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Fachverband Physik sozio-ökonomischer Systeme (SOE)

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Overview of Invited Talks and Sessions

(lecture rooms H 0110, H 0105, HE 101, MA 004, MA 001; Poster F)

Keynote Talks related to SOE

SOE 4.1	Mon	14:00–14:45	H 0105	**The Fragility of Interdependency: Coupled Networks & Switching Phenomena** — •H. Eugene Stanley

Tutorial and Panel Discussion Scientific Writing

SOE 1.1	Sun	16:00–16:20	H 0105	**Tutorial for authors and referees** — •Hernan Rozenfeld
SOE 1.2	Sun	16:20–16:40	H 0105	**From submission to publication with IOP journals - a guide for authors** — •Tim Smith
SOE 1.3	Sun	16:40–17:00	H 0105	**Preparing and submitting a scientific paper** — •Rachel Won
SOE 1.4	Sun	17:00–17:20	H 0105	**Writing to meet expectations** — •Mark Buchanan

Invited Talks

Further invited talks are listed below as parts of focus sessions.

SOE 11.1	Wed	9:30–10:15	H 0110	**Adaptive Networks of Opinion Formation in Humans and Animals** — •Thilo Gross
SOE 17.1	Thu	9:30–10:15	H 0110	**Common design principles of metabolic networks and industrial production** — •Marc Hütt

Focus Session: Big Data

SOE 5.1	Mon	15:00–15:30	HE 101	**Cities and Complexity** — •Michael Batty
SOE 5.2	Mon	15:30–16:00	HE 101	**Experimental Computational Finance & Big Data Environment** — •Philip Treleaven
SOE 5.3	Mon	16:00–16:30	HE 101	**Embedding high dimensional data on networks** — •Tiziana DiMatteo
SOE 5.4	Mon	16:30–17:00	HE 101	**Econophysics and social research with large sets of data** — •Rosario N. Mantegna

Focus Session: Models of War and Conflict

SOE 8.1	Tue	9:30–10:00	H 0110	**The distribution and dynamics of war sizes** — •Aaron Clauset
SOE 8.2	Tue	10:00–10:30	H 0110	**Modeling Wars and Terrorism: From particles to people** — •Neil Johnson
SOE 8.3	Tue	10:30–11:00	H 0110	**Spatio-Temporal Dynamics of Violence in Jerusalem** — •Karsten Donnay

Award Ceremony: Young Scientist Award for Socio and Econophysics

SOE 16.1	Wed	18:00–18:40	H 0105	**The Role of Agent Based Models in Understanding Human Societies** — •Stefan Thurner
SOE 16.2	Wed	18:50–19:30	H 0105	**The evolution of cooperation in simple agent based models** — •Arne Traulsen

Invited talks of the joint symposium SYCF

See SYCF for the full program of the symposium.

SYCF 1.1	Wed	9:30–10:00	H 0105	**Der Reaktorunfall von Fukushima: Unfallablauf, Emissionen, Immissionen** — •Gerald Kirchner, Bernhard Fischer
SYCF 1.2	Wed	10:00–10:30	H 0105	**Radiologische und radioökologische Aspekte des Reaktorunfalles von Fukushima** — •Gerhard Proehl
SYCF 1.3	Wed	10:30–11:00	H 0105	**Wie Fukushima die Energiepolitik und Energieforschung in Deutschland und international verändert** — •Joachim Knebel
SYCF 1.4	Wed	11:00–11:30	H 0105	**Entscheidungszwänge in der Weltenergieversorgung und Klimapolitik bei hoher Unsicherheit** — •Carl Christian von Weizsäcker

Invited talks of the joint symposium SYND

See SYND for the full program of the symposium.

SYND 1.1	Thu	9:30–10:00	H 0105	**Controlling Complex Networks with Compensatory Perturbations** — •Adilson E. Motter
SYND 1.2	Thu	10:00–10:30	H 0105	**Toward control, prediction, and optimization of biological and engineering complex networks** — •Kazuyuki Aihara
SYND 1.3	Thu	10:30–11:00	H 0105	**Design of robust functional networks as complex combinatorial optimization problem** — •Alexander S. Mikhailov
SYND 1.4	Thu	11:00–11:30	H 0105	**Braess Paradox, (In-)Stability and Optimal Design: Nonlinear Dynamics of Modern Power Grids** — •Marc Timme, Dirk Witthaut, Martin Rohden, Andreas Sorge
SYND 1.5	Thu	11:30–12:00	H 0105	**Delay-Coupled Laser Networks: Complex Behavior, Synchronization and Applications** — •Ingo Fischer

Sessions

SOE 1.1–1.4	Sun	16:00–18:30	H 0105	**Tutorial and Panel Discussion Scientific Writing**
SOE 2.1–2.4	Mon	9:30–10:45	H 0110	**Financial Markets and Risk Management I**
SOE 3.1–3.6	Mon	11:00–12:30	H 0110	**Economic Models and Evolutionary Game Theory I**
SOE 4.1–4.1	Mon	14:00–14:45	H 0105	**Keynote Talk**
SOE 5.1–5.4	Mon	15:00–17:00	HE 101	**Focus Session: Big Data**
SOE 6.1–6.6	Mon	17:15–18:45	HE 101	**Focus Session: Big Data (Contributed Talks)**
SOE 7	Mon	19:00–19:30	H 0110	**Annual Member's Assembly of SOE**
SOE 8.1–8.3	Tue	9:30–11:00	H 0110	**Focus Session: Models of War and Conflict**
SOE 9.1–9.6	Tue	11:15–12:45	H 0110	**Energy and Environment**
SOE 10.1–10.6	Tue	14:00–15:30	H 0110	**Social Systems, Opinion and Group Dynamics I**
SOE 11.1–11.1	Wed	9:30–10:15	H 0110	**Networks, From Topology to Dynamics I (joint w. DY)**
SOE 12.1–12.9	Wed	10:15–12:45	H 0110	**Networks, From Topology to Dynamics II (joint w. DY)**
SOE 13.1–13.7	Wed	14:00–15:45	H 0110	**Communication and Language**
SOE 14.1–14.7	Wed	15:00–16:45	MA 004	**Networks, From Topology to Dynamics III (joint w. DY)**
SOE 15.1–15.21	Wed	16:45–17:50	Poster F	**Poster Session**
SOE 16.1–16.2	Wed	18:00–20:00	H 0105	**Award Ceremony: Young Scientist Award for Socio- and Econophysics**
SOE 17.1–17.1	Thu	9:30–10:15	H 0110	**Traffic Dynamics, Urban and Regional Systems I**
SOE 18.1–18.4	Thu	10:15–11:15	H 0110	**Traffic Dynamics, Urban and Regional Systems II**
SOE 19.1–19.3	Thu	11:30–12:15	H 0110	**Social Systems, Opinion and Group Dynamics II**
SOE 20.1–20.5	Thu	14:00–15:15	H 0110	**Social Systems, Opinion and Group Dynamics III**
SOE 21.1–21.6	Thu	15:30–17:00	H 0110	**Economic Models and Evolutionary Game Theory II**
SOE 22.1–22.8	Fri	10:00–12:00	MA 001	**Networks, From Topology to Dynamics IV (joint w. DY)**

Annual General Meeting of the Physics of Socio-economic Systems Division

Mo 19:00–19:30 H 0110

SOE 1: Tutorial and Panel Discussion Scientific Writing

Although the publication of research results is one of the most essential things for being successful in science, for many scientists writing papers can be an exhausting thing. Especially for those who are at the beginning of their scientific career there are many unclear questions concerning the topic "scientific writing". How should the manuscript be written? Which results should be presented in the paper and how? With the help of experienced editors from some of the most important international journals our tutorial will try to demystify the topic and will answer the above and other related questions. A special intention is to provide young physicists with useful information since their chances to learn more about writing scientific publications are usually very rare. Our tutorial is, therefore, divided into two equal parts. In the first our panel guests will give a short introduction to the topic, whereas in the second part we will pick up some particular aspects for a group discussion. This part will also be open for questions from the audience.

Time: Sunday 16:00–18:30 Location: H 0105

Tutorial SOE 1.1 Sun 16:00 H 0105

Tutorial for authors and referees — •Hernan Rozenfeld — APS Editorial Office. Ridge, NY USA.

In this talk we will start by explaining how editors process a manuscript that is submitted for publication to an APS journal, including a brief overview on how we choose referees. We will show how to write a well-structured manuscript and what is expected in each section and will provide some hints on how to prepare referee reports. After the presentation the audience will be given a chance to ask questions to a panel of editors from different journals.

Tutorial SOE 1.2 Sun 16:20 H 0105

From submission to publication with IOP journals - a guide for authors — •Tim Smith — IOP Publishing, Bristol, UK

This talk will provide an overview of the editorial process involved in publishing a research paper in IOP journals. Particular focus will be placed on the process of editorially assessing articles for suitability (including referee selection), the expectations of referees in assessing key criteria for publication and tips for authors in preparing a manuscript for submission. Finally I will take a look at Video Abstracts (recently launched by New Journal of Physics) and how these can represent a new option for authors looking to broaden the reach of their work.

Tutorial SOE 1.3 Sun 16:40 H 0105

Preparing and submitting a scientific paper — •Rachel Won — Nature Photonics, Tokyo, Japan

Rachel will talk you through the concept of scientific detailed information and the guidelines on scientific manuscript preparation and submission, as well as an overview on the editorial and peer-review processes. You will learn what editors seek, how to write a good cover letter and a good scientific paper, and how to make an appeal.

Tutorial SOE 1.4 Sun 17:00 H 0105

Writing to meet expectations — •Mark Buchanan — 35a West St, Abbotsbury, UK

The human mind isn't a blank slate. Readers come to any scientific paper – indeed, to any piece of writing – with preconceptions, expectations, habits and instincts, some genetically hard wired. Effective communication aligns itself with such instincts, avoiding needless confusion by laying out arguments in a style that meets readers' expectations and works with the human brain, not against it. I'll illustrate these points with examples from scientific papers.

There will be a panel discussion with all invited speakers after their contributions, chaired by Stefan Hildebrandt (Editor in chief pss-journals).

SOE 2: Financial Markets and Risk Management I

Time: Monday 9:30–10:45 Location: H 0110

SOE 2.1 Mon 9:30 H 0110

Systemic Risks in Techno-Socio-Economic Systems: Need of a New Science — •Dirk Helbing — ETH Zurich, Clausiusstr. 50, 8092 Zurich

Globalization and technological progress have created strongly connected, complex, and global techno-socio-economic-environmental systems. These systems often show large-scale cascading effects (such as the financial, economic, public spending and political crises, for example) and extreme events. However, such effects are largely neglected by models of risk assessment and risk management, leading to insufficient preparations for cases of crisis. It is argued that we need to develop a new systems science, push complexity science towards practical applications, and develop the data science required for this. Furthermore, I will outline the strategy of the FuturICT flagship project to get towards a more resilient and sustainable world.

SOE 2.2 Mon 10:00 H 0110

A Random Matrix Approach to Credit Risk — Michael C. Münnix, •Rudi Schäfer, and Thomas Guhr — Fakultät für Physik, Universität Duisburg-Essen, Germany

We estimate generic statistical properties of a structural credit risk model by considering an ensemble of correlation matrices. We use Random Matrix Theory to setup this ensemble. We demonstrate analytically that the presence of correlations severely limits the effect of diversification in a credit portfolio if the correlations are not identically zero. The existence of correlations alters the tails of the loss distribution considerably, even if their average is zero. Under the assumption of randomly fluctuating correlations, a lower bound for the estimation of the loss distribution is provided.

SOE 2.3 Mon 10:15 H 0110

A time-homogeneous credit mechanism using money and anti-money — •Andreas Schacker and Dieter Braun — Faculty of Physics, LMU Munich

The appearance of monetary crises throughout human history and their interplay with the real economy have puzzled generations of economists. There are many schools of thought on as to what are the actual causes of such crises and how monetary policy can try to avert them. The growing application of tools from statistical physics promises to provide new insight into monetary and creditary dynamics. In particular, it has been suggested that creation of credit money might itself be a source of financial instability.

We show that bank lending via current creditary mechanisms creates non-local purchasing power transfers adversely affecting non-involved asset holders, which might lead to increasing price levels. Starting from this observation, we construct a bi-currency system of non-bank assets ('money') and bank assets ('anti-money') in which a payment can either be made by passing on money or by receiving anti-money. Motivated by an analogy to physics, we impose the symmetry of time homogeneity on the system. This leads to a constant money supply per market participant and prohibits non-local transfers of purchasing power. The issue of credit crunches commonly associated with a constant money supply is overcome by introducing a novel mechanism of

liquidity transfer that relies on a free floating exchange rate between non-bank assets and bank assets.

SOE 2.4 Mon 10:30 H 0110

Comprehensive analysis of market conditions in the foreign exchange market: Fluctuation scaling and variance-covariance matrix — •Aki-Hiro Sato[1] and Janusz Holyst[2] — [1]Graduate School of Informatics, Kyoto University, Yoshida-Honmachi, Sakyo-ku, Kyoto 606-8501, JAPAN — [2]Faculty of Physics and Center of Excellence for Complex Systems Research, Warsaw University of Technology, Koszykowa 75, PL-00-662, Warsaw, POLAND

We investigate quotation and transaction activities in the foreign exchange market for every week during the period of June 2007 to December 2011. A scaling relationship between the mean values of quotations numbers (or transactions numbers) for various currency pairs and the corresponding standard deviations holds for a majority of the weeks. However, the scaling breaks in some time intervals, which is related to the emergence of market shocks. There is a monotonous relationship between values of scaling indices and global averages of currency pair cross-correlations when both quantities are observed for various window lengths Δt.

SOE 3: Economic Models and Evolutionary Game Theory I

Time: Monday 11:00–12:30 Location: H 0110

SOE 3.1 Mon 11:00 H 0110

The tragedy of the commons of BitTorrent: a concrete application of agent based models — •Steve Genoud[1], Tamás Vinkó[2], Sergi Lozano[1], and Dirk Helbing[1] — [1]ETHZ, Zürich, Switzerland — [2]TUD, Delft, The Netherlands

Peer to peer (p2p) softwares allows the creation of new cheap, decentralised and scalable means of computing. Any Skype call, for instance, rests on this technology. The BitTorrent protocol is another example of a successful implementation of p2p file-sharing.

The distribution of a load across individual users give p2p systems their strength. But this creates a situation similar to a public goods game. As producer-consumer, users are tempted to consume as much as possible, while producing nothing. Therefore the users behaviors, especially their sharing preferences, are crucial for the system performance. These aspects, especially the dynamic effects of incentives, are currently overlooked in the literature.

We propose an agent based model of BitTorrent as a *techno-social system*. We compose a detailed simulation of the protocol with a decision model of the agents. The resulting model should obey the macro social behavior we observe in real communities. We can use measurements of the performance of actual systems to fix the parameters of the model. Finally, we show how this framework may be used to test new protocols.

SOE 3.2 Mon 11:15 H 0110

Multidimensional multiplicative noise arising in evolutionary dynamics — Arne Traulsen[1], •Jens Christian Claussen[2], and Christoph Hauert[3] — [1]Evolutionary Theory Group, Max-Planck-Institute for Evolutionary Biology, Plön — [2]Institut für Neuro- und Bioinformatik, Univ. Lübeck — [3]Dept. of Mathematics, Univ. of British Columbia, Vancouver

We present a general framework to describe the evolutionary dynamics of an arbitrary number of types in finite populations based on stochastic differential equations. For large, but finite populations this allows to include demographic noise without requiring explicit simulations. Instead, the population size only rescales the amplitude of the noise. Moreover, this framework admits the inclusion of mutations between different types, provided that mutation rates, μ, are not too small compared to the population size N, i.e., limitations occur for $\mu N \ll 1$. We illustrate our approach by a Rock-Scissors-Paper game with mutations, where we demonstrate excellent agreement with simulation based results for sufficiently large populations. In the absence of mutations the excellent agreement extends to small population sizes.

