In our work we decided to focus on technical indicators. The main aim of the work was to investigate, if there are any connections between Hurst exponent and a few popular indicators used in technical analysis on the foreign exchange market and if Hurst exponent could be used as an indicator as well. We use different time scale to see if the effect of self-fulfilling prophecy depends also on the interval between data.

16:45 Oral

Almost Periodically Correlated Time Series in Business Fluctuations Analysis

Mateusz Pipień, Łukasz Lenart

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We propose a non-standard subsampling procedure in order to make formal statistical inference about the business cycle, one of the most important unobserved feature characterising fluctuations of economic growth. We show that some characteristics of business cycle can be modelled in a non-parametric way by discrete spectrum of the Almost Periodically Correlated (APC) time series. On the basis of estimated characteristics of this spectrum it is possible to extract business cycle by filtering. On the basis of our results we characterise the main properties of business cycles in industrial production index for Polish economy.

17:00 Oral

Utility functions invariant with respect to some classes of transformations

Jacek Chudziak

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A von Neumann-Morgenstern utility function U is said to be invariant with respect to a family of transformations G provided for every member g of G , the function U and $U \circ g$ represent the same preference. According to the classical result of Pfanzagl [P] a continuous utility function is invariant with respect to the shift transformations if and only if it is either a linear or an exponential function. Recently, Abbas [A] has proved that a utility function invariant with respect to a single shift value may depend on an arbitrary periodic function. Therefore the following problem arises naturally: given a nonempty set T of shifts determine all utility functions invariant with respect to every shift from T . In the present talk we give a complete answer to this question. As a consequence of our results we obtain the forms of utility functions invariant with respect to the families of commuting transformations. In this way we generalize the results from [A].

[A] A.E. Abbas, Invariant utility functions and certain equivalent transformations, *Decision Analysis* 4 (2007), 17--31.

[P] J. Pfanzagl, A general theory of measurement. Applications to utility, Naval Res. Logist. Quart. 6 (1959), 283--294.

17:15

Oral

Basic sources of economic complexity

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The catastrophe theory and the deterministic chaos constitute basic elements of the science of complexity. Elementary catastrophes were the first remarkable form of nonlinear, topological complexity that were seriously studied in economics. The deterministic chaos and other types of complexity succeed the catastrophes theory. In general, chaos means seemingly random behavior of a deterministic system, which stems from high sensitivity to initial condition. The nonlinear dynamical systems theory, which unites various manifestations of complexity into one integrated system, is contrary to assumptions that markets and economies spontaneously strive for the state of equilibrium. Just the opposite, their complexity seems to grow due to the influence of classic economic laws. In my paper, I indicate that with time model economic systems strive for the state we call the edge of chaos. I consider three cases. The first one concerns the cobweb theorem and indicates that price expectations shape up in such a way that it makes the market more complex. Next, I consider the Cournot-Puu duopoly model in which striving for the edge of chaos stems from profit maximization by entrepreneurs. The third case concerns an economy based on a two-stage accelerator, where the economic cycle takes up a form of chaotic hysteresis. The evolution of systems at the edge of chaos can be sudden, which makes it necessary to consider it in terms of elementary catastrophes.

17:30

Oral

Classification scheme of correlation between time series on the example of GDP per capita of the most developed countries.

Janusz Miśkiewicz

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Based on Manhattan distance the classification scheme of correlation between time series is proposed. The method allows to measure the strength of dependence between time series as a order of polynomial fitted to the cumulated Manhattan distance between time series. Moreover, the methods allows to measure stability of correlation by estimating the quality of the fit appropriate curves. The method is illustrated on the example of the correlation analysis of GDP per capita for 19 of the most developed countries in the world. The correlations were analysed in the short, medium and long time distance correlation range (10, 20 and 30 years respectively). The obtained distance matrices were used to construct network structures assuming that the link between countries exists if the distance between them is

greater than given reference values (median, mean and the mean minus and plus standard deviation). Obtained network are than discussed. The results were compared with analysis based on the ultrametric correlation distance.

17:45

Oral

Phase transitions in the generalized voter model with nonconformity.

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There are two widely recognized types of nonconformity: anti-conformity and independence. From a social point of view, it is very important to distinguish between independence and anti-conformity. The term 'independence' implying the failure of attempted group influence. Independent individuals evaluate situations independently of the group norm. On the contrary, anti-conformists are similar to conformers in the sense that both take cognizance of the group norm - conformers agree with the norm, anticonformers disagree. We show how the both types of nonconformity can be introduced into opinion dynamics models with binary opinions taking as an example the generalized voter model. We discuss the differences and similarities between aniconformity and independence from different perspectives - simple physical microscopic models and social reality.

