Physics of Socio-economic Systems Division
Fachverband Physik sozio-ökonomischer Systeme (SOE)

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Overview of Invited Talks and Sessions

(lecture rooms H10, H44, H46 and H1; Poster C)

Plenary Talks related to SOE

PV X	Thu	8:30– 9:15	H1	**Complex Networks: From Statistical Physics to the Cell** — •Albert Laszlo Barabasi

Tutorial

SOE 1.1	Sun	16:00–18:00	H10	**Time Series Analysis in Sociophysics and Econophysics** — •Johannes J. Schneider, •Tobias Preis

Invited Talks

SOE 2.1	Mon	9:30–10:15	H44	**Don't panic! - The physics of pedestrian dynamics and evacuation processes** — •Andreas Schadschneider
SOE 7.1	Tue	9:30–10:00	H44	**Humans playing spatial games** — •Arne Traulsen
SOE 12.1	Wed	9:30–10:15	H44	**The hidden complexity of open source software** — •Frank Schweitzer
SOE 17.1	Thu	9:30–10:15	H44	**Wave localization in complex networks** — •Jan W. Kantelhardt
SOE 22.1	Fri	9:30–10:15	H44	**Hypergraphs and social systems** — •Guido Caldarelli

Focus Session: Science of Science

SOE 4.1	Mon	13:30–14:00	H44	**Following the actors: individual and collective behavior in epistemic landscapes** — •Andrea Scharnhorst
SOE 4.2	Mon	14:00–14:30	H44	**Tracking science in real-time from large-scale usage data.** — •Johan Bollen
SOE 4.3	Mon	14:45–15:15	H44	**Mapping change in science** — •Martin Rosvall, Carl Bergstrom
SOE 4.4	Mon	15:15–15:45	H44	**Statistical physics of citation behavior** — •Santo Fortunato

Young Scientist Award for Socio- and Econophysics

SOE 5.1	Mon	16:00–16:45	H44	**Tying the double knot: Robustness of interconnected networks** — •Shlomo Havlin
SOE 5.2	Mon	17:00–17:45	H44	**Unveiling the patterns of human mobility and global disease dynamics** — •Dirk Brockmann

Sessions

SOE 1.1–1.1	Sun	16:00–18:00	H10	**Tutorial: Time Series Analysis in Sociophysics and Econophysics**
SOE 2.1–2.1	Mon	9:30–10:15	H44	**Traffic Dynamics, Urban and Regional Systems I**
SOE 3.1–3.6	Mon	10:15–12:00	H44	**Traffic Dynamics, Urban and Regional Systems II**
SOE 4.1–4.4	Mon	13:30–15:45	H44	**Focus Session: Science of Science**
SOE 5.1–5.2	Mon	16:00–18:00	H44	**Award Ceremony: Young Scientist Award for Socio- and Econophysics**
SOE 6.1–6.8	Mon	18:00–20:00	Poster C	**Poster Session**
SOE 7.1–7.5	Tue	9:30–11:00	H44	**Evolutionary Game Theory I (with BP)**
SOE 8.1–8.5	Tue	11:15–12:30	H44	**Evolutionary Game Theory II (with BP)**
SOE 9.1–9.2	Tue	12:30–13:30	H44	**Social Systems, Opinion and Group Dynamics I**
SOE 10.1–10.7	Tue	14:00–16:00	H44	**Evolutionary Game Theory III (with BP)**
SOE 11	Tue	16:00–16:30	H44	**SOE Members' Assembly**
SOE 12.1–12.1	Wed	9:30–10:15	H44	**Social Systems, Opinion and Group Dynamics II**
SOE 13.1–13.9	Wed	10:15–12:45	H44	**Networks: From Topology to Dynamics I (with BP, DY)**
SOE 14.1–14.8	Wed	14:00–16:00	H44	**Social Systems, Opinion and Group Dynamics III**
SOE 15.1–15.4	Wed	16:00–18:00	H44	**Financial Markets and Risk Management I**
SOE 17.1–17.1	Thu	9:30–10:15	H44	**Networks: From Topology to Dynamics II (with BP, DY)**
SOE 18.1–18.10	Thu	10:15–13:00	H44	**Networks: From Topology to Dynamics III (with BP, DY)**
SOE 19.1–19.7	Thu	14:00–16:00	H44	**Networks: From Topology to Dynamics IV (with BP, DY)**
SOE 20.1–20.5	Thu	16:00–17:15	H44	**Networks: From Topology to Dynamics V (with BP, DY)**
SOE 21.1–21.6	Thu	10:15–13:30	H46	**Financial Markets and Risk Management II**
SOE 22.1–22.1	Fri	9:30–10:15	H44	**Social Systems, Opinion and Group Dynamics III**
SOE 23.1–23.5	Fri	10:15–13:00	H44	**Financial Markets and Risk Management III**

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

Tue 16:00–16:30 H44

SOE 1: Tutorial: Time Series Analysis in Sociophysics and Econophysics

Time: Sunday 16:00–18:00 Location: H10

Tutorial SOE 1.1 Sun 16:00 H10

Time Series Analysis in Sociophysics and Econophysics — •Johannes J. Schneider and •Tobias Preis — Center for Computational Research Methods in Natural Sciences, Johannes Gutenberg University of Mainz

In the last decades, an increasing number of physicists have applied models and methods from statistical physics to complex systems in various research fields, such as sociology, politology, finance, and economy, thus founding the new interdisciplinary research fields of sociophysics and econophysics. Due to the IT revolution, including the creation of large databases stored in data warehouses and the acceleration of business processes by replacing traditional ways of communication and transactions by modern electronic counterparts, nowadays a truly gargantuan amount of data is accessible for both elaborate applications and academic research. Based on these developments, the creation of models for the considered problems can be well founded and verified by the analysis of the available datasets. Thus, the first step is mostly to perform a statistical analysis of the available time series in order to detect the properties of the underlying system.