SOE 3.3 Mon 11:30 H 0110

Game theoretic foundations of macroeconomic rational expectation equilibria — •Eckehard Olbrich[1], Nils Bertschinger[1], and David H. Wolpert[2] — [1]MPI MiS, Leipzig, Germany — [2]Santa Fe Institute, NM, USA

We investigate the game-theoretic foundations of rational expectation equilibria in a prototypical macroeconomic model, the famous "coconut" model [1, 2]. In this model agents have to decide whether to make a costly investment in a production facility. Agents only value goods produced by *other* agents, but can trade a good they produce for a good produced by another agent. In this model a market failure equilibrium can arise as a self-fulfilling prophecy, where everyone believes nobody else invests, and therefore nobody makes the investment necessary to have a good to trade. However in other equilibria, the self-fulfilling prophecy leads everyone to invest, and there is no market failure. We show that there are multiple ways to formulate the coconut model as a game, each resulting in different Nash equilibria. We also show that the equilibrium analysis of [2] contains inconsistencies and resolve them. In particular, we establish that the dynamical system analyzed in [2] is only a necessary condition for Nash equilibria, but does not provide a reasonable model for *off*-equilibrium agent behavior. To correct this we introduce learning to the model, and present a modified stability analysis. [1] P. Diamond, *Aggregate demand management in search equilibrium*, J. Pol. Econ. **90**, 881–894. [2] P. Diamond and D. Fudenberg, *Rational expectations business cycles in search equilibrium*, J. Pol. Econ. **97** (1989), 606–619.

SOE 3.4 Mon 11:45 H 0110

Response to social norms enhancement by heterogenous populations — •Claudio J. Tessone[1], Anxo Sánchez[2], and Frank Schweitzer[1] — [1]Chair of Systems Design, ETH Zürich. Kreuzplatz 5, CH-8032 Zürich, Switzerland — [2]Grupo Interdisciplinar de Sistemas Complejos (GISC), Departamento de Matemáticas, Universidad Carlos III, E-28933 Leganés , Spain

We study the appearance of diversity-induced resonance in a purely economic model of cooperating and defecting agents. The contribution of an agent to a public good is seen as a social norm. So, defecting agents face a social pressure, which decreases if free-riding becomes widespread. Diversity, in this model, comes from the different sensitivity of agents towards the social norm, which itself can change over time in a periodic manner. We study the evolution of cooperation in response to the social norm (i) for the replicator dynamics, and (ii) for the logit dynamics, both analytically and by means of computer simulations. Diversity-induced resonance is observed as a peak in the response of the agents to a change in the strength of the social norm, as a function of the diversity in the individuals. We provide an analytical, mean-field approach for the logit dynamics that is in very good agreement with the simulations, making explicit the connection with the physical paradigm of diversity-induced resonance in bistable systems. From a socio-economic perspective, our results show that, counter-intuitively, idiosyncratic diversity in the individual sensitivity to social norms may result in a society that better follows such norms as a whole, even if part of the population is less prone to follow them.

SOE 3.5 Mon 12:00 H 0110

Complex dynamics in game learning — •James Sanders[1], Tobias Galla[1], and J. Doyne Farmer[2] — [1]School of Physics and Astronomy, The University of Manchester, Manchester, UK — [2]Santa Fe Institute, Santa Fe, New Mexico, USA

Game learning processes are of interest in many fields, from the study of financial markets in which traders learn from their past successes and failures, to the design of computer systems that can improve their behaviour based on previous experiences. We study experience-weighted attraction, an empirically-based model of game learning behaviour, focusing in particular on the conditions under which it displays chaotic dynamics. We discuss low-dimensional games as well as those with a large number of strategies, where very high-dimensional chaotic attractors can be seen. This has potential implications for complex systems that can be modelled using experience-weighted attraction, as the presence of this kind of complex dynamics places severe limits on the predictability of a system.

SOE 3.6 Mon 12:15 H 0110

Self-organized cartel dynamics in a modified trust game — •Tiago P. Peixoto and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen, Otto-Hahn-Allee 1, D-28359 Bremen, Germany

We investigate the dynamics of a trust game on a mixed population where individuals are forced to play against a predetermined number of partners, which they are allowed to dynamically choose. Players are also allowed to update their level of trustworthiness, based on payoff. The dynamics undergoes a transition at a specific value of the strategy update rate, above which an emergent cartel organization is observed, where individuals have similar values of below optimal trustworthiness. This dynamics is marked by large fluctuations and a high degree of unpredictability for most of the parameter space, and serve as a plausible qualitative explanation for observed fluctuations in certain commodity prices.

SOE 4: Keynote Talk

Time: Monday 14:00–14:45 Location: H 0105

Keynote Talk SOE 4.1 Mon 14:00 H 0105

The Fragility of Interdependency: Coupled Networks & Switching Phenomena — •H. Eugene Stanley — Departments of Physics, Chemistry, & Biomedical Engineering, Boston University, Boston, MA 02215 USA

Recent disasters ranging from financial "shocks" to large-scale power outages and terrorist attacks dramatically demonstrate what dangerous vulnerability hides in the many interdependencies which exist among different networks. In the past year, we have quantified failures in interconnected networks, and demonstrated the need to consider mutually dependent network properties in designing resilient systems. Specifically, we have uncovered new laws governing the nature of switching phenomena in coupled networks, and found that phenomena that are smooth in isolated networks become abrupt in interdependent networks [S. V. Buldyrev, R. Parshani, G. Paul, H. E. Stanley, & S. Havlin, *Nature* **464**, 1025 (2010); J. Gao, S. V. Buldyrev, H. E. Stanley, & S. Havlin, *Nature Physics* **8** (1 Jan. 2012)]. We conclude by discussing the possibility that financial crashes are not unlike the catastrophic failures occurring in coupled networks. Specifically, we find that "trend switching phenomena" in complex financial systems are remarkably independent of the scale over which they are analyzed. For example, we find that the same laws governing the formation and bursting of the largest financial bubbles govern the tiniest bubbles too, over a factor of 10^9 in time scale [T. Preis, J. Schneider, & H. E. Stanley, *Proc. Natl. Acad. Sci. USA* **108**, 7674 (2011); T. Preis & H. E. Stanley, *Physics World* **24**, No. 5, 29 (May 2011)].

SOE 5: Focus Session: Big Data

Time: Monday 15:00–17:00 Location: HE 101

Invited Talk SOE 5.1 Mon 15:00 HE 101

Cities and Complexity — •Michael Batty — CASA, UCL, Gower Street, London WC1E 6BT

Cities, like many human systems, evolve as the product of a multitude of individual decisions concerning location and movement, generating order that emerges from the bottom up. In the last decade, they have been used as exemplars par excellence of many features that now define the complexity sciences: interacting dynamic systems, far-from-equilibrium, with strong path dependence, and surprising and novel behaviours. Cities are thus the crucibles of innovation in the economy and society and have become ever more central to the way we articulate our understanding of human systems. In parallel to these concerns, cities appear to becoming even more complex. New forms of behaviour are being generated largely through the development of new information technologies which enable individuals to communicate in countless novel ways a for example in the development of social media, while new forms of city-wide data are emerging as ICT is being fashioned into new systems underpinning the wired city. Transport of all kinds if being revolutionized by the import of ICT and in the near future, it is likely that the development of new forms of urban econophysics dealing with urban markets for land, housing as well as specific markets involving the production and consumption of goods at the spatial level will become the subject of the city focus. In this talk, I will summarise three of these developments: cities and the complexity sciences the rise of big data and the city, and smart cities.

Invited Talk SOE 5.2 Mon 15:30 HE 101

Experimental Computational Finance & Big Data Environment — •Philip Treleaven — University College London, UK

High-frequency algorithmic trading is growing rapidly accounting for 70% of US equity volumes in 2010 (according to Reuters and Bloomberg), but is also of major concern due to potential catastrophic "Flash Crashes". Likewise, the behavior and risk of individual trading algorithms is poorly understood.

For the past seven years UCL has worked with the major investment banks and funds developing algorithmic trading systems, and more recently with the regulators investigating high-frequency trading risk and systemic risk. To support this work we have developed our Algorithmic Trading & Risk Analytics Development Environment (ATRADE) platform which can be used both for virtual and real trading and has access to terabytes of "big" data. It has been designed to: a) speed the development of trading algorithms, b) evaluate algorithm risk, and c) assess algo programmers. As an evaluation of the performance of ATRADE, in 2011 it was used to support a global algorithmic trading competition which attracted over 300 traders in 100 teams scattered across Europe, North America and Australia. Moving forward, UCL is now extending ATRADE with a comprehensive social media engine that supports scraping and analyzing of a wide range of social media data (called Social media Streaming, Repository and Analytics Manager (SocialSTREAM) platform). This presentation will present ATRADE and SocialSTREAM.

Invited Talk SOE 5.3 Mon 16:00 HE 101

Embedding high dimensional data on networks — •Tiziana DiMatteo — King's College London

In this talk I will introduce a graph-theoretic approach to extract clusters and hierarchies in complex data- sets in an unsupervised and deterministic manner, without the use of any prior information [1,2]. This is achieved by building topologically embedded networks containing the subset of most significant links and analyzing the network structure. For a planar embedding [3] this method provides both the intra-cluster hierarchy, which describes the way clusters are composed, and the inter-cluster hierarchy which describes how clusters gather together. I will discuss performance, robustness and reliability of this method by investigating several synthetic data-sets finding that it can outperform significantly other established approaches. Applications to financial data-sets show that industrial sectors and specific activities can be extracted and meaningfully identified from the analysis of the collective fluctuations of prices in an equity market.

[1] Won-Min Song, T. Di Matteo, T. Aste, Discrete Applied Mathematics 159 (2011) 2135. [2] Won-Min Song, T. Di Matteo, T. Aste, "Hierarchical information clustering by means of topologically embedded graphs", PLoS ONE (2011). [3] M. Tumminello, T. Aste, T. Di Matteo, R. N. Mantegna, PNAS 102, n. 30 (2005) 10421.

Invited Talk SOE 5.4 Mon 16:30 HE 101

Econophysics and social research with large sets of data — •Rosario N. Mantegna — Dipartimento di Fisica, Università di Palermo, Viale delle Scienze Ed. 18, 90128, Palermo, Italy

The interaction between physics, economics and social sciences, that econophysicists have pursued over the past twenty years, is based on the idea of using statistical physics methods and paradigms to describe

economic and social systems. This interaction is not new, for example, Daniel Bernoulli introduced one of the key concepts of Economics, i.e. the utility function while he was also contributing to hydrodynamics. The interaction was not only in the old past but it has been present in other periods of the history of science. For example, it was proposed again, in the last century, by Ettore Majorana in its tenth article published posthumously in 1942. However, the recent contribution of econophysicists in the analysis and modeling of economic and social systems presents specific aspects because nowadays economic and social sciences have switched from disciplines characterized by a low rate of data production to disciplines with a high rate of data production. Today the society produces an enormous amount of data from scientific, social and business activities. The latter type of data is a gold mine for the study of economic and social phenomena when searching for stylized facts (a technical term used to indicate statistical regularities). The data mining of these data allows the building of an empirical base that is used in the modeling of economic and social phenomena taking into account statistical regularities observed empirically.

SOE 6: Focus Session: Big Data (Contributed Talks)

Time: Monday 17:15–18:45 Location: HE 101

SOE 6.1 Mon 17:15 HE 101

Quantifying the behavior of stock correlations under Market stress — Tobias Preis[1,2,3], •Dror Kenett[4], H. Eugene Stanley[1], Dirk Helbing[2,5], and Eshel Ben-Jacob[4] — [1]Center for Polymer Studies, Department of Physics, 590 Commonwealth Avenue, Boston, MA 02215, USA, — [2]Chair of Sociology, in particular of Modeling and Simulation, ETH Zurich, Clausiusstr. 50, 8092 Zurich, Switzerland — [3]Artemis Capital Asset Management GmbH, Gartenstr. 14, 65558 Holzheim, Germany — [4]School of Physics and Astronomy, Tel-Aviv University, Tel-Aviv, Israel — [5]Santa Fe Institute, 1399 Hyde Park Road, Santa Fe, NM 87501, USA

Understanding of correlations in complex systems is crucial in the face of crises, such as the ongoing financial crisis. However, in complex systems, such as financial systems, correlations are not constant but instead vary in time. Here we address the question of quantifying state-dependent correlations in stock markets, since reliable estimates of correlations are most needed to protect a port- folio. We find the striking result that the average correlation among stocks belonging to a given index scales linearly with market stress reflected by the normalized value of the index return. Consequently, the diversification effect of the portfolio value melts away in times of market losses, just when it would most urgently be needed. Our empirical findings could be used to anticipate diversification break- downs leading to protected individual portfolios and could contribute to increased stability of financial markets in general.

SOE 6.2 Mon 17:30 HE 101

Quantifying Trading Behavior in Financial Markets Using Google Trends — Tobias Preis[1,2,3], •Helen Susannah Moat[1,4], H. Eugene Stanley[2], and Dirk Helbing[1,5] — [1]Chair of Sociology, in particular of Modeling and Simulation, ETH Zurich, Clausiusstr. 50, 8092 Zurich, Switzerland — [2]Center for Polymer Studies, Department of Physics, 590 Commonwealth Avenue, Boston, Massachusetts 02215, USA — [3]Artemis Capital Asset Management GmbH, Gartenstr. 14, 65558 Holzheim, Germany — [4]Department of Mathematics, UCL, Gower Street, London, WC1E 6BT, UK — [5]Santa Fe Institute, 1399 Hyde Park Road, Santa Fe, New Mexico 87501, USA

Crises in financial markets affect humans worldwide. Detailed market data on trading decisions reflect some of the complex human behavior that has led to these crises. We show that massive new data sources resulting from human interaction with the Internet offer a different perspective on the behavior of market participants in periods before large market movements. Analyzing Google query volumes for search terms related to finance, we find that we can identify early warning signs of stock market moves. We further demonstrate that a trading strategy based on our analysis can outperform the market. Our results illustrate the unprecedented potential that combining extensive behavioral data sets offers for a better understanding of collective human behavior.

See also: http://www.tobiaspreis.de; http://www.suzymoat.co.uk; http://polymer.bu.edu/hes; http://www.soms.ethz.ch/people/dhelbing

SOE 6.3 Mon 17:45 HE 101

Complex Economic Behavior Captured by Big Data — •Tobias Preis — Chair of Sociology, in particular of Modeling and Simulation, ETH Zurich, Clausiusstr. 50, 8092 Zurich, Switzerland — Center for Polymer Studies, Department of Physics, 590 Commonwealth Avenue, Boston, Massachusetts 02215, USA — Artemis Capital Asset Management GmbH, Gartenstr. 14, 65558 Holzheim, Germany

Financial market fluctuations are characterized by abrupt switches between upward trends and downward trends, which can last for hundreds of days or just a few minutes. Here, we address two questions. Firstly, can these ubiquitous switching processes be quantified? Secondly, what insight do new big social data sources offer into this collective behavior?

www.tobiaspreis.de

SOE 6.4 Mon 18:00 HE 101

Who writes Wikipedia, a data-driven modeling of Wikipedia editorial activity — •Taha Yasseri, Róbert Sumi, and János Kertész — Institute of Physics, Budapest University of Technology and Economics, Budapest, Hungary

Recently developed Internet-based technologies facilitate collective cooperation of individuals more than ever. Among all possible examples, Wikipedia, the free encyclopaedia written by unknown volunteers from all around the world, is the one, in which self-organised value formation occurs with no external supervision or guidance. Moreover, similar to other online societies, the complete set of information about the activity of individuals is digitalised and collected in an easily accessible way, so that statistically analysing this big data corpus is achievable now.

In this contribution, we report on our recent investigations [1] on the accumulated data of the activity of Wikipedia editors in 34 languages (more than 1 billion records from more than 25 million editors), (i) to observe and evaluate the universalities and differences among various societies of editors and, (ii) to have an estimation of the geographical distribution of editors in the globe, based on the data-driven model for editor activities. We believe such studies could shed light to unknown aspects of the Wikipedia development process, its biases and limitations.

[1] T. Yasseri, R. Sumi and J. Kertész, Circadian patterns of Wikipedia editorial activity: A demographic analysis, to appear in *PLoS ONE, pre-print: arXiv/1109.1746.*

SOE 6.5 Mon 18:15 HE 101

Analysis and modeling of human behavior observed in cyber space communication data — •kenta yamada[1], yukie sano[2], hideki takayasu[3], and misako takayasu[4] — [1]Waseda University, Japan — [2]Nihon University, Japan — [3]Sony CSL, Japan — [4]Tokyo Institute of Technology, Japan

Analysis and modeling of human behavior become major targets of twenty-one century science. Especially, huge data of articles in cyber space such as blogs and twitters are attracting attention because the data directly reflect trends and topics in the society.

In this presentation, we report our analysis and modeling of the huge blog database which contains 300,000 bloggers including 70 million articles from 11/01/2006 to 8/31/2011. We observed some characteristic patterns in appearance frequency of some key words per day. We categorize them into three patterns: ordinary words, news words and trendy words. Ordinary words like adverbs are characterized by stationary processes, while the frequency of the news words and trendy words are characterized by non-stationary processes. A news word such as "tsunami" shows a sharp increase by sudden appearance of news and the number decays slowly following a power law. In the case of a trendy word, the number of entries per day increases exponentially.