CONFERENCE DINNER

tram: 6, 11 i 12 + spacer ul. Długa

Friday evening, 20 April, 19:00

"Browarnia" ul. Szafarnia 9, Stare Miasto

Saturday, 21 April

LECTURE

Saturday morning, 21 April, 9:00

aula 3

Chair: Prof. Struzik

9:00

Oral

The emotional experience mathematical model

Yury Glazunov

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This paper considers the problem of modeling how objectives are set by a human being. We find this problem interesting mainly in context of the research of so-called goal-pursuing systems, which include: enterprises, schools, military troops, administrative regions, manned aircraft etc. An inherent element of such systems is a human being, who performs a function of setting objectives. The reason that underlies setting objectives is emotional experience. It is also connected with motivation of activity in the process of achieving objectives. It is emotional experience that changes one's initial state of spirit into aim and motive.

To start a procedure of formulating goal there must be a requirement and opportunity to satisfy it. This state creates disharmony between something objectively essential (but absent) and current condition of the body. Structure, which satisfies the requirement is called the impulse. After finding the impulse and under the influence of emotion, requirement transforms into motive and impulse - into goal.

The emotional experience model was formulated as a Cauchy's task for a system of differential equations. The solution allowed for drawing the emotional intensity curve and specifying its fundamental characteristics: the beginning of emotion, the moment and height of emotional "peak" as well as points of changes in the nature of the course of emotion, and others. The solution allows for drawing the following conclusions.

1. The biggest importance of emotions' intensity reaches later as there is a bigger initial range between the pragmatic information whose possession guarantees the need's satisfaction and an actually existing level of pragmatic information which an individual has at the actual time.
2. An emotional elevation created once does not "fall half asleep". Gradually decreasing the intensity, the emotion does not die but stays in an individual's subconsciousness forever.
3. There is a doorstep of affection for perceiving emotions.
4. A fast rise of pragmatic information increases the level of the emotional tension. An ability of a fast processing information shows an individual's intellect: the biggest individual's intelligence is, the better this ability is developed. It means that the people who are more intelligent are "less emotional.", their emotional experience is not that strong and does not last long like in case of the other people.

The results of the research opened the way for applying mathematics in studying other psychological phenomenons which leads to creating and developing mathematical psychology.

9:20 Oral

Analytical approach to model of scientific revolutions

Paweł Kondratiuk, Grzegorz Siudem, Janusz A. Hołyst

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The model [1] of scientific paradigms spreading throughout the community of agents with memory is analyzed using the master equation. Our analytical solutions are compared with numerical simulations. The case of two competing ideas is considered for various networks of interactions, including agents placed at chains, complete graphs, ER graphs, stars, square lattices and BA graphs. The pace of

adopting a new idea by the community is analyzed, along with the distribution of periods between dominating paradigm shifts. We study the impact of the interactions topology onto the dynamics, as well as the role of hubs in the process. The approach is extended for the chain topology onto the more general case when more than two ideas compete.

The preprint of our paper can be found at [2].

[1] S. Bornholdt, M. H. Jensen, and K. Sneppen, *Phys. Rev. Lett.*, 106(5):058701, Feb 2011.

[2] P. Kondratiuk, G. Siudem, and J. A. Hołyst, arXiv:1106.0438v2 [physics.soc-ph], June 2011.

9:40 Oral

Literary and scientific texts in network representation

Andrzej Kulig¹, Iwona Grabska-Gradzińska², Stanisław Drożdż^{1,3}, Jarosław Kwapien¹

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We present results from our quantitative study of statistical and network properties of literary and scientific texts written in two languages: English or Polish. By using the Zipf analysis, we show some quantitative differences between the Polish and English language as well as between literary and scientific texts in both languages. We then transform the texts into their network representations and find that in each case the corresponding networks are hierarchical. If we quantify the networks by their basic statistics like the clustering coefficient, the average shortest path length, and the network centrality, we find other differences between the languages, which can be attributed to differences in grammar. However, we observe also important similarities between different texts written in either language.