In order to understand the origin of these characteristic motions, we introduce a state transition type agent-based model similar to the SIR (Susceptible-Infected-Recovered) model which is a basic epidemic model. We show that our simple agent-based model reasonably repro-

duces these three typical patterns.

SOE 6.6 Mon 18:30 HE 101

Mapping dietary Patterns and their Transitions: Implications for the Environment — Prajal Pradhan, •Dominik E. Reusser, and Jürgen P. Kropp — Potsdam Institute for Climate Impact Research

This study analyzes global, long term data on food consumption per country to identify typical patterns of diets. From these patterns, we derive typical food transition pathways on a global scale. Subsequently we assess the environmental consequences from green-house-gas (GHG) emission and anthropogenic inputs.

We used Self Organizing Map to identify the patterns and the transition pathways based on supply of 12 food groups from FAOSTAT dataset for a period 1961-2007. Data on energy output/input ratio for crop production and agricultural emission were used to estimate fossil energy used and GHG emission associated with the patterns.

We identified nine typical dietary patterns consisting high, moderate and low food intake with varied compositions along with a typical food transition pathway with one bifurcation. As expected, the high dietary patterns require higher fossil energy and lead to higher GHG emission. However related non-CO2 GHG emission intensities are relatively low.

Changes in dietary patterns are a part of the global change processes. Identification of past transitions is way to anticipate possible future transitions, which may supports policy processes.

SOE 7: Annual Member's Assembly of SOE

Time: Monday 19:00–19:30 Location: H 0110

The annual assembly of the members of SOE. There will be a social gathering in one of Berlin's many beautiful restaurants after the meeting. Details will be announced during the assembly.

SOE 8: Focus Session: Models of War and Conflict

Time: Tuesday 9:30–11:00 Location: H 0110

Invited Talk SOE 8.1 Tue 9:30 H 0110

The distribution and dynamics of war sizes — •Aaron Clauset[1,2], Lars-Erik Cederman[3], and Kristian Gleditsch[4,5] — [1]University of Colorado, Boulder, USA — [2]Santa Fe Institute, USA — [3]ETH Zurich, Switzerland — [4]University of Essex, UK — [5]Center for the Study of Civil War, Norway

The severity of international wars over the past 200 years robustly follows a power-law distribution, a pattern first observed by L.F. Richardson in the 1940s. It remains unknown, however, what socio-political mechanisms produce this behavior, to what degree the underlying processes are non-stationary, and whether the more frequent civil wars follow fundamentally different rules.

We present a novel analysis of a worldwide database of civil war severities since World War II and show that a conflict's severity generically evolves according to a multiplicative random walk whose length is governed by a decreasing cessation probability. For civil wars, the walk's origin and limits are constrained by population, which leads to non-power-law behavior in the upper tail. When these limit is removed—analogous to an international conflict in which war spreads like a contagion—Richardson's power-law returns. A simple non-parametric model with these features alone confirms these qualitative results and robustly reproduces the large-scale statistical patterns in civil wars worldwide.

Invited Talk SOE 8.2 Tue 10:00 H 0110

Modeling Wars and Terrorism: From particles to people — •Neil Johnson — Physics Dept., University of Miami, Florida, U.S.A.

I attempt to bridge the gap between simple particle-like models which have been recently used by mathematical scientists to describe the kinetics of insurgent conflicts and terrorist activity and the complex reality of real-world scenarios in which social, cultural and behavioral aspects play a crucial role in the underlying decision-making at the level of both individuals and groups. Using empirical data from a wide variety of modern insurgent conflicts and terrorist events, I attempt to describe the evolution – and possible turning points – of such collective human engagement in terms of the heterogeneity of the actors, and the bounded rationality under which each decision is made. This work builds upon our earlier efforts [1,2].

Funding provided by HSCB ONR Grant N000141110451

[1] Juan Camilo Bohorquez et al. Nature 462, 911 (2009); Neil Johnson et al. Science 333, 81 (2011); Zhenyuan Zhao et al. Phys. Rev. Lett. 103, 148701 (2009); Blazej Ruszczycki et al. Eur. Phys. Jour. 72, 289 (2009)

[2] Neil F. Johnson, "Escalation, timing and severity of insurgent and terrorist events: Toward a unified theory of future threats" arXiv:1109.2076

SOE 8.3 Tue 10:30 H 0110

Spatio-Temporal Dynamics of Violence in Jerusalem — •Karsten Donnay[1], Dirk Helbing[1], Dan Miodownik[2], and Ravi Bhavnani[3] — [1]Sociology, Modeling and Simulation, ETH Zurich, Switzerland — [2]Department of Political Science, Hebrew University of Jerusalem, Israel — [3]Graduate Institute of International and Development Studies, Geneva, Switzerland

Studies of conflict severity and timing have featured prominently in Nature [1] and Science [2]; employing techniques adopted from Physics these studies underscore the importance of quantitative approaches for the understanding of conflicts at large. The case analyzed here, the city of Jerusalem, is arguably among the most contested urban spaces in the world. After a sharp decline in violence following the end of the second Intifada in 2004, increasing tensions between Israeli security forces and both Palestinian and Ultra-Orthodox residents have led to a steady increase of violence in recent years. While the literature on Jerusalem is extensive, patterns of violence in the city have not been studied in detail. Our analysis of a rich data set of violent events for the period 2001-2009 reveals clear differences in inter-group violence dynamics, spatial/temporal clustering and severity between the Intifada and post-Intifada period. We can further isolate hot spots of violence and lend support to the argument that both retaliatory dynamics and the symbolic significance of certain parts of Jerusalem play an important role in defining when and where violence ensues. References: [1] JC Bohorquez et al. Nature 462: 911-914 (2009) [2] N Johnson et al. Science 333: 81-84 (2011)

SOE 9: Energy and Environment

Time: Tuesday 11:15–12:45 Location: H 0110

SOE 9.1 Tue 11:15 H 0110

Stylized facts and fluctuations in future power markets — •Stefan Börries and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen

In terms of an enlarged integration of so-called renewable energy resources the structure of the corresponding power market as well as the grid design are expected to underly fundamental changes. Load fluctuations caused by power generation replace the former base load. In order to dampen these fluctuations, new pricing schemes are discussed

to adapt consumers consumption to varying supply levels.

We investigate a model based on the minority game [1] to simulate effects of a dynamic pricing structure while incorporating the main characteristics of power markets: the limited storability of power [2] and a constant requirement for energy consumption. In this regard large load fluctuations occur and the corresponding market shows aspects of stylized facts known from financial markets [3], jeopardizing the security of power supply.

[1] D. Challet, Y. -C. Zhang, Physica A 246, 407 (1997).

[2] R. Weron, B. Przybylowicz, Physica A 283 (2000) 462.

[3] P. Gopikrishnan, V. Plerou, L. A. N. Amaral, M. Meyer, H. E. Stanley, Phys. Rev. E 60, R6271 (1999).

SOE 9.2 Tue 11:30 H 0110

Topology and Stability in Power Grids — •Peter J. Menck[1,2], Naoya Fujiwara[1], Jobst Heitzig[1], and Jürgen Kurths[1,2] — [1]Potsdam-Institut für Klimafolgenforschung, Potsdam, Deutschland — [2]Institut für Physik, Humboldt-Universität zu Berlin, Berlin, Deutschland

In recent years there has been growing interest in applying Complex Network Theory to energy transmission networks, or power grids. Several studies focused on the interplay between topology and vulnerability, in many cases regarding the nodes' properties as static. In contrast to this, we employ a dynamic alternating-current model of the nodes that allows us to explore the influence of topology on features of the operating state of the grid (which is a synchronous state). The model, called swing equation model, has been widely used in the engineering community to gain qualitative understanding of how a power grid works. We believe that its combination with Complex Network Theory will lead to new insights. In our numerical investigations we place particular emphasis on the relation between topology of the network and stability of the operating state. Therefore first of all we specify a concept of stability we consider suitable to power grids. Questions we then address include: Which topological properties are beneficial to stability? Which are detrimental?

SOE 9.3 Tue 11:45 H 0110

Empirical distributions for firms' energy consumption and energy saving behaviour — •Patrick Plötz and Tobias Fleiter — Fraunhofer-Institut für System- und Innovationsforschung ISI, Breslauer Straße 48, 76139 Karlsruhe

A simple and often cost-effective way to reduce energy consumption and green house gas emissions is a more efficient use of energy. It is generally assumed that firms of different size behave differently when adopting energy-efficiency measures. A few studies have tried to identify a net effect of firm size and other firm characteristics. However, detailed empirical results of the influence of firm size on adoption of energy efficiency measures are still missing. Here, we study empirical distributions of firm size and adoption rates and how these interact. We identify general empirical trends by using data from different countries and industry branches. Thus, a more detailed picture of the adoption behaviour of firms of different size is obtained including the large diversity that prevails among firms and that dominates firms' adoption decision. This is a first step towards a more realistic consideration of diversity among firms and needed for building complex models of firm behaviour and interaction. The revealed broad empirical trends have consequences for the future design of models and policies to understand and influence the adoption of energy efficiency measures in industry.

SOE 9.4 Tue 12:00 H 0110

On the Predictability of El Niño by Climate Networks — •Josef Ludescher[1], Avi Gozolchiani[2], Mikhail Bogachev[1], Shlomo Havlin[2], and Armin Bunde[1] — [1]Institut für Theoretische Physik III, Justus Liebig Universität Gießen, 35392 Gießen, Germany — [2]Minerva Center and Department of Physics, Bal Ilan University, Ramat Gan, Israel

We construct and analyze climate networks based on gridded observational data starting 1948. The grid sites form the nodes of the network and links represent cooperative behavior between these nodes. We define the link weight as the strength of the crosscorrelation between the time series at the nodes, which can be temperature, pressure, wind data etc. We find that the surface air temperature links that connect the El Niño basin with the rest of the equatorial Pacific are the most sensitive for El Niño and show that the network strength of this area, defined as the sum of the link weights, in most cases precedes the El Niño Index by several months. We use ROC analysis to show that most El Niño events and non-events can be predicted in the preceding year.

SOE 9.5 Tue 12:15 H 0110

Applying Stochastic Small-Scale Damage Functions to German Winter Storms — •Boris Prahl[1], Diego Rybski[1], Jürgen Kropp[1], Olaf Burghoff[3], and Held Hermann[1,2] — [1]Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany — [2]University of Hamburg, Germany — [3]Gesamverband der Deutschen Versicherungswirtschaft (GDV), Berlin, Germany

Analyzing insurance loss data we derive stochastic storm damage functions for residential buildings. On district scale we find power law relations between daily loss and maximum wind speed, spanning more than 4 orders of magnitude. The estimated power law exponents for 439 German districts typically range from 8 to 11 and are considerably larger than previously published exponents. In addition, we find correlations among the parameters and socio-demographic data which we employ in a simplified parametrization of the damage function with just 2 independent parameters. The Monte Carlo method is used to generate loss estimates and confidence bounds of daily and annual storm damages for Germany. Our approach reproduces the annual progression of winter storm losses and enables to estimate daily losses over several orders of magnitude.

SOE 9.6 Tue 12:30 H 0110

The influence of sea level rise on coastal flood damages — •Markus Boettle, Diego Rybski, and Jürgen P. Kropp — Potsdam Institute for Climate Impact Research (PIK), Germany

The estimation of costs due to climate change and the identification of possible adaptation measures are of particular interest at coastal regions threatend by sea level rise. In terms of cost-benefit analysis one wants to quantify how efficient adaptation measures are and when their investments are amortized. Thus, reliable damage estimations, especially in the context of rising mean sea levels, are needed. We propose a probabilistic framework and study the general effect of sea level rise and changing variability of extreme events on coastal flood damages. Surprisingly simple relations describing the interplay between mean sea levels and economic losses are found. Moreover, taking into account protection measures, which may reduce the impacts from moderate flooding (e.g. by sea dikes), we obtain further expressions for the decay of damages if a predefined protection level is supposed. Applying the approach to the city of Copenhagen, our general results can be confirmed and a steeper increase of expected damages than the rise of mean sea levels is found. Our findings have important implications for the estimation of future damages and therefore for the allocation of adaptation funds.

SOE 10: Social Systems, Opinion and Group Dynamics I

Time: Tuesday 14:00–15:30 Location: H 0110

SOE 10.1 Tue 14:00 H 0110

The Wisdom of Crowds Effect at Work: The Good, The Bad, and The Ugly — Pavlin Marodiev[1], Claudio Tessone[1], Jan Lorenz[1,2], and •Frank Schweitzer[1] — [1]Chair of Systems Design, ETH Zurich, Kreuzplatz 5, 8032 Zurich, Switzerland — [2]Center for Social Science Methodolgy, University of Oldenburg, Ammerlander Heerstr. 114 - 118, 26129 Oldenburg, Germany

Wisdom of crowds (WoC) refers to the phenomenon that the aggregate prediction of a group of individuals can be surprisingly more accurate than individual estimates. However, as recent experiments with human subjects (PNAS, vol 108, no 22, 2011, pp. 9020-9025) revealed, already a mild social influence can undermine the WoC effect considerably. Specifically, if individuals are allowed to reconsider their estimates after having received either aggregated or full information of the estimates of others, they tend to converge to less accurate results

while becoming overconfident of their false improvement. To better understand the conditions under which the WoC effect is likely to fail we provide a model where individuals are represented by Brownian agents which are coupled by information exchange. We demonstrate that the model can reproduce the empirical findings mentioned. We further discuss the impact of initial diversity and accuracy of estimates which directly determine whether social influence can improve or hamper the WoC effect.

SOE 10.2 Tue 14:15 H 0110

Consensus formation and the scientific process: When does consensus equal truth? — •Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen

Science partly is a social endeavor: Not only has a scientific truth to be found, but also be accepted by the scientific community. History of science is full of scientific discoveries that took considerable time to break a prevalent (untrue) consensus, often surpassing the lifetime of the discoverer, as for example the concept of continental drift by Alfred Wegener.

A first mathematical model studying the interplay of convergent opinion formation and exploratory truth seeking was proposed by Hegselmann and Krause [1]. We here study an alternative implementation, replacing the one-dimensional opinion space of that model by an infinitely large space of possible hypotheses, as proposed in a recent cellular automaton model for the emergence of paradigms [2]. Striving for new ideas is represented by a never-return rule that breaks detailed balance of exchange of ideas, while pressure towards consensus is implemented through social interaction rules. One observes that consensus-seeking counteracts truth discovery in the model. These models may provide insights for science funding and policy.

[1] R. Hegselmann and U. Krause, Truth and Cognitive Division of Labor: First Steps towards a Computer Aided Social Epistemology, Journal of Artificial Societies and Social Simulation 9 (2006).

[2] S. Bornholdt, M.H. Jensen, and K. Sneppen, Emergence and Decline of Scientific Paradigms, Phys. Rev. Lett. 106 (2011) 058701.

SOE 10.3 Tue 14:30 H 0110

Is there an optimum strategy for the penalty shoot-out in soccer? — •Metin Tolan — TU Dortmund, Fakultät Physik & DELTA, metin.tolan@tu-dortmund.de

The most exciting events of soccer tournaments are always penalty shoot-outs. Five players from each team have to shoot from 11 meters alternately on the goal. In this talk we will discuss some basic facts about the penalty shot and the penalty shoot-out. It will turn out that the penalty is a sort of an optimum compromise between a punishment of one team for some sort of unfair play and excitement since it is not sure that a penalty yields a goal. We will also discuss the optimum strategy for the team manager to figure out the order in which his players should do their penalty kicks. We will also see that the pressure on the first shooter is almost independent on the probability of the average success rate of his penalty shot.

SOE 10.4 Tue 14:45 H 0110

Towards the optimum prediction of soccer matches: concepts and limits — •Andreas Heuer and Oliver Rubner — Institut f. Phys. Chemie, WWU Münster, 48149 Münster

For an optimum prediction of soccer matches several key questions have to be answered. (1) What is the information content of different observables (previous results, chances for goals, home strength, market value of players, ...) about the quality of a team and how can this information content be defined? (2) How do these pieces of information transform into the explicit prediction of soccer matches? (3) How important are random, i.e. non-predictable, contributions? (4) How to define an optimum prediction on a solid statistical basis? Answers to these questions will be presented. It can be shown, that the predictions, based on the above-mentioned observables, are close but still slightly below the limit of optimum predictability. These concepts are applied to the Bundesliga season 2011/12 where the probabilities (and their statistical uncertainties) for all teams to reach a specific goal (Champions League, Europa League, avoiding relegation), based on the then available knowledge in March 2012, are calculated.

SOE 10.5 Tue 15:00 H 0110

Physics in penguin colonies — •Daniel P. Zitterbart[1,2], Sebastian Richter[1], Celine Le Bohec[3], Werner Schneider[1], Claus Metzner[1], Richard Gerum[1], Yvon Le Maho[3], Barbara Wienecke[4], and Ben Fabry[1] — [1]Biophysics Lab, Department of Physics, University of Erlangen, Germany — [2]Ocean Acoustics Lab, AWI, Bremerhaven — [3]IPHC, Centre National de la Recherche Scientifique, Strasbourg, France — [4]Australian Antarctic Division, Australia

In polar regions, highly adapted social behavior is crucial for the survival of several species. One prominent example is the huddling behavior of Emperor penguins. To understand how Emperor penguins solve the physical problem of movement in densely packed huddles, we observed an Emperor penguin colony (Atka Bay) with time-lapse imaging and tracked the positions of more than 1400 huddling penguins. The trajectories revealed that Emperor penguins move collectively in a highly coordinated manner to ensure mobility while at the same time keeping the huddle tightly packed. Every 30 - 60 seconds, all penguins make small steps, which travel as a wave through the entire huddle. Over time, these small movements lead to large-scale reorganization of the huddle. Our data show that the dynamics of penguin huddling is governed by intermittency and approach to kinetic arrest in striking analogy with inert non-equilibrium systems. We will also present observations from a different Emperor penguin colony (Adélie Land), an Adélie penguin colony (Adélie Land), and a King penguin colony (Crozet Island).

SOE 10.6 Tue 15:15 H 0110

Swarm model for the huddling behavior of Emperor penguins — •Richard Gerum, Claus Metzner, Daniel P. Zitterbart, and Ben Fabry — Biophysics Group, Friedrich-Alexander University, Erlangen, Germany

To withstand the Antarctic cold on open land for more than two months, Emperor penguins are forming densely packed huddles with a hexagonal lattice structure. Video recordings have revealed striking dynamical reorganization processes within those huddles (PLoS One, 6:e20260, 2011), including wave-like patterns, global rotatory motions and abrupt transitions to a disordered state. Here we show that basic aspects of the huddling behavior can be reproduced with simple systems of interacting point particles. For a more realistic modeling, the individual animals are treated as self-driven, information processing agents with situation-dependent behavior, similar to simulations of collective swarm behavior in flocks and herds. We present a multi-agent simulation in which both the spontaneous huddle formation and the observed wave patterns emerge from simple rules that only encompass the interaction between directly neighboring individuals. Our model shows that a collective wave can be triggered by a forward step of any individual within the dense huddle. The group velocity of the resulting wave is dependent only on the reaction times and the step velocity of the animals. By including the mutual adaption of individual body orientations, we present first results on rotary and curved movement patterns.

SOE 11: Networks, From Topology to Dynamics I (joint w. DY)

Time: Wednesday 9:30–10:15 Location: H 0110

Invited Talk SOE 11.1 Wed 9:30 H 0110

Adaptive Networks of Opinion Formation in Humans and Animals — •Thilo Gross — University of Bristol, Department of Engineering Mathematics, Merchant Venturers School of Engineering, Bristol, UK

A central challenge in socio-physics is understanding how groups of self-interested agents make collective decisions. For humans many insights in the underlying opinion formation process have been gained from network models, which represent agents as nodes and social contacts as links. Over the past decade these models have been expanded to include the feedback of the opinions held by agents on the structure of the network. While a verification of these adaptive models in humans is still difficult, evidence is now starting to appear in opinion formation experiments with animals, where the choice that is being made concerns the direction of movement. In this talk I show how

analytical insights can be gained from adaptive networks models and how predictions from these models can be verified in experiments with swarming animals. The results of this work point to a similarity between swarming and human opinion formation and reveal insights in the dynamics of the opinion formation process. In particular I show that in a population that is under control of a strongly opinionated minority a democratic consensus can be restored by the addition of uninformed individuals.

SOE 12: Networks, From Topology to Dynamics II (joint w. DY)

Time: Wednesday 10:15–12:45 Location: H 0110

SOE 12.1 Wed 10:15 H 0110

Diffusion on random networks with spatial constraints — •Thorsten Emmerich[1], Shlomo Havlin[2], and Armin Bunde[3] — [1]Institut für Theorethische Physik 3, Justus Liebig Universität Giessen, Giessen, Germany — [2]Minerva Center and Department of Physiks, Bar Ilan University, Ramat Gan, Israel — [3]Institut für Theorethische Physik 3, Justus Liebig Universität Giessen, Giessen, Germany

We consider random networks with spatial constraints. The networks are embedded in a linear chain or in a square lattice with embedding dimension $d_e = 1$ and 2, respectively. Each node has a fixed number of links. The length of the links are chosen with probability $p(r) \sim r^{-\delta}$, where r is the Euclidean distance between them. We show how the dimension of those networks can be determined and that it plays a basic role in determining the dynamical properties of the networks. The physical features are determined by δ: For $\delta < d_e$, the spatial constraints are irrelevant, while for $\delta > 2d_e$ the network behaves as a regular lattice. In between, for $d_e \leq \delta \leq 2d_e$ the network shows intermediate behavior and its dimension increases monotonically with decreasing δ.
We show that the dimension obtained from evaluating the structure of the networks appears also in the probability of return to the origin of a diffusing particle as well as in the survival properties of diffusing particles in the chemical reactions $A + A \to C$ und $A + B \to C$.

SOE 12.2 Wed 10:30 H 0110

Topological properties of networks with spatial constraints — •Stefano Mattiello[1], Shlomo Havlin[2], and Armin Bunde[1] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Giessen, Giessen, Germany — [2]Minerva Center and Department of Physics, Bar-Ilan University, Ramat-Gan, Israel

We investigate the effects of spatial constraints on the topological properties of networks embedded in one or two dimensional space. The nodes are embedded in a linear chain or in a square lattice with embedding dimension $d_e = 1$ and $d_e = 2$, respectively. The length of the links are chosen with probability $p(r) \sim r^{-\delta}$, where r is the Euclidean distance between them. We consider Erdös -Rényi networks, where the distribution of the degrees of the nodes is Poissonian, as well as scale-free networks where the degree distribution follows a power law $P(k) \sim k^{-\gamma}$, with γ typically between two and three.

We study the mean topological distance l and the clustering coefficient C of both kind of networks. We focus on the dependence of these properties on the size of the system N and the exponent δ, in particular in the region $d_e \leq \delta \leq 2d_e$, where we expect an anomalous behavior.

SOE 12.3 Wed 10:45 H 0110

Vaccine allocation in metapopulations — •Vitaly Belik — Massachusetts Institute of Technology, Cambridge, MA, USA — Max-Planck-Institut für Dynamik und Selbstorganization, Göttingen

Preparing for the 2009 H1N1 influenza pandemic, goverments of many countries acquired large stocks of vaccine or antivirals against this influenza strain. However due to low uptake of the vaccine in the population the governments needed to destroy the vaccine thus loosing many millions of dollars. This motivates the question addressed in this study - how to distribute the vaccine in the economically optimal way among different geographical regions. We propose an approximative method allowing with relatively little computational efforts to determine the optimal vaccination levels in real world systems for influenza-like diseases.

SOE 12.4 Wed 11:00 H 0110

Interplay between epidemics and network topology in a growing population — •Güven Demirel[1] and Thilo Gross[2] — [1]Max Plax Institute for the Physics of Complex Systems, Dresden, Germany — [2]Merchant Venturers School of Engineering, University of Bristol, Bristol, UK

The structure of social contact networks strongly influences the dynamics of epidemic diseases. In particular the scale-free structure of real-world social networks allegedly allows unlikely diseases with low infection rates to spread and become endemic. However, in particular for potentially fatal diseases also the impact of the disease on the social structure should not be neglected. In this study, we consider the growth of a network by preferential attachment from which nodes are simultaneously removed due to an SIR epidemic. By comparison to network simulations we show that the interplay between topological evolution and epidemic dynamics can be captured by an analytical approximation. This reveals that increased infectivity increases the prevalence of the disease but also leads to the reemergence of an epidemic threshold by causing a transition from scale-free to exponential topology.

SOE 12.5 Wed 11:15 H 0110

The vaccination dilemma with imperfect effectiveness — •Bin Wu[1,2], Feng Fu[1], and Long Wang[1] — [1]Center for Systems and Control, College of Engineering, Peking University, Beijing 100871, China — [2]Max-Planck-Institute for Evolutionary Biology, Plön 24306, Germany

Achieving widespread population immunity by voluntary vaccination poses a major challenge for public health administration [1]. The situation is complicated even more by imperfect vaccines. How the vaccine efficacy affects individuals' vaccination behavior has yet to be fully answered. To address this issue, we combine a game theoretical model of vaccination behavior with an epidemiological process. Our analysis shows that, in a population of self-interested individuals, the vaccine uptake level increases rapidly as the effectiveness of vaccination increases. Moreover, when the basic reproductive number exceeds a certain threshold, all individuals opt for vaccination for an intermediate region of vaccine efficacy. We further show that increasing effectiveness of vaccination always increases the number of effectively vaccinated individuals and therefore attenuates the epidemic strain. The results suggest that although increases in vaccination effectiveness lead to increased uptake level, it may drop due to free-riding effects. Nonethelss, the impact of the epidemic is mitigated by more effective vaccines [2].

[1] Rino Rappuoli, Science 316: 1287 (2007)
[2] Bin Wu, Feng Fu and Long Wang, PLoS ONE 6(6): e20577 (2011)

15 min. break

SOE 12.6 Wed 11:45 H 0110

Cascading Failures on the Banking Network — •Maximilian Thess[1,2], Eckehard Schöll[2], and Sitabhra Sinha[1] — [1]Institute of Mathematical Sciences Chennai, India — [2]Institut für Theoretische Physik, Technische Universität Berlin, Germany

Following the recent financial crisis complex networks have been applied increasingly to study properties of the financial system. The interplay between topology and dynamics of networks is of current interest in systems ranging from physics and biology to the social sciences and economics. Dynamical and topological properties of the financial system are of crucial importance to its stability and an increased understanding can inform for example better regulatory policies.

In our contribution we study a simple model of cascading bank failures on the US interbank lending network. We characterize the network using measures from complex network theory and illustrate local and global stability. Through numerical simulations we study the impact of single-bank defaults on global system stability. To identify superspreader-banks based on their topological features we compare several ways of measuring their importance .

SOE 12.7 Wed 12:00 H 0110

The informativeness of local constraints in the structure of the global trade network — •Tiziano Squartini[1], Giorgio Fagiolo[2], and Diego Garlaschelli[1] — [1]Lorentz Institute for Theoretical Physics, University of Leiden, Niels Bohrweg 2, NL-2333 CA Leiden, The Netherlands — [2]LEM, Sant'Anna School of Advanced Studies, Pisa, ITALY

The network of international trade relationships, or World Trade Web (WTW), has received renewed multidisciplinary interest due to recent advances in network theory. However, it is still unclear whether the network approach conveys additional, nontrivial information with respect to traditional international-economics analyses that describe world trade only in terms of local country-specific properties. In this work we use a recent randomization method to assess in detail the role that local structural properties have in shaping higher-order patterns of the WTW in all its possible representations (binary/weighted, directed/undirected, aggregated/disaggregated) and across several years. We find that all higher-order properties observed in the binary description can be completely traced back to the degree sequence, which is therefore maximally informative. This implies that the degree sequence, which is currently neglected by economic models, should instead become among the focuses of theories. By contrast, the weighted patterns of the WTW cannot be completely explained by local properties, which are therefore of limited informativeness. Indirect weighted trade interactions are not simply combinations of direct ones, and can only be successfully captured by the network description of trade.

SOE 12.8 Wed 12:15 H 0110

Networks of animal trade: from temporal paths to epidemic centrality — •Mario Konschake[1,3], Hartmut Lentz[1,2], Thomas Selhorst[1], Igor M. Sokolov[2], and Philipp Hövel[3] — [1]Friedrich-Loeffler-Institut, Wusterhausen — [2]Humboldt-Universität, Berlin — [3]Technische Universität, Berlin

Centrality of nodes is a major concept in network epidemiology which has been extensively studied. For temporal networks, however, a theoretical understanding is still in its infancy. In our case, a time-resolved topology arises from a series of static snapshots of the network taken at discrete time steps. The available animal-trade data has a temporal resolution of one day and includes 90.000 nodes.

We report on epidemiological relevant centrality measures based on the spread of an SIR-type disease. We analyse the robustness of the proposed measures under varying time of primary infection and under different infectious periods. We find the ranking of the nodes according to the measures sufficiently stable for different infectious periods, to be utilizable in the practical contexts of disease prevention and control. We thereby conclude that, for the analysed network, nodes with high epidemiological centrality can be identified independently of a specific disease.

We also find a threshold in the final size of the epidemic, so that diseases with an infectious period shorter than the intrinsic time constant of the network cannot propagate.

SOE 12.9 Wed 12:30 H 0110

A comparison of probabilistic distribution for fitting the degree distribution of real-world social networks — •Faustino Prieto and Jose Maria Sarabia — University of Cantabria, Santander, Spain

In this paper, the degree distribution of social and information networks is analyzed. Several functional forms have been proposed in the network science literature, including the classical power law and many others. Now, six different probabilistic models are fitted in the entire range by maximum likelihood. The used models are Lognormal, Gamma, Weibull, power law and two special cases of the Pareto Positive Stable (PPS) distribution. The models are compared using the Akaike information criterion (AIC) and the Kolmorov-Smirnov (KS) statistic. A two-parameter PPS distribution is found to be the better choice in the whole range, to several social and information network datasets. Finally, the PPS model is validated graphically by using log-log rank-size plots and double log-log plots.

SOE 13: Communication and Language

Time: Wednesday 14:00–15:45 Location: H 0110

SOE 13.1 Wed 14:00 H 0110

Rhythms in mobile-phone data — •Philipp Hövel[1,2] and Albert-László Barabási[2] — [1]Technische Universität Berlin, Germany — [2]CCNR, Northeastern University, Boston, USA

We present an analysis of temporal and spatial regularity of empirically obtained network data. The source of data is given by anonymized mobile-phone traces that include information about time and place of the connections between two mobile phones. Therefore, it contains next to temporal and spatial information an additional social component. This makes it a versatile tool to enhance our understanding of human dynamics. Based on the anonymized mobile-phone data, we investigate patterns of human behavior by a detailed mobility analysis on various timescales. We identify, for instance, rhythms of daily routine and deviations from it during weekend activities. This contributes to a general theory of synchronization in complex, real-world networks.

This work is supported by a postdoctoral fellowship of the Deutsche Akademische Austauschdienst (DAAD).

SOE 13.2 Wed 14:15 H 0110

The role of emotions in on-line communication — •Antonios Garas, David Garcia, and Frank Schweitzer — Chair of Systems Design ETH Zurich, Kreuzplatz 5, CH-8032 Zurich

Internet has changed the way we communicate over the last years. With people engaged in ever growing number of on-line interactions, questions about the nature of this new form of communication are of particular interest. Is our on-line communication different from other, more traditional, means of communication? How we express our emotions through written text exchange on-line? We show that the frequency of word use is closely related to its emotional content. More precisely, we show that words with a positive emotional content are more frequently used, and they create a bias in human expression. This finding is validated across three different languages, and is related to established psychological hypotheses. Furthermore, we show that people are very persistent in the way they express their emotions on-line. This comes as a surprise, given the high degree of anonymity, but is a hint that social norms are applicable in on-line interactions. We created a model based on simple psychological assumptions, that is able to reproduce the observed stylized facts of on-line communication. Our results can be important for understanding the dynamics of on-line social communities, and allows us to test different hypothesis regarding their emotional impact in on-line communication.

SOE 13.3 Wed 14:30 H 0110

Sentiment Classification in Social Media - an exemplar study in the micro-blogging platform Twitter — •René Pfitzner, Antonios Garas, and Frank Schweitzer — Chair of Systems Design, ETH Zurich, Switzerland

Social Mediae are changing the way people communicate and stay in touch. One particular case, the micro-blogging platform Twitter, has gained much scientific attention in the last one or two years. This attention is justified by its inherent openness that allows public accessibility to user profiles, and to user contributions expressed through short texts (called "tweets"), leaving researchers with valuable datasets. Here we study the "tweeting" behavior of users, by distinguishing between the pure act of "tweeting" as *information creation* mechanism, and the practice of "retweeting" as *information distribution* mechanism. Especially, by determining the emotional value of a tweet using SentiStrength, an automated sentiment classifier for short and informal text, we consider the influence of the *emotional* value of a tweet on its chances of diffusion in the network.