10:00 Oral

Personal incomes vs households incomes in Poland

Piotr Łukasiewicz¹, Krzysztof Karpio², Arkadiusz J. Orłowski^{2,3}

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In this paper we study dependencies between distributions of personal and households incomes in Poland in 2000 to 2010. For example, the distributions of households incomes in US can be obtained by a convolution of distributions of personal incomes of family members. As was derived from our previous studies for 2005, in Poland there is no such a simple dependency. In principle, there is a very little knowledge about a type of relationship between those incomes in

Poland. In the case of US, personal incomes of family members are probably independent of each other. On the other hand, in Poland they are for sure dependant variables. In this paper we study personal and households incomes in Poland, their changes in time and their mutual relationship. Incomes distributions have been described by the three-parameter Dagum function.

10:15

Oral

Subsequent movements' proportions of share prices included in the WIG over recent years

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A large amount of intraday data of stock prices allow us to create a summary of subsequent movements' proportions of the collected share prices in the form of histogram. I have created two kinds of histograms. One for proportions of subsequent increasing and decreasing price movements. Second for proportions of subsequent price movements in the same direction. I have also created the same kinds of histograms for duration of price movements. All the histograms quite well fit the gamma probability distribution. The distribution coefficients' values for price are above 1, for time are below 1. Some proportions of price movements occur more frequently than others, creating a peak on the graph. Similar regularity occurs for the time factor. This property is often used in trading. The values of some peaks in comparison with the background are placed in a table.

10:30

Oral

Long-range dependencies in quick-sorting

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In this presentation it will be shown that there is a possibility to establish direct connections between some applications of statistical mechanics and analysis of algorithmic processing. As a basis we assume that a computer system is a machine in which we have a transformation of free energy into useful work, i.e., mathematical computations. We present the case of quick-sort algorithm and its statistical mechanics analysis in terms of possible existence of long-range dependencies. Sorting is one of the most frequently used types of processing in computer systems. In our approach sorting will be considered as an introduction of order into processed input task and algorithm as a physical system. Our analysis will show how the dependencies in processed tasks can influence the behavior of algorithm (or equivalently Turing machine). Normally, analysis of any algorithm behavior is done in terms of classical computational complexity, which usually considers only tree cases: pessimistic, optimistic and average assuming that only those instances are important. This is done in order to ensure the independence of this measure on specific input sets properties. However, this approach doesn't allow to answer some interesting questions, for example: is there any influ-

ence of input set on processing dynamics? In the case of quick sorting this question will be: is there any influence of input set properties (for example the existence long-range dependencies) on quick sorting dynamics. In our research we show that such a dependency exists. The investigations are based on computer simulations performed for set of 1000 instances with different values of H parameter. Each input set has 10^6 elements. The rate of existence of long-term correlations in processing dynamics is calculated basing on Hurst coefficient. This allows for description of this algorithm in a different way: as a physical machine in which processing (energy consumption) is governed or not by long-range dependencies.

10:45

Oral

Models of rating dynamics

Urszula Grzybowska, Marek J. Karwanski, Arkadiusz J. Orłowski

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The measures of probability of default (PD) used in banks are done on the aggregated level, that means that companies are grouped in rating classes and a specific value of PD is assigned to each class. Internal rating systems use the methodology called PIT (Point in Time). In practice it is necessary to re-calibrate models and estimate the PDs every time the state of economy changes. Fortunately, the study of credit rating dynamics can be reduced to the analysis of migration matrices. It is convenient to consider migration process as a stationary Markov chain to obtain stable estimates. However, ratings don't have the properties of stationary Markov processes. There are many proposals of the so-called non-Markov processes, such as: "rating drifts", hidden Markov chains, Markov Mixture Models.

In this paper, the authors would like to present the model of Markov process based on the direct link between the transition matrix and time. Temporal changes occur relatively slowly, and we can assume the properties of defaults are close to exponential distribution. This is the reason of existence an intensity matrix for a Markov process which allows to enter hazard space. The intensity matrix defines the levels of hazard in the space corresponding to the ratings. In general, the levels are deterministic functions of time or stochastic processes such as random walks. The transition from the intensity of the migration matrix requires Monte Carlo simulations. The authors tried to link the resulting model with external factors such as the state of the economy "crisis/development." Inferences were drawn based on simulated data.

Literature:

1. H. Frydman, T. Schuermann (2007), „Credit Rating Dynamics and Markov Mixture Models”, Wharton;
2. G. Giampieri, M. Davis, M. Crowder (2005), “A Hidden Markov Model of default interaction”, Quantitative Finance;
3. D. Lando, T. Skødeberg (2002), “Analyzing Ratings Transitions and Rating Drift with Continuous Observations,” Journal of B&F;

COFFEE

Saturday morning, 21 April, 11:00
sala Rady Wydziału Mat. Fiz. Inf.