SOE 13.4 Wed 14:45 H 0110

Group-structured speech community and language change — •Cristina-Maria Pop and Erwin Frey — Arnold Sommerfeld Center and CeNS, Ludwig-Maximilians-Universität München, Theresienstr. 37, 80333 München, Germany

The processes leading to language change are manifold. The need to reduce ambiguity in the transmission of informations favors agreement on a conventional sign for a recurring problem. On the other hand, speakers tend to use particular linguistic variants associated with the

social groups they identify with. Innovations and the influence of other groups propagating across the speech community as new variant forms sustain the competition between linguistic variants.

With the Utterance Selection Model, an evolutionary description of language change, Baxter et al. [1] have provided a mathematical formulation of the interactions inside a group of speakers, revealing the mechanisms that lead to or inhibit the fixation of linguistic variants. Taking the Utterance Selection Model one step further by describing a speech community consisting of multiple interacting groups allows us to gain more understanding about the way in which linguistic variants propagate and how their distribution depends on the interaction strength between groups.

[1] Utterance selection model of language change, G. J. Baxter, R.A. Blythe, W. Croft, Phys. Rev. E **73**, 046118 (2006)

SOE 13.5 Wed 15:00 H 0110

Burstiness and long-range correlation in natural language — •Eduardo G. Altmann — Max Planck Institute for the Physics of Complex Systems

Recent temporal analysis of different large-scale databases of human activities show that two ubiquitous patterns are the intermittency in the occurrence of events (burstiness) and correlations on arbitrarily long times. Natural language is a prominent human activity that not only creates these temporal patterns but also reproduces the patterns of external events. Here we perform a detailed analysis of the burstiness and correlations of literary texts. We show how these two phenomena relate to each other on different linguistic scales. In particular, we explain the correlations observed in different low-level encodings (ASCII,letters, vowels, etc.) by tracing their origin to the burstiness of specific words. We discuss how this burstiness depends on the semantics of the words and on the authors of the texts, and can be used in practical applications such as document classification and authorship recognition. Our framework of analysis is general and can be applied also to other hierarchical systems.

SOE 13.6 Wed 15:15 H 0110

Personnel Portfolio and Communication — •Magda Schiegl — Cologne University of Applied Sciences, Köln, Germany

Most of the successive companies develop employee strategies. They perform empirical studies to learn more about the employees they will have and they need in the future to meet upcoming challenges of their business.

We model the personnel portfolio of a company as an agent based model. The agents correspond to the employees of the company. They are characterised by several internal parameters as for instance age, sex, seniority, salary, motivation and the level of education. The agents interact with each other an on hierarchical levels. There are deterministic rules for the time dynamics of some internal variables and others are changed in a rule based probabilistic way. Depending on the values of their internal parameters the agents will change their motivation, leave the company, retire or stay with the company. New agents can be hired. The focus in our model is on the interaction of the single agents, groups and the whole company that influences the motivation via communication and collaboration on different levels of the organisational structure. The agents' motivation is spread across the organisation: Its time dynamics is modelled via the concept of fields. This concept is often used in the field of socio-economic-physics. We investigate the dynamics of the personnel portfolio: The number of employees and the distribution of the internal parameters. On this basis communication and personnel strategies are evaluated and discussed.

SOE 13.7 Wed 15:30 H 0110

Using social network analysis to explore narrative structure — •Andrzej Jarynowski[1,2], Stephanie Boland[1,3], Elva Robinson[1], Richard Walsh[1], Dan Franks[1], and John Forrestor[1] — [1]YCCSA, University of York, UK — [2]Smoluchowski Insitute of Physics, Jagiellonian University, Cracow, Poland — [3]English, University of Exeter, UK

Network theory is useful when it comes to studying nature from a systems perspective, and social network analysis has been already applied to human societies. We want to make a cross-disciplinary leap, and use the tools of network theory to understand and explore narrative structure in literary fiction, a still under-utilized approach. However, the systems in fiction are sensitive on reader's subjectivity and attention must to be paid to different methods of extracting networks. The project aims to investigate the different ways social interactions are "read" in texts by comparing networks produced by automated algorithms-natural language processing (NLP) with those created by surveying more subjective human responses. Conversation networks from fiction have been already extracted by scientists, but the more general framework surrounding these interactions was missing. We propose several NLP methods for detecting interactions, and test them against a range of human perceptions. In doing so, we uncovered some limitations of using network analysis to test literary theory (e.g. interaction, which correspond to the plot, do not form climax).

SOE 14: Networks, From Topology to Dynamics III (joint w. DY)

Time: Wednesday 15:00–16:45 Location: MA 004

SOE 14.1 Wed 15:00 MA 004

Efficient transport and symmetries in models of Light Harvesting Systems — Tobias Zech[1], •Roberto Mulet[1,2], Torsten Scholak[1], Thomas Wellens[1], and Andreas Buchleitner[1] — [1]Quantum optics and statistics, Institute of Physics Albert Ludwigs University of Freiburg Hermann-Herder-Str. 3 D-79104 Freiburg — [2]Group of Complex Systems, Department of Theoretical Physics. Physics Faculty, University of Havana. La Habana, Cuba

Recent experimental results suggest the existence of quantum coherence and efficient transport in Light Harvesting Systems. Particularly motivated by results on the FMO complex we study exciton transport in random tri-dimensional lattices of seven sites with long range dipolar interactions. We show that some of these networks are consistent with efficient transport.

Moreover, we present evidence that the statistically relevant Hamiltonians associated with the efficient transport are centro-symmetric. We compare our results with numerical tests on realistic Hamiltonians for Light Harvesting systems and present a finite size scaling analysis of the model. Some implications of our results for the comprehension of the role of symmetry in Biology and for Quantum Communications are outlined.

SOE 14.2 Wed 15:15 MA 004

Traveling fronts and stationary patterns in bistable reaction-diffusion systems on networks — •Nikos Kouvaris[1], Hiroshi Kori[2], and Alexander Mikhailov[1] — [1]Department of Physical Chemistry, Fritz Haber Institute of the Max Planck Society, Faradayweg 4-6, D-14195 Berlin, Germany — [2]Division of Advanced Sciences, Ochadai Academic Production, Ochanomizu University, Tokyo 112-8610, Japan

We focus on activation fronts in bistable one-component systems on large complex networks. Fronts can trigger a transition from the one stable state to the other which spreads in the entire network. However, depending on the connectivity pattern of the network and the strength of diffusive coupling, the fronts can be pinned forming stationary localized patterns or can be retracted into their sources. Particularly, a front can be spread through nodes with low degrees, can be pinned at nodes with higher degrees, or can be retracted from nodes with even higher degrees. Similar behavior is observed for various values of coupling. This reach dynamical behavior can be described in terms of a mean field theory, while for the specific class of complete k-ary tree networks, saddle-node bifurcations have been found that distinguish the different dynamical regimes of traveling fronts and stationary patterns. Theoretical predictions have been verified by numerical simulations in large k-ary trees, Erdös-Rényi and scale-free networks, showing a very good agreement.

SOE 14.3 Wed 15:30 MA 004

Network evolution towards optimal dynamical performance — •Steffen Karalus and Markus Porto — Institut für Theoretische Physik, Universität zu Köln, Germany

The functionality of a large number of real world networks is associated with dynamical processes based on the network in the sense

that the network structure defines the local interaction pattern between the individual elements of the system. A deeper understanding of the interplay between the network topology and the behavior of the dynamical process in such cases is, however, still missing. As the 'fitness' of these networks is primarily determined by their functionality, we presume that they are driven into 'fitter' structures by an evolutionary process with mutation acting on topology and selection acting on dynamical properties. We propose a simple optimization scheme in which the latter are determined by the eigenvalue spectrum of the associated time evolution operator. Exemplifying this approach with the graph Laplacian, the relevant operator for fundamental processes such as random walks on a network, we show that our algorithm is able to successfully evolve networks into states with a given eigenvalue spectrum and corresponding dynamical behavior.

SOE 14.4 Wed 15:45 MA 004

High performance simulation and visualization of epidemics on complex networks — •Peter A Kolski[1], Martin Clauss[2], Thomas Selhorst[3], and Arkadi Pikovsky[1] — [1]University of Potsdam, Germany — [2]University of Leipzig, Germany — [3]Friedrich-Loeffler-Institut, Germany

Dynamical processes on complex networks are a growing field of interest. Performing simulations on large system of this kind demand a high computational power. To handle dynamics on networks the NetEvo C++ library can assign dynamical systems to edges and nodes. Furthermore it solves these ODEs via the ODEint library and can perform heuristic optimization. We introduce an extension to NetEvo using OpenCL on GPUs. With this approach we achieve an increase of computational performance up to a factor of 87, compared to an optimized C++ code on a modern CPU. Additionally we developed a framework to visualize intermediate results and to perform instantaneous visual analytics. The software will be applied in epidemiology, simulating disease spread on trade networks by solving the SIR model*s ODEs. The modification of parameter in real-time and the immediate access to simulation results leads to intuitive insights into the behavior of epidemics on large complex networks.

SOE 14.5 Wed 16:00 MA 004

Information spread via on-line networks: from time series to co-evolving functional networks — •Jan W. Kantelhardt[1], Mirko Kämpf[1], Shlomo Havlin[2], and Lev Muchnik[3] — [1]Institut für Physik, Martin-Luther Universität Halle-Wittenberg, Halle/Saale, Germany — [2]Physics Department, Bar-Ilan University, Ramat Gan, Israel — [3]Leonard N. Stern School of Business, New York University, USA

Human interaction and information spread via on-line networks is becoming increasingly important for our contemporary technological society. Here, we characterize and compare three organizational and dynamical network structures associated with the online encyclopedia Wikipedia. We study (i) the network of the direct links between Wikipedia articles of various languages, (ii) the usage network as determined from cross-correlations between click-count time series of many pairs of articles, and (iii) the edit network as determined from coincident edit events. The major goal is to find correlations between components of these three networks that characterize the dynamics of information spread in the complex system. We find that even though the dynamics of article click and edit time series are characteristically different - download activity is characterised by strongly persistent fluctuations (scaling exponent $\alpha \approx 0.9$), while edit activity is only short-term correlated - there are indications of a co-evolution of the corresponding dynamic networks. The results help in understanding the complex process of collecting, processing, validating, and distributing information in self-organised social networks.

SOE 14.6 Wed 16:15 MA 004

Complete Reconstruction of Correlation Networks — •Jan Nagler, Magdalena Kersting, Annette Witt, and Theo Geisel — MPI DS, Göttingen

Consider a network of N vertices, each associated with a wide-sense stationary stochastic process. To what extent is it possible to reconstruct the interrelationships of the whole network knowing only a limited number of correlation functions? Under what circumstances is the system over- or underdetermined? Compared with the usual time series analysis we present a different approach to these questions by means of the Wiener-Khintchine Theorem and unfold the basic structure underlying correlation networks. Except for networks with certain loop structures, we show that either N crosscorrelation functions, or $N-1$ crosscorrelation functions together with a single autocorrelation function determine the full network dynamics. We analytically derive explicit expressions for the missing correlation functions and study exemplarily the ubiquitous case of exponentially decaying correlation functions.

SOE 14.7 Wed 16:30 MA 004

Formation of the frozen core in critical Boolean Networks — •Marco Möller and Barbara Drossel — Festkörperphysik, TU Darmstadt, Germany

We investigate numerically and analytically the formation of the frozen core in critical random Boolean networks with biased functions. We demonstrate that a previously used efficient algorithm for obtaining the frozen core, which starts from the nodes with constant functions, fails when the number of inputs per node exceeds 4. We present computer simulation data for the process of formation of the frozen core and its robustness, and we show that several important features of the data can be derived by using a mean-field calculation.

SOE 15: Poster Session

Time: Wednesday 16:45–17:50 Location: Poster F

Please note: Posters can and should be on display all day.

SOE 15.1 Wed 16:50 Poster F

Evolvement of uniformity and volatility in the stressed global financial village — •Dror Y. Kenett[1], Matthias Raddant[2,3], Thomas Lux[2,3], and Eshel Ben-Jacob[1] — [1]School of Physics and Astronomy, Tel-Aviv University, Tel-Aviv, Israel — [2]Kiel Institute for the World Economy, Kiel, Germany — [3]Department of Economics, University of Kiel, Kiel, Germany

In the current era of strong worldwide market couplings, the global financial village has become highly prone to systemic collapses, events that can rapidly sweep through out the entire village. We present a new methodology to assess and quantify inter-market relations. The approach is based on the correlations between the market index, the index volatility, the market Index Cohesive Force and the meta-correlations (correlations between the intra-correlations). We investigated the relations between six important world markets - U.S., U.K., Germany, Japan, China and India from January 2000 until December 2010. We found that while the developed "western" markets (U.S., U.K., Germany), are highly correlated, the interdependencies between these markets and the developing "eastern" markets (India and China) are very volatile and with noticeable maxima at times of global world events (2001: 9/11-attacks, 2003: Iraq war, SARS, etc). The Japanese market switches "identity" - it switches between periods of high meta-correlations with the "western" markets and periods that it behaves more similar to the "eastern" markets. The methodological framework provides a way to quantify the evolvement of interdependencies in the global market, and to evaluate the world financial network.

SOE 15.2 Wed 16:50 Poster F

Bursting behavior of non-linear stochastic model and empirical high-frequency return — •Aleksejus Kononovicius, Vygintas Gontis, Julius Ruseckas, and Bronislovas Kaulakys — Institute of Theoretical Physics and Astronomy, Vilnius University, A. Gostauto 12, 01108 Vilnius, Lithuania

Recently we have proposed a nonlinear stochastic model reproducing power law probability density and power spectral density of absolute return in financial markets [1,2]. The proposed model and its generalizations also exhibit power law bursting behavior (see [3] for numerical evidence). We show that bursting behavior reproduced by the proposed model and observed in the financial markets are similar.

[1] V. Gontis, J. Ruseckas and A. Kononovicius (2010): A Non-

linear Stochastic Model of Return in Financial Markets, in: Stochastic Control, ed. C. Myers, Scyio.

[2] V. Gontis, J. Ruseckas and A. Kononovicius (2010): A long-range memory stochastic model of the return in financial markets, Physica A 389.

[3] B. Kaulakys, M. Alaburda and V. Gontis (2009): Modeling scaled processes and clustering of events by the nonlinear stochastic differential equations, AIP Conf. Proc. 1129.

SOE 15.3 Wed 16:50 Poster F

Agent-Based Models of Monetary Exchange to understand Income Distributions — •Jose M Miotto[1,3] and Martin G Zimmermann[2] — [1]Depto. de Fisica - UBA, Intendente Güiraldes 2160 - Ciudad Universitaria - CABA C1428EGA, Argentina — [2]UDeSA, Vito Dumas 284, San Isidro B1644BID, Buenos Aires, Argentina — [3]MPI for the Physics of Complex Systems, Nöthnitzer Strasse 50, Dresden 01187, Deutschland

Several problems arising in Economics are analyzed using concepts and quantitative methods from Physics. In this work in particular, different Multiple Agents-based Models are explored, applied to the study of Income and Wealth Distribution.

We present Computational Models that simulate a Market of Bilateral Exchanges with Conserved Wealth. Different types of Systems are studied based on the type of restrictions imposed to the Interactions: the first, with restrictions on the amount of Exchange; the second, allowing agents to interact just with some neighbors, in simple networks of agents (significant networks for Social Systems are chosen); and the third, on bipartite networks, where a second class of agents, the firms, are introduced. The defined environment is static, and the basis for a dynamical model is studied.

Different possible variations of these models are analyzed, with the aim of obtaining a realistic income or wealth distribution minimizing the assumptions.

SOE 15.4 Wed 16:50 Poster F

Spin models as microfoundation of macroscopic financial market models — •Sebastian M. Krause and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen, Otto-Hahn-Allee, 28359 Bremen

The prices of financial assets show a typical behavior, known as stylized facts. The logarithmic absolute returns are power law distributed, which means that big changes are more common than in a Gaussian random walk, and they occur clustered.

There are two model types concerning stylized facts. Macroscopic models model the stochastic properties of prices and are broadly used to estimate future risks. Microscopic agent based models provide a better understanding of the emergence of stylized facts from local behavior. We here investigate a modified Ising model [1] which is an agent based model known to reproduce several stylized facts. We deduce a macroscopic Langevin equation for this model and use the comparison of micro- and macro-description to understand the mechanism behind fat-tailed logarithmic absolute returns. Additionally we find a crossover with consequences for the finite size scaling.

[1] S. Bornholdt, Expectation bubbles in a spin model of markets: Intermittency from frustration across scales; Int. J. Mod. Phys. C 12 (2001) 667-674.

[2] S. M. Krause and S. Bornholdt, Spin models as microfoundation of macroscopic financial market models (2011) arXiv:1103.5345v1.

SOE 15.5 Wed 16:50 Poster F

Stochastic analysis of coupling between stock prices — •Alex Neumüller, Matthias Wächter, and Joachim Peinke — ForWind - Center for Wind Energy Research, Institute of Physics, University of Oldenburg

Portfolio optimization is a large and important area of economic science. Commonly portfolios are selected by comparing and evaluating the correlations between different shares. This approach nevertheless neglects the time dependence and mutual influences of the shares. In extension to this, we aim at obtaining a functional relation between different share prices in terms of separate stochastic and deterministic contributions by reconstructing a multi-dimensional Langevin equation from non-equidistant time series of stock prices. In this way we aim to obtain a dynamical correlation of different shares.

SOE 15.6 Wed 16:50 Poster F

From probabilities of recurrence to stock index interrelations — •Bedartha Goswami[1], G. Ambika[2], Norbert Marwan[1], and Jürgen Kurths[1,3] — [1]Potsdam Institute for Climate Impact Research, P.O. Box 60 12 03, 14412 Potsdam, Germany — [2]Indian Institute of Science Education and Research, Pashan, Pune - 411021, India — [3]Department of Physics, Humboldt University Berlin, Newtonstr. 15, 12489 Berlin, Germany

Financial data is extensively studied for correlations using Pearson's cross-correlation coefficient ρ as the point of departure, such that ρ is now synonymous with the idea of 'connectivity'. We apply a recurrence-plot-based estimator—the Correlation of Probability of Recurrence (CPR)—to analyze 'connections' between nine stock indices spread worldwide; and suggest a modification of the CPR to get more robust results. We examine trends in CPR using an approximately 19-month window and compare them to ρ. Binning CPR into three levels of connectedness: strong, moderate and weak, we extract the trends in number of connections in each bin over time. CPR mainly uncovers that the markets move in and out of periods of strong connectivity erratically, instead of moving monotonously towards increasing global connectivity. This is in contrast to ρ, which gives a picture of ever increasing correlation. We use significance tests using Twin Surrogates to interpret all the measures estimated in the study.

SOE 15.7 Wed 16:50 Poster F

Coping with uncertainty in future market evolution of competing technologies — •Patrick Plötz — Fraunhofer-Institut für System- und Innovationsforschung ISI, Breslauer Straße 48, 76139 Karlsruhe

The diffusion of innovations and prediction of future market evolution are important processes and the corresponding models have applications in many fields. The logistic equation is one of most important models in this context. Extensions of this approach as the Lotka-Volterra model have been developed to include the effect of mutual influences between innovations such as competition. However, many of the parameters entering this description are uncertain, difficult to estimate or simply unknown, particularly at early stages of the market diffusion. Here, a systematic way to study the effect of uncertain or unknown parameters on the future diffusion of interacting innovations is proposed. The input required is a general qualitative understanding of the system: is the mutual influence positive or negative and does it apply symmetrically to either technology? The methodology is developed in detail and applied the case of three types of upcoming electric vehicle propulsion technologies. The relation to Monte Carlo methods and the general use of random matrices in physics are discussed. The approach can easily be generalised to include other initial conditions, more technologies or other technological areas to find stable results for future market evolution independent of specific parameters.

SOE 15.8 Wed 16:50 Poster F

Link-based social dynamics in complex networks: time evolution and heterogeneous asymptotic states — •Juan Fernández-Gracia, Víctor M. Eguíluz, and Maxi San Miguel — IFISC, Instituto de Física interdisciplinar y Sistemas Complejos (CSIC-UIB), Campus Universitat Illes Balears, E-07122 Palma de Mallorca, Spain

Motivated by the idea that some characteristics are specific of the relations between individuals and not of the individuals themselves, we model them as states on the links in a network of interacting agents. Each link in the network can be in one of two equivalent states and, in each dynamical step a link is chosen, and this one takes the state of the majority of links surrounding it. We can characterize the nodes by the link heterogeneity index, which measures the tendency of a node to have links in one state or the other. On a fully connected network and a square lattice we fully characterize the non-trivial asymptotic configurations accessible from random initial conditions. For Erdös-Renyi random networks we also characterize the asymptotic configurations and the mechanisms leading to them. All these non-trivial asymptotic configurations are quite heterogeneous for a fully connected network and random networks. Furthermore those configurations are not stable for the node majority rule, which highlights the importance of modeling link-based dynamics. Once the asymptotic states are understood we can explain the evolution of the distributions of link heterogeneity indices on the different networks.

SOE 15.9 Wed 16:50 Poster F

The Interplay between Microscopic and Mesoscopic Structures in Complex Networks — •Jörg Reichardt[1], Roberto Alamino[2], and David Saad[2] — [1]Institute for Theoretical Physics, Würzburg University, Germany — [2]NCRG, Aston University, Birm-

ingham, UK

Understanding a complex network's structure holds the key to understanding its function. The physics community has contributed a multitude of methods and analyses to this cross-disciplinary endeavor. Structural features exist on both the microscopic level, resulting from differences between single node properties, and the mesoscopic level resulting from properties shared by groups of nodes. Disentangling the determinants of network structure on these different scales has remained a major, and so far unsolved, challenge. Here we show how multiscale generative probabilistic exponential random graph models combined with efficient, distributive message-passing inference techniques can be used to achieve this separation of scales, leading to improved detection accuracy of latent classes as demonstrated on benchmark problems. It sheds new light on the statistical significance of motif-distributions in neural networks and improves the link-prediction accuracy as exemplified for gene-disease associations in the highly consequential Online Mendelian Inheritance in Man database.

SOE 15.10 Wed 16:50 Poster F

Node weighted measures for complex interacting networks — Marc Wiedermann[1,2], •Jonathan F. Donges[1,2], Jobst Heitzig[1], and Jürgen Kurths[1,2] — [1]Potsdam Institute for Climate Impact Research, Potsdam, Germany — [2]Department of Physics, Humboldt University, Berlin, Germany

When network theory is used in the study of complex systems, the typically finite set of nodes of the network of interest is frequently either explicitly or implicitly considered representative of a much larger finite or infinite set of objects of interest. The selection procedure, e.g., formation of a subset or some kind of discretization or aggregation, typically results in individual nodes of the studied network representing quite differently sized regions of the domain of interest. This heterogenous sampling may induce substantial biases in derived network statistics. Examples are among others frequently studied spatially embedded networks, where nodes may represent differently sized areas or volumes, or trade networks, where nodes stand for economies of widely varying gross domestic product (GDP). To avoid these problems, we propose an axiomatic scheme based on the idea of node splitting invariance to derive consistently weighted variants of various commonly used statistical network measures which approximate the corresponding properties of the underlying domain of interest. We show that these measures can be generalized to study the topology of complex interacting networks and demonstrate their applicability to several real world networks.

SOE 15.11 Wed 16:50 Poster F

Networks in a bucket, from dynamics to topology — •Nora Molkenthin[1,2], Norbert Marwan[1], and Jürgen Kurths[1,2] — [1]Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany — [2]Department of Physics, Humboldt University, Berlin, Germany

Recently the study of complex networks constructed from time series has attracted much attention for example in climate system science. A particular interest is in studying networks that represent the statistical interdependencies between observational or simulated time series at different locations, e.g., surface air temperature time series distributed over the Earth's surface. The theoretical background of this research, however, is still largely unclear. We have now attempted to compute networks in a bottom-up-approach directly from simple fluiddynamical advection-diffusion setups. A few examples are presented here both analytically and numerically.

SOE 15.12 Wed 16:50 Poster F

Investigation and modeling of human driver behavior based on Langevin analysis — •Michael Langner and Joachim Peinke — Istitute of Physics - Forwind, University of Oldenburg, Germany

Based on experimental data, taken from a driving simulator, we present different ways how a stochastic model of the driver behavior can be estimated directly from the given data. This method is called Langevin analysis and allows the separation of a given dataset into a stochastic diffusion- and a deterministic drift field equivalent to a stochastic potential. Usually this method is used to get a model for data that possess strong Markovian properties and a strong statistical component, but it also yields interesting results if it is used in a more general way. In this case it is used to model the variations in the car trajectories caused by the human behavior.

This work is part of the IMoST (Integrated Modeling for Safe Transportation) project. The data for the modeling purpose was collected with a driving simulator located at the DLR in Braunschweig.

SOE 15.13 Wed 16:50 Poster F

Quantitative analysis of Role behaviour and time evolution in usenet groups — •Eleni Hitchinson[1] and Christian von Ferber[1,2] — [1]Applied Mathematics Research Centre, Coventry University, UK — [2]Physikalisches Institut, University Freiburg

A number of `usenet` groups have a long history where individual users are found to participate over long time ranges. These groups therefore offer the possibility to test hypotheses like e.g. preferential attachment scenarios on such time scales. Our focus is in particular on developing quantitative indicators for the type of discussion (e.g. technical or philosophical) and the self-defined roles of the participants. Analysing technical discussion we identify time evolving network motives that describe 'expert' members who answer many questions while in 'philosophical' discussions some members occur who initiate a multitude of discussions. In this way we observe quantitatively how these roles evolve and may change with time.

SOE 15.14 Wed 16:50 Poster F

Fighting and writing, conflicts and editorial wars in Wikipedia — •Taha Yasseri, Róbert Sumi, András Rung, András Kornai, and János Kertész — Institute of Physics, Budapest University of Technology and Economics, Budapest, Hungary

Wikipedia is one of the few examples of large-scale collective cooperation of individuals with no external supervision or motivation, in which considerable amount of valuable information is generated and collected. Despite the recent efforts to characterize the rapid growth and development of Wikipedia, the underlying mechanisms that modulate this improvement are yet to be unravelled. This would yield a better understanding of the emergence of information through consensus of opinions on numerous article contents. In this work, we first develop a method to detect and rank the controversial issues [1] which are most disputed and debated by the Wikipedia editors. Based on this analysis, we characterize the temporal features of the editorial wars. On short-time scales, we observe an evident relation between the bursts of the editorial activities and the intensity of the conflicts. Peaceful situations on the other hand, result in more diverse and uncorrelated editorial contributions. On long-time scales, our phenomenological model can distinguish between the external factors which influence the behaviour of the editors and the internal causes of the conflicts related to the diversity of editors' opinions on the solid facts.

[1] R. Sumi, T. Yasseri, A. Rung, A. Kornai, and J. Kertész, Edit wars in Wikipedia, *IEEE SocialCom, 3rd Intl Conf on Social Computing*, Boston Oct. (2011).

SOE 15.15 Wed 16:50 Poster F

Dynamics of Hierarchical Coalition Formation — •Jobst Heitzig — Potsdam Institute for Climate Impact Research

In many situations of strategic interaction of many agents, complex coalition structures can form, and the question which coalitions will form can have considerable consequences, as is obvious from the ongoing international climate negotiations. Still, the dynamical process of coalition formation by boundedly rational agents is only understood quite rudimentary yet. We present first results of a new dynamical model of coalition formation that allows for hierarchical coalition structures (coalitions of coalitions). In particular, we argue that the possibility of first forming small regional coalitions and then forming an overarching global coalition later might increase the prospects of efficient climate mitigation.

SOE 15.16 Wed 16:50 Poster F

Ranking scientific publications by investigating the papers' wake — •David F. Klosik and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen, Otto-Hahn-Allee, 28359 Bremen

Organisations providing scientific resources have one major question to answer: How to assess a scholar's or institution's scientific quality? Due to its availability citation information concerning the individual publications is widely used as a proxy for scientific impact. The use of raw direct citations, however, has been criticized against for a long time, and there have been several concepts trying to tackle the shortcomings of direct citation counting by considering the network-character of the aggregate citation information (e.g. centrality measures like PageRank or CiteRank as used by Maslov and collaborators

[1]).

Emphasizing pioneering publications that prepared the ground for a new line of research, we investigate a ranking scheme for scientific publications which is based on the paper's 'wake' in the citation network.

[1] D. Walker, H. Xie, K.-K. Yan, S. Maslov, Ranking scientific publications using a model of network traffic; J. Stat. Mech. (2007) P06010.

SOE 15.17 Wed 16:50 Poster F

The role of noise and initial conditions in the asymptotic solution of the Deffuant *et al.* model — •Adrián Carro Patiño, Maxi San Miguel, and Raúl Toral — IFISC (CSIC - UIB), Palma de Mallorca, Spain

The Deffuant *et al.* model was introduced in 2000 to model the dynamics of continuous opinions under bounded confidence. In its original version, agents meet in random pairwise encounters and, if the difference between their continuous-value opinions is less than a certain confidence level, they interact, that is, they adjust their opinion towards the opinion of the other agent.

While most of the existing literature has focused on the important role played by the bound of confidence parameter, we have studied the strong importance of the initial distribution of opinions in determining the asymptotic configuration. Thus, we have sketched the structure of attractors of the dynamical system, by means of the numerical computation of the time evolution of the agents density. In particular, we have used a discrete density-based reformulation of the model as discussed by J. Lorenz.

Furthermore, the influence of noisy perturbations was studied. The role played by this noise is that of a free will, as individuals are given the opportunity to change their opinion, with a given probability, and return to a fundamental opinion taken from a given distribution. As a consequence, the importance of the initial condition is replaced by that of the basal distribution.

SOE 15.18 Wed 16:50 Poster F

Negative Stimmgewichte bei Bundestagswahlen — •Daniel Lübbert — Wissenschaftl. Dienst, Dt. Bundestag, Berlin

Wahlen sind ein Grundpfeiler der Demokratie. Wo Wahlabläufe insgesamt äußerst vielschichtig sind, da scheint zumindest ein Detail linearvorhersehbar: die Umrechnung von Stimmenzahlen in Parlamentssitze. Aber auch hier warten Überraschungen: Analysen der letzten Bundestagswahlen haben gezeigt, dass in nicht wenigen Einzelfällen eine Partei einen Sitz hinzugewonnen hätte, wenn weniger Wähler für diese Partei gestimmt hätten (und umgekehrt). Diese Diagnose eines "negativen Stimmgewichts" ist in jahrelanger Diskussion erhärtet worden und hat im September 2011 zu einer Änderung des Bundeswahlgesetzes geführt.

Der Vortrag skizziert, wie das Problem im alten Wahlsystem zustande kam und wie das neue Gesetz vom September 2011 es zu lösen versucht. Zuvor werden die inzwischen etablierten numerischen Diagnoseinstrumente eingeführt: Um den Einfluss zusätzlicher Wählerstimmen auf die Sitzverteilung zu detektieren, bedarf es einer differentiellen Analyse, für die Konzepte aus der mehrdimensionalen Analysis durchaus hilfreich sind. Wegen der ganzzahligen Sitzzahlen führen letztlich jedoch nur umfangreiche Computer-Simulationen zum vollständigen Verständnis. Ob das Wahlrecht damit "unter Computervorbehalt" steht? Vor dem genannten Hintergrund erstaunt es jedenfalls nicht, dass die Wahlrechtsdebatte der letzten Jahre von einigen Physikern mit geprägt wurde. Vieles bleibt noch zu erforschen, so dass sich hier auch für die Zukunft ein interessantes Betätigungsfeld für Physiker eröffnet.

SOE 15.19 Wed 16:50 Poster F

Fluctuation Analysis of Traffic Data: Comparison of Numerical Simulations, Driving-Simulator Experiments, and Real-World Data — •Mirko Kämpf[1], Jan W. Kantelhardt[1], Matthew Fullerton[2], and Fritz Busch[2] — [1]Institut f. Physik, Martin-Luther Universität Halle-Wittenberg, Halle (Saale), Germany — [2]Lehrstuhl für Verkehrstechnik, TU München, Munich, Germany

The understanding of dynamical properties of traffic flow is essential for distinguishing traffic states or patterns and designing optimization rules and control systems. Here, we employ Detrended Fluctuation Analysis (DFA) to check if time series of velocity and density generated by a common traffic simulation model show the same scaling behaviour as real world data. In particular, we analyse average-level and individual-level speeds and densities simulated by a (microscopic) Wiedemann traffic model combined with a VISSIM lane changing model on a straight road with one or two lanes and no exits. The same scaling analysis is applied to data obtained from driving simulator experiments with groups of four drivers and to measured data from a multi-lane highway near Madrid. Our results show that the model describes the long-range interactions (regarding large groups of cars) fairly well. For small groups of cars, however, we find strong long-term persistent anti-correlations in the simulated velocity data, which are not observed in experimental traffic simulator data and real world data. This way, DFA has reviled that short-range interactions between cars are probably too strong in the current model.