LECTURE

Saturday morning, 21 April, 11:30
Chair: Prof. Kulakowski

11:30 Oral

Hate Networks Revisited: Observations of Gazeta Wyborcza discussion forum 2009-2011

Paweł Sobkowicz¹, Antoni Sobkowicz²

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We present an analysis of the properties of a social network, formed by users participating in one of the most popular Polish political discussion forums, gathered at three periods within a two year time, during which events that significantly increased the already strong political division of the Polish society occurred. We find that despite communication is motivated by controversy and negative emotions, the resulting social network is remarkably similar to networks formed in discussion boards based on similarity of views; showing power-law like behavior of user popularity and activity. All collected messages have been analyzed to determine their content type, author's political sympathies and emotion level. An automatic emotion recognition algorithm is presented, giving results closely corresponding to human evaluations. Using the data on reader evaluation of the comments we present estimates of the political sympathies of the 'silent majority' of forum readers. The data from the observations are used as the input for an agent based computer simulation model, reproducing many observed characteristics of the forum. We observe a remarkable stability of individual political support. Extensive discussions among the forum users did not lead to changes in their political affiliations or specific opinions. In contrast, emotions expressed by the forum users, mainly negative, were found to vary from post to post and between the discussion threads. We show that differences in a user interface between the two alternative forum Web pages, especially effects of features promoting direct one-to-one communication, have significant impact on message content and decrease negative emotions. Implications of such changes on promoting communication across a political divide are discussed.

12:00 Oral

Monte Carlo studies of the p-spin models on complex scale-free hypernetworks

Andrzej Krawiecki

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Complex hypernetworks are generalizations of complex networks in which the edges, called hyperedges, can relate more than two nodes. In particular, scale-free hypernetworks can be obtained as evolving networks, using a generalization of a "preferential attachment" algorithm. Hypernetworks occur in natural way in various models in social and economic sciences, where the nodes represent the agents and hyperedges represent relationships or interactions involving more than two agents which lead to the appearance of new, so-called emergent phenomena (e.g., groups of authors who published papers together, three-way relationships between resources, tags, and users in the folksonomy, etc.). So far little has been known about critical phenomena in systems with the structure of complex hypernetworks. In this work, p -spin models on complex scale-free hypernetworks are investigated by means of Monte Carlo simulations, with the spins located in the nodes and the hyperedges connecting p nodes corresponding to ferromagnetic p -spin exchange interactions. In particular, systems without time-reversal symmetry, with $p = 3, 5, 7 \dots$ are considered. Studying phase transitions in such systems is a natural extension of the previous investigations of the ferromagnetic transition in the Ising model on scale-free networks. The models considered in this work differ from the mean-field p -spin models which have often been applied to study spin-glass transition mainly by the presence of the topological structure of interactions. In the systems under study the ground state can be highly degenerate: many spin-glass-like states, with apparently random orientations of spins, can have energy equal to that of the ferromagnetic ordered state. The degeneracy of the ground state is determined by the hypernetwork topology, which in turn depends on the details of the "preferential attachment" algorithm used to build the hypernetwork. If in the thermodynamic limit the degeneracy is finite, evidence for the phase transition is found, e.g., the cusp in the magnetic susceptibility, and below the critical temperature the ferromagnetic state is a possible stable phase. In contrast, if there are infinitely many degenerate ground states, neither ferromagnetic nor spin-glass transition is observed.

12:30 Oral

Accuracy of the box-counting algorithm for noisy fractals

Andrzej Z. Górski¹, Mariusz Stróż^{1,2}, Paweł Oświęcimka¹, Janusz Skrzat³

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The box-counting algorithm is applied to calculate fractal dimensions of four fractal sets. The sets are contaminated with white noise of amplitude $\gamma = 10^{-5} \div 10^{-1}$. The accuracy of calculated numerical values of the fractal dimensions is analyzed as a function of γ for different sizes of the data sample (n_{tot}).

**Konkurs na najlepszą pracę doktorską, magisterską
i licencjacką: 5-cio minutowe prezentacje
laureatów**

Saturday afternoon, 21 April, 13:00

LUNCH

Saturday afternoon, 21 April, 13:30

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