SOE 15.20 Wed 16:50 Poster F

Population numbers of trains - physical models — •Uli Spreitzer[1], Alexander Rabanser[1], and Robert Löw[2] — [1]Bonus Pensionskassen AG, Traungasse 14-16, 1030 Vienna, Austria — [2]

Population numbers of trains are being calculated with a model of finite number of train stations. In a first model we assume the random number of people who enter and leave the train as independent of the number of persons inside the train. In a second model we modify the model, so that, the number of people leaving the train is proportional to the number of people within the train. For both models we see convergence of the occupation number with increasing number of train stations. We will discuss this convergence of the occupation number and also similarity to boltzmann distribution

SOE 15.21 Wed 16:50 Poster F

Bicycle Helmets And Accident Risk Of Children Cyclists In Germany — •Ingo R. Keck — University of Regensburg, Regensburg, Germany

Bicycle accidents and bicycle helmets are in the focus of the public attention since more than 20 years. In recent years the call for helmet laws is getting more insistend in Germany and countries in the European Union like Austria, the Czech Republic and Sweden have recently introduced helmet laws for children. At the same time information about the effects of helmet use in Germany and other European countries is spare.

In this submission it will be shown that the accident data of children cyclists in Germany in recent years can be described by a simple mathematical model. The most interesting finding is that the data of different age groups leads to very similar model parameters and that increasing helmet usage is connected to a clear increase in risk of severe injury or death.

SOE 16: Award Ceremony: Young Scientist Award for Socio- and Econophysics

Time: Wednesday 18:00–20:00 Location: H 0105

Invited Talk SOE 16.1 Wed 18:00 H 0105

The Role of Agent Based Models in Understanding Human Societies — •Stefan Thurner — Medical University of Vienna, Vienna, Austria — Santa Fe Institute, Santa Fe, NM, USA

Humans exhibit a surprising weakness in coping with complex systems in rational and predictive ways. I try to argue that agent based models - the decendents of our spin models in physics - offer a fantastic tool to acquire intuition for mechanisms governing complex adaptive systems, human societies in particular. I try to make this point clear with examples of agent based models in the context of opinion formation, buerocratic inefficiency, and the scientific refereeing system. I will show an example for a novel generation of agent based models where agents are actual humans interacting in an online game. Finally, I will show that in some lucky situations, the understanding gained through agent based models can be destilled into relatively simple relations which then become concrete testable predictions for socio-economic systems.

Presentation of the Young Scientist Award for Socio- and Econophysics to Dr. Arne Traulsen, Max-Planck Institute for Evolutionary Biology.

Prize Talk SOE 16.2 Wed 18:50 H 0105

The evolution of cooperation in simple agent based models — •Arne Traulsen — Max Planck-Institute for Evolutionary Biology, Plön, Germany

Why would I help someone that I will certainly never see again? Why should I cut down my CO_2 emissions if my neighbor drives an SUV? The evolution of cooperation, one of the most challenging problems in sociobiology, is attracting growing interest from a community of interdisciplinary researchers.

Based on the interaction of agents, evolutionary game theory is a key approach to analyze the dynamics on networks. Methods from theoretical physics, combined with data from economic experiments, can help to shed light on the problem of cooperation in humans. Some cases call for detailed behavioral models with many parameters, but in other cases a coarse grained phenomenological description is more appropriate. Stochastic evolutionary game dynamics based on minimalistic agents bridges between these two approaches and allows analyzing the impact of noise in these systems. This leads to entirely new perspectives on models for the evolution of cooperation and several new dynamical phenomena.

After the awardee's talk, there will be a social gathering with beer and pretzels in front of the lecture hall H 0105 (Audimax).

SOE 17: Traffic Dynamics, Urban and Regional Systems I

Time: Thursday 9:30–10:15 Location: H 0110

Invited Talk SOE 17.1 Thu 9:30 H 0110

Common design principles of metabolic networks and industrial production — •Marc Hütt, Moritz Beber, Till Becker, Mirja Meyer, and Katja Windt — Jacobs University Bremen

Metabolism is a fascinating natural production and distribution process. Metabolic systems need to show high performance under typical environmental conditions and, at the same time, maintain some function under a broad range of perturbations and modified conditions. It is precisely this robustness with respect to large environmental changes that makes metabolic networks a potentially very interesting role model for technical production and distribution systems.

First, we summarize some fundamental design principles of metabolic systems from the perspective of production logistics: just-in-time production of enzymes in metabolic pathways, categories of enzyme essentiality, topological properties of metabolic networks, and the coexistence of different control types.

On this basis we then perform a detailed comparison of industrial production systems and metabolic systems. While many characteristics of network architecture are similar between the two types of production systems (metabolic and industrial), we find striking differences on the level of dynamical quantities: material flow sizes and paths, robustness against changing environmental conditions and scaling laws relating material flow and regulation.

Guided by simulated evolution studies, we argue that these observations can serve as templates for the design of robust production systems.

SOE 18: Traffic Dynamics, Urban and Regional Systems II

Time: Thursday 10:15–11:15 Location: H 0110

SOE 18.1 Thu 10:15 H 0110

Simulation of dynamical information spread during pedestrian evacuation — •Mirko Kämpf[1], Christian Napierala[2], and Jan W. Kantelhardt[1] — [1]Institut für Physik, Martin-Luther Universität Halle-Wittenberg, Halle/Saale, Germany — [2]Fakultät für Maschinenbau, Otto-von-Guericke-Universität, Magdeburg, Germany

The collecting and spreading of up-to-date information is crucial for optimizing the evacuation of pedestrian crowds from buildings or large gatherings. If no global communication system is operative (e.g., during emergency situations), information might be collected automatically by future smart-phones (e.g., by accelerometers) and spread using local ad-hoc communication between them. To simulate and characterize the dynamics of such information spread, we combine an agent-based lattice-gas simulation of the evacuation process with a network analysis approach. The model system is a combination of two coupled networks, one representing the paths in the building and one representing the communication network between the agents smart-phones. We study how fast a change of the systems state is recognized, how fast this information is spread and what quality of information is available at a certain location and at a certain time, depending on several parameters. We also compare our results with well-known epidemic infection models (SIR and SIS) and with previous results of simulations in an unrestricted geometry. Furthermore, we analyze the time evolution of the agents information status to find out if we can detect and avoid interference effects.

SOE 18.2 Thu 10:30 H 0110

Optimizing evacuation flow in simple agent-based models — •Tobias Galla — Complex Systems and Statistical Physics Group, School of Physics and Astronomy, University of Manchester, Manchester M13 9PL, United Kingdom

I will discuss simple cellular automata of pedestrian motion, including stylized models based on exclusion processes, to describe situations in which agents have to choose between several escape routes during an evacuation event. Based on simulations, and where feasible analytical approaches, we compute control strategies, maximising the total current through the system. We also address the effects of agent-to-agent communication in such situations.

SOE 18.3 Thu 10:45 H 0110

Public Transport Networks: Fractal Properties — •Christian von Ferber[1,2], Taras Holovatch[1,3], Yurij Holovatch[4], and Vasyl Palchykov[4] — [1]Applied Mathematics Research Centre, Coventry University, UK — [2]Physikalisches Institut, University Freiburg, Germany — [3]Institut Jean Lamour, Nancy University, France — [4]Institute for Condensed Matter Physics Lviv, NAS Ukraine

Public transport networks (PTNs) are often discussed without reference to their geographical embedding. The question arises if there is any underlying structure or principle characterising the observed behaviour of geographically embedded transport routes. Here, we analyse transport routes with respect to their fractal properties in terms of random walks, self-avoiding walks and Levy flights.

For routes optimizing the time of passenger travel one may expect distance to grow linearly with the path length L. Surprisingly, the empirical data show quite a different behavior. For all means of transport analyzed within this study the dependence of the mean square distance $<R^2>$ on L is well described by a power law with an exponent that is significantly smaller than two. For most transport routes this power law appears to be close to that known for the self-avoiding walk. Furthermore, the analysis of the distribution of station intervals along routes displays a range with power law behaviour. This indicates that the travel along these routes may in part also be described as Levy-flights.

SOE 18.4 Thu 11:00 H 0110

Proximity based city growth — •Diego Rybski, Anselmo García Cantú Ros, and Jürgen P. Kropp — Potsdam Institute for Climate Impact Research, Potsdam, Germany

We propose a simple city model which is based on proximity. The probability that a site is occupied is solely determined by the distance to other occupied sites. We study the cluster size distribution and find power-law probability densities, consistent with real cities. In contrast, the growth is random as expected from the model. Studying the boundary of the largest cluster, we find fractal structures which we

relate to the model parameter. We find that this basic approach reproduces various important features of urban structures and conclude that proximity is a dominating aspect of spatial development.

SOE 19: Social Systems, Opinion and Group Dynamics II

Time: Thursday 11:30–12:15 Location: H 0110

SOE 19.1 Thu 11:30 H 0110

Serial phases of primacy in growing networks of cooperation — •Anne-Ly Do[1], Abhishek Dasgupta[2], and Thilo Gross[3] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden, Deutschland — [2]University of Oxford, Oxford, Great Britain — [3]University of Bristol, Bristol, Great Britain

Intelligent agents, such as individuals, companies, or nations, can form complex networks of collaborative interactions. In these networks the collaborative behavior of an individual is strongly influenced by the topological neighborhood, while the topology of the network itself evolves in response to the agents' behavior. We discuss a class of simple but general models, in which growing populations of rational, self-interested agents are able to establish and maintain different levels of cooperation with different, self-chosen partners. We show analytically and numerically that the network growth features distinct phases. In every such phase, a small group of agents succeeds to obligate all newly added agents and thus to acquire privileged topological positions, which enable them to extract extraordinarily high payoffs. We determine the factors that qualify an agent for primacy as well as the factors that indicate a forthcoming shift in primacy.

SOE 19.2 Thu 11:45 H 0110

Reconciling long-term cultural diversity and short-term collective social behavior — •Diego Garlaschelli — Lorentz Institute for Theoretical Physics, University of Leiden, Niels Bohrweg 2, NL-2333 CA Leiden, The Netherlands

An outstanding open problem is whether collective social phenomena occurring over short timescales can systematically reduce cultural heterogeneity in the long run. Theoretical models suggest that short-term collective behavior and long-term cultural diversity are mutually excluding, since they require very different levels of social influence. The latter jointly depends on two factors: the topology of the underlying social network and the overlap between individuals in multidimensional cultural space. However, while the empirical properties of social networks are intensively studied, little is known about the large-scale organization of real societies in cultural space, so that random input specifications are necessarily used in models. Here we use a large dataset to perform a high-dimensional analysis of the scientific beliefs of thousands of Europeans. We find that inter-opinion correlations determine a nontrivial ultrametric hierarchy of individuals in cultural space. When empirical data are used as inputs in models, ultrametricity has strong and counterintuitive effects. On short timescales, it facilitates a symmetry-breaking phase transition triggering coordinated social behavior. On long time-scales, it suppresses cultural convergence by restricting it within disjoint groups. Thus the distribution of individuals in cultural space appears to optimize the coexistence of short-term collective behavior and long-term cultural diversity.

SOE 19.3 Thu 12:00 H 0110

Can We Measure Nations' Solidarity and Justice? — •Hermann Rampacher — Seehaldenstraße 10 D-88662 Überlingen

Assuming social systems could be stabilized by specific n-tupels [r(i)] of social rules, solidarity and justice using these rules can become observables. Each rule prohibits an action, which risks with probability p(i)the stability of the global cicilization. If a certaim rule r(i) is broken, this contributes to self-destroying the global cicilization and as well to harm individuals. The [n(i)] have to be constructed by computer simulation, because the rules r(i) are mutually strongly correlated and compatible. Elementary rules can be identified using thought experiments, non-elementary rules only by empirical research. Breaking a first rule does effect breaking of all those rules with first rule. The grater the risks p(i, the lower the nation's solidarity; optimal yolidarity can be reached only if all agents contribute actively. The values of the p(j)) belonging to rules, prohibiting violence measure a nation's social temperature T. Hence a higher T is an alarm signal. To measure J we concentrate on the breaking of elementary rules. State authorities have to intervene to limit the harm arising from broken rules. The value of the nation's total harm after all contraventions of r plus all interventions measures the actual valuJ. This approach can serve to diagnose an nation's current situation and its foreseeable evaluation in the nearest future.

SOE 20: Social Systems, Opinion and Group Dynamics III

Time: Thursday 14:00–15:15 Location: H 0110

SOE 20.1 Thu 14:00 H 0110

Fragmentation Transitions in Multi-State Voter Models — •Gesa A. Böhme[1] and Thilo Gross[2] — [1]Max-Planck-Institute for the Physics of Complex Systems, Dresden, Germany — [2]University of Bristol, Department of Engineering Mathematics, Bristol, UK

Adaptive networks can display fragmentation transitions, where the network breaks into disconnected components. Fragmentation transitions frequently occur in models for opinion formation. We investigate opinion formation in a model society with N opinions. Voters in this model align with their social environment or cut relationships to disagreeing individuals according to given rates. The system can reach different regimes, which are characterized by their number of disconnected components, ranging from 1 (full consensus) to N (full fragmentation). Transitions between these regimes, i.e. the fragmentation thresholds, depend on the parameters of the system. In this talk we give an analytical estimation of the fragmentation thresholds for the example of three opinions, and generalize the results to models with an arbitrary number of opinions. Based on eigenvalue bounds, we reveal equivalence principles for special state-network topologies which allow for a significant reduction of the parameter space.

SOE 20.2 Thu 14:15 H 0110

Early fragmentation in the adaptive voter model on directed networks — •Gerd Zschaler[1], Gesa A. Böhme[1], Michael Seissinger[1], Cristián Huepe[2], and Thilo Gross[3] — [1]Max-Planck-Institut für Physik komplexer Systeme, Dresden, Germany — [2]614 N. Paulina Street, Chicago IL 60622-6062, USA — [3]University of Bristol, Bristol, UK

We consider voter dynamics on a directed adaptive network with fixed out-degree distribution. A transition between an active phase and a fragmented phase is observed. This transition is similar to the undirected case if the networks are sufficiently dense and have a narrow out-degree distribution. However, if a significant number of nodes with low out-degree are present, then fragmentation can occur even far below the estimated critical point due to the formation of self-stabilizing structures that nucleate fragmentation. This process may be relevant for fragmentation in current political opinion formation processes.

SOE 20.3 Thu 14:30 H 0110

Single vs multiple source mechanisms in social diffusion — •Paula Tuzón Marco, Víctor M. Eguíluz, and Maxi San Miguel — IFISC (UIB-CSIC), Palma de Mallorca, Spain

Diffusion processes in social systems, such as rumours, fashions, innovations or opinions, are typically modeled following two different mechanisms: one based on epidemic-like spreading models and the other on threshold models. The main difference lies in the number of sources involved for an agent to adopt; while in the epidemic-like models, a single source is enough to trigger contagion, in threshold mod-

els, multiple sources are necessary to convince an individual, and the threshold refers to the number of signals that an agent has to receive to adopt. Despite the theoretical work, it is not clear which approach is closer to the empirical evidence. For instance, how the probability for a consumer to buy a new product depends on the number of neighbours buying this product? In this work, we propose a model that interpolates between single and multiple signal integration in a certain window, and explore how both mechanisms affect the adoption curve and cascades.

SOE 20.4 Thu 14:45 H 0110

Opinion diffussion on commuting populations — •Juan Fernández-Gracia, Víctor M. Eguíluz, and Maxi San Miguel — IFISC, Instituto de Física interdisciplinar y Sistemas Complejos (CSIC-UIB), Campus Universitat Illes Balears, E-07122 Palma de Mallorca, Spain

We model a network of interaction having into account explicitly commuting patterns, which accounts for most intracity mobility, and explore the effect of this interaction network on the dynamics of opinion competition. In particular we make use of a simple agent based model (the voter model) in which agents can have one of two equivalent opinions and they update their opinion by copying the opinion of another agent they come in touch with. Referring to the network of interaction, we have a substrate of cities and certain fluxes of commuting agents between them. We measure analitycally and numerically the impact on the evolution of the global opinion of different topologies such as lattices in one and two dimensions with (a) heterogeneous populations and (b) commuting patterns. Furthermore we asses the impact of the strength with which populations are mixed, which is a tunable parameter in the model.

SOE 20.5 Thu 15:00 H 0110

Interdependent choices under social influence — •Ana Fernández del Río, Elka Korutcheva, and Javier de la Rubia — Departamento de Física Fundamental (UNED), Madrid, Spain

Mean-field Ising equilibrium dynamics can be used to describe the collective properties of certain choice or decision making processes when we want to mimic a generic tendency of individuals to conform to the norm, understood in this case as the accurately perceived average behaviour of the group [2,3,4]. Even very simple models already have interesting interpretations in social contexts and direct parallelisms can be drawn between them and some utility maximising scenarios from traditional discrete choice theory in the social sciences literature [1]. Besides, they provide a framework in which to naturally introduce heterogeneity, characterising the group through probability distributions describing individual attitudes towards the particular choice. The study of the system at finite temperature allows for the consideration of fluctuations varying in time, which can encode lack of information or a more fundamental uncertainty on human nature concerning free will.

The use of two coupled Ising models to describe a group where individuals have to make two choices which affect each other is discussed, and the system's phase diagrams for some particular cases in the light of binary interdependent decisions described.

[1] Durlauf. PNAS, 96:10582-10584, 1999. [2] Föllmer. J.Math.Econ., 1:51-62, 1974. [3] Galam. Phys.A, 238:66-80 ,1997. [4] Gordon, Nadal, Phan and Semeshenko. M3AS, 19(1):1441-1481, 2008.

SOE 21: Economic Models and Evolutionary Game Theory II

Time: Thursday 15:30–17:00 Location: H 0110

SOE 21.1 Thu 15:30 H 0110

Financial bubbles from opinion formation with feedbacks — •Sebastian M. Krause and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen, Otto-Hahn-Allee, 28359 Bremen

Herding behavior is at the basis of financial bubbles and crashes. Opinion formation mechanisms in this field (ranging from conversation among investors to political regulation) are affected by the overall system state. An illustrative example is the influence of panic on discussions.

The modified Ising model in [1] incorporates a global feedback as a plausible representation of reactions to market imbalances [2]. Such global feedbacks are missing in most opinion formation models. However, in markets there are macroscopic quantities visible for every agent as, for example prices of assets. We here present an opinion formation model related to the voter model and introduce a feedback representing the response behavior of single agents to their neighbors. Despite its simplicity, our model shows a rich dynamics. We observe metastable, balanced, and ordered states which are absent in the system without feedback.

[1] S. Bornholdt, Expectation bubbles in a spin model of markets: Intermittency from frustration across scales; Int. J. Mod. Phys. C 12 (2001) 667-674.

[2] S. M. Krause and S. Bornholdt, Spin models as microfoundation of macroscopic financial market models (2011) arXiv:1103.5345v1.

SOE 21.2 Thu 15:45 H 0110

An approach to stochastic social modeling: the second moment variables — •Felipe Lara-Rosano — Universidad Nacional Autonoma de Mexico, Mexiko Stadt, Mexiko

In this paper we introduce the second moment probabilistic approach as a way to model uncertainty in social phenomena like risk management. In order to express uncertainty in second moment terms, we will adopt a subjective or Bayesian probabilistic approach.

A second moment random variable (vector), SMRV, is a random variable (vector) for which the mean value (vector) and the variance (covariance matrix) have been assigned. Different random variables having different probability distributions but identical mean value and variance are then identical as second moment random variables. Also a SMRV defines a random vector only to within the class of random vectors that have the given mean vector and covariance matrix. This approximation is often sufficient for social and management applications. In fact in economic forecasting and decision making it is usual to consider only expected values as a first approximation.

Considering the fact that most social data are collected in a discrete way, for instance, from year to year, we will refer in this paper to time series analysis. We will show how a second moment markovian sequence can be used to model vector time series and how it can be manipulated as the state vector of a linear discrete dynamic system, offering a wide field of applications.

SOE 21.3 Thu 16:00 H 0110

Universality in time-lagged return correlations - a generalization of the Epps effect — •Jürgen Stockburger and Daniel Jaschke — Institut für Theoretische Physik, Universität Ulm

Statistical correlations of asset returns are essential parameters of portfolio theory. However, correlation coefficients generally decrease considerably when very short return intervals are considered [1,2,3]. The dual constraints of a large enough return interval and a maximum time interval compatible with the assumption of stationarity therefore appear to pose a fundamental constraint on the accuracy of empirically determined correlations. Here we propose to circumvent this constraint by including time-lagged correlations of short-time returns in the analysis, allowing the consideration of arbitrarily small time intervals as well as tuning the analysis for the specific time horizon of an investment decision. Extensions of the procedure at ultrashort times due to a transition from classical, correlation-based analysis to microstructure-based strategies are discussed.

[1] Epps, T. W., J. Am. Statist. Assoc., **74**, 291 (1979)
[2] Tóth, B. and Kertész, J., Quant. Fin. Routledge, **9**, 793 (2009)
[3] Münnix, M. C., Schäfer, R. and Guhr, T., arXiv:1009.6157

SOE 21.4 Thu 16:15 H 0110

Microscopic herding model leading to long-range processes and 1/f noise with application to absolute return in financial markets — •Bronislovas Kaulakys, Vygintas Gontis, Aleksejus Kononovicius, and Julius Ruseckas — Institute of Theoretical Physics and Astronomy, Vilnius University, A. Gostauto 12, LT-01108 Vilnius, Lithuania

Starting from agent-based Kirman's herding model we obtain and analyze the nonlinear stochastic differential equations (NSDE) for the ratio of number of agents [1]. We provide evidence that for some value

of the parameters the strong herding behavior yields NSDE of the form of Refs. [2] for the long-range processes with the $1/f^{\beta}$ noise. The nonlinear terms in the transition probabilities are crucial for the herding dynamics and for appearance of the long-range power-law correlations and distributions with the diverging variance [2]. Application of the model for description of the absolute return in financial markets [3] will be presented.

[1] J. Ruseckas, B. Kaulakys and V. Gontis, EPL, *Herding model and 1/f noise* (Accepted).

[2] B. Kaulakys and M. Alaburda, J. Stat. Mech. P02051 (2009); J. Ruseckas and B. Kaulakys, Phys. Rev. E **84**, 051125 (2011).

[3] A. Kononovicius and V. Gontis, Physica A **391**, dx.doi.org/10.1016/j.physa.2011.08.061 (2012).

SOE 21.5 Thu 16:30 H 0110

Fundamental proof of S-functional trade-offs in long term economic growth — •Hans Danielmeyer and Thomas Martinetz — Institut für Neuro- und Bioinformatik, Uni Lübeck

There is only one and the same time passing by. Either mankind produces more with more working time, or has more spare time at home for enjoying whatever is produced. In three lines of straight physics we show that just this fundamental trade-off leads to the observed S-functional growth and to inevitable final trade offs between the per capita quantities and their growth rates: increasing annual output (GDP, G7 current mean at 30.000 € p. a. per capita) with decreasing growth rate since 1950, and increasing national wealth (physical capital PC, G7 current mean 120.000 € p.c.) with decreasing growth rate. Not knowing anything about these trade-offs caused the accumulation of public debt, private fortunes, and the banking disaster with surplus investment capital.

There are still no adjustable parameters, just the national saving constant and three constants of the human species. Easily measurable time shifts between the normalized national pairs of GDP and PC confirm the effective lifetime of the destructible PC (25 years according to EU's Central Bank) and the existence of a second but per capita indestructible storable quantity with a lifetime of 62 years. They correspond to national recoveries and the collective industrial evolution.

SOE 21.6 Thu 16:45 H 0110

Modelling of annual European Union household incomes by using an equilibrium solution of the threshold Fokker-Planck equation — •Maciej Jagielski and Ryszard Kutner — Institute of Experimental Physics, Faculty of Physics, University of Warsaw, Hoża 69, PL-00681 Warszawa, Poland

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.

SOE 22: Networks, From Topology to Dynamics IV (joint w. DY)

Time: Friday 10:00–12:00 Location: MA 001

SOE 22.1 Fri 10:00 MA 001

k-shells on weighted networks — •Antonios Garas[1], Frank Schweitzer[1], and Shlomo Havlin[2] — [1]Chair of Systems Design ETH Zurich, Kreuzplatz 5, CH-8032 Zurich — [2]Minerva Center and Department of Physics, Bar-Ilan University, 52900 Ramat Gan, Israel

We discuss the decomposition of networks using k-shells in order to rank the nodes according to their centrality. We introduce a generalized method that considers the link weights in the calculation of k-shells. Our method is directly applicable to weighted networks, without the need of any arbitrary threshold on the weight values, and we show that it is able to partition a network in a more refined way, in comparison with the unweighted case. Using the classic SIR model, we show that nodes with higher spreading potential are located into shells closer to the core, and subsequently, we we discuss applications in different systems ranging from economic networks to on-line communities.

SOE 22.2 Fri 10:15 MA 001

All scale-free networks are sparse — •Charo Del Genio[1], Thilo Gross[1], and Kevin Bassler[2,3] — [1]Max-Planck-Institut für Physik komplexer Systeme, Dresden, Deutschland — [2]University of Houston, Houston, TX, USA — [3]Texas Center for Superconductivity, Houston, TX, USA

We study the realizability of scale free-networks with a given degree sequence, showing that the fraction of realizable sequences undergoes two first-order transitions at the values 0 and 2 of the power-law exponent. We substantiate this finding by analytical reasoning and by a numerical method, proposed here, based on extreme value arguments, which can be applied to any given degree distribution. Our results reveal a fundamental reason why large scale-free networks without constraints on minimum and maximum degree must be sparse.

SOE 22.3 Fri 10:30 MA 001

Information storage, loop motifs and clustered structure in complex networks — •Joseph T. Lizier, Fatihcan M. Atay, and Jürgen Jost — Max Planck Institute for Mathematics in the Sciences, Inselstrasse 22, 04103 Leipzig, Germany

Information storage is a key operation in distributed computation, and an important analytic tool for understanding dynamics on, and information processing capabilities of, complex networks. We use a standard discrete-time linear Gaussian model to analyze information storage capability of individual nodes in complex networks, given network structure and link weights. In particular, we investigate the role of two and three-node motifs in contributing to information storage, and express information storage analytically in terms of the contributions of these motifs. We show analytically that directed feedback loops and feedforward loop motifs are the dominant contributors to information storage capability. Crucially, where the network contains positive edge weights on average, the information storage capability is positively correlated to the counts of these motifs. We also show the direct relationship between clustering coefficient(s) and information storage which results from these expressions. These results explain the dynamical importance of clustered structure, and offer an explanation for the prevalence of these motifs in biological and artificial networks.

SOE 22.4 Fri 10:45 MA 001

Statistical description of subgraph fluctuations in random graphs — •Christoph Fretter[1], Matthias Müller-Hannemann[2], and Marc-Thorsten Hütt[1] — [1]School of Engineering and Science, Jacobs University, Bremen, Germany — [2]Institut für Informatik, Martin-Luther Universität Halle-Wittenberg, Germany

The pattern of over- and under-representations of three-node subgraphs has become a standard method of characterizing complex networks and evaluating, how this intermediate level of organization contributes to network function. We explored this relationship in previous publications [1,2]. Understanding statistical properties of subgraph counts in random graphs, their fluctuations and their interdependencies with other topological attributes is an important prerequisite for such investigations. Here we introduce a formalism for predicting subgraph fluctuations induced by perturbations of uni-directional and bi-directional edge densities. On this basis we predict the over- and under-representation of subgraphs arising from a density mismatch between a network and the corresponding pool of randomized graphs serving as null model. Such mismatches occur for example in modular and hierarchical graphs.

[1] Krumov L., Fretter, C., Müller-Hannemann, M., Weihe, K. and Hütt, M.-Th., Motifs in co-authorship networks and their relation to the impact of scientific publications. Eur. Phys. J. B, (2011) in press. [2] Marr, C., Theis, F.J., Liebovitch, L.S. and Hütt, M.-Th., Patterns of subnet usage in the transcriptional regulatory network of Escherichia coli. PLoS Computational Biology 6, e1000836 (2010).

SOE 22.5 Fri 11:00 MA 001

Impact of boundaries on fully connected random geometric networks — Justin Coon[1], Carl Dettmann[2], and •Orestis Georgiou[3] — [1]Toshiba Telecommunications Research Laboratory, Bristol, UK — [2]School of Mathematics, University of Bristol, Bristol, UK — [3]Max-Planck-Institute for the Physics of Complex Systems, Dresden, Germany

Many complex networks exhibit a percolation transition involving a macroscopic connected component, with universal features largely independent of the microscopic model and the macroscopic domain geometry. In contrast, it turns out that the transition to full connectivity is strongly influenced by the details of the boundary and exhibit an alternative form of universality. The statistical physics approach taken produces a generalized formula for the probability of fully connectivity. This result is largely model independent and facilitates system design to promote or avoid full connectivity for diverse geometries in arbitrary dimension. I will also discuss applications of this formula to wireless communication networks.

SOE 22.6 Fri 11:15 MA 001

Self-organized critical adaptive networks — •Matthias Rybarsch and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen, Otto-Hahn-Allee, 28359 Bremen

Dynamical systems of spins on a network can exhibit self-regulated evolution towards a critical state and are used as toy models for self-tuning in biological neural networks [1]. If, however, the model is changed from spin type to a network composed of Boolean state nodes which are more plausible in the biological context [2], this rewiring algorithm will no longer evolve the system to criticality and cannot be directly transferred in a simple way. Also, the function of such self-organized networks is often limited to a certain network topology like a regular lattice in case of ref. [1]. Here, we discuss a correlation-dependent mechanism for self-organized connectivity evolution which adresses these difficulties and evolves a biologically motivated, yet minimalistic network model to an average connectivity close to criticality in terms of damage spreading, both on lattice or random network topology.

[1] S. Bornholdt and T. Roehl: Self-organized critical neural networks, Phys. Rev. E 67, 066118 (2003)

[2] M. Rybarsch and S. Bornholdt: On the dangers of Boolean networks: Activity dependent criticality and threshold networks not faithful to biology, arXiv:1012.3287 (2010)

SOE 22.7 Fri 11:30 MA 001

Continuous Percolation by Discontinuities — •Jan Nagler — MPI DS, Göttingen

The extent to which a complex network is connected crucially impacts its dynamics and function. Percolation, the transition to extensive connectedness on gradual addition of links, is often used to describe and model many different types of structure in the real world. How single links may *explosively* change macroscopic connectivity in networks where links add competitively according to certain rules has been debated extensively in the past three years. In the very recent article [Science **333**, 322 (2011)], O. Riordan and L. Warnke state that (i) *any rule based on picking a fixed number of random vertices gives a continuous transition*, and (ii) that *explosive percolation is continuous*. It is equally true that certain percolation processes based on picking a fixed number of random vertices are discontinuous. Here we resolve this apparent paradox. We identify and analyze this by studying an extremal case of a process that is continuous in the sense of Riordan and Warnke but still exhibits infinitely many discontinuous jumps in an arbitrary vicinity of the transition point. We demonstrate analytically that continuity at the transition and discontinuity of the percolation process are compatible for certain competitive percolation systems.

SOE 22.8 Fri 11:45 MA 001

The role of nonlocal coupling in the transition from coherent to incoherent states — •Bruno Riemenschneider[1], Iryna Omelchenko[1,2], Philipp Hövel[1,2], Yuri Maistrenko[3,4], and Eckehard Schöll[1] — [1]Institut für Theoretische Physik, Technische Universität Berlin — [2]Bernstein Center for Computational Neuroscience, Humboldt-Universität zu Berlin — [3]Institute of Mathematics, National Academy of Sciences of Ukraine — [4]National Center for Medical and Biotechnical Research, National Academy of Sciences of Ukraine

We investigate the spatio-temporal dynamics of coupled chaotic systems with nonlocal interactions, where each element is coupled to a fixed number of nearest neighbours. Characteristic examples of such networks appear in neuroscience, chemical oscillators, electrochemical systems, and Josephson junctions. Depending upon the coupling parameters, i.e., strength and range, we find variations in temporal behaviour, as well as characteristic spatial patterns. These include wave-like solutions and a transition from spatial coherence to incoherence. Partially coherent, chimera-like states represent the characteristic spatio-temporal patterns at the transition, which leads to spatial chaos. The systems have been analyzed by both numerical simulations and theoretical derivations. To demonstrate the universality of our findings, we consider time-discrete as well as time-continuous models, i.e., logistic maps, Rössler and Lorenz systems, respectively. For each system we choose parameters that lead to chaotic behaviour in the uncoupled case.