This tutorial will present both basic and advanced methods of time series analysis covering examples both from sociophysics and from econophysics. The focus will lie on two different scenarios: from sociophysics, election results and their impacts on the member numbers of large parties shall be studied. In econophysics, a plethora of information exists—this tutorial will concentrate on financial market datasets. These data can be investigated by basic methods, such as correlation measures and scaling exponents. Furthermore, advanced procedures based on pattern comparisons and renormalization methods shall be described.

SOE 2: Traffic Dynamics, Urban and Regional Systems I

Time: Monday 9:30–10:15 Location: H44

Invited Talk SOE 2.1 Mon 9:30 H44

Don't panic! - The physics of pedestrian dynamics and evacuation processes — •Andreas Schadschneider — Institut für Theoretische Physik, Universität zu Köln, 50937 Köln

Besides the obvious practical relevance, pedestrian and crowd dynamics provide fascinating examples for collective phenomena and complex behaviour. This has inspired the application of physics-based approaches in this field. In theoretical descriptions pedestrian crowds are either viewed as exotic fluids, particles which interact via (social) forces violating Newton's laws or systems governed by stochastic rules.

Surprisingly, the empirical situation of pedestrian dynamics is far from clear. There is still no consensus even about some of its most fundamental properties. This is reflected in very different legal regulations even within different parts of Germany. Also it is still under debate whether notions like "panic" are useful or relevant for the understanding of catastrophic events.

In the talk we discuss recent large-scale experiments and their implication for modelling approaches, especially cellular automata models with stochastic dynamics. As an application, the development of a so-called "evacuation assistent" for the Espritarena Düsseldorf is described. It uses fast online simulations which allow to react quickly to a specific emergency situation and support local authorities in their decision making.

SOE 3: Traffic Dynamics, Urban and Regional Systems II

Time: Monday 10:15–12:00 Location: H44

SOE 3.1 Mon 10:15 H44

Towards a non-equilibrium statistical physics for mobility on road networks — •Bazzani Armando[1], Rambaldi Sandro[2], and Marchioni Monica[3] — [1]University of Bologna, INFN, Bologna, Italy — [2]University of Bologna, INFN, Bologna, Italy — [3]University of Bologna, Bologna, Italy

New communication technologies allow to record dynamical microscopic data on large social systems. In Italy single vehicle trajectories are monitored by a GPS system for insurance reason. The data concern 2% of the whole vehicle population and the trajectories are sampled at a spatial scale of 2 Km. Recent studies of Florence urban area[A.Bazzani et al "Statistical Laws in Urban Mobility from microscopic GPS data in the area of Florence" submitted for publication 2009] have pointed out that in the average the GPS data represent an urban mobility that can be described by an ergodic principle based on the existence of a "mobility energy" for the daily mobility paths and by a Benford's law for the activity downtime distribution. To enrol the system complexity is then necessary to study transient states out of equilibrium, like, for instance, the rise of congestion phenomena. In this work we analyze the GPS data recorded on the whole Emilia-Romagna region during November 2007 to look for congestion effects and their evolution. We propose to describe the congestion dynamics by using the instant velocity and the trajectories of the monitored vehicles. We consider also the behavior of some selected drivers that are used to move in the considered area.

SOE 3.2 Mon 10:30 H44

Braess's paradox at work: does an incomplete highway upgrade pay off? — •Thimo Rohlf — Programme d'Epigenomique, Genopole Campus 1 - Genavenir 6, 5 rue Henri Desbruères, F-91030 Évry cedex, France — Max-Planck-Institute for Mathematics in the Sciences, Inselstr. 22, D-04103 Leipzig, Germany

It is well known that adding new roads to an existing road network may sometimes increase congestion (Braess's paradox). Here, we investigate this problem for the special case of a highway that is two-lane only in a limited section, using the Nagel-Schreckenberg model of traffic flow. We compare fundamental diagrams and average travel time for different relative lengths of the two-lane section with the purely one-lane and purely two-lane case. Further, the influence of different foresight ranges and different types of cooperative behavior at the bottlenecks near the merging points of both lanes is studied.

SOE 3.3 Mon 10:45 H44

Phase Synchronization in Train Connection Timetables — •Christoph Fretter[1], Matthias Müller-Hannemann[1], Lachezar Krumov[2], Karsten Weihe[2], and Marc-Thorsten Hütt[3] — [1]Martin Luther Universität Halle-Wittenberg — [2]TU Darmstadt — [3]Jacobs University Bremen

Train connection timetables are an important research topic in algorithmics. Finding optimal or near-optimal timetables under the subsidiary conditions of minimizing travel times and other criteria is an important contribution to the functioning of public transportation. In addition to efficiency (given, e.g. by minimal average travel times), the robustness of the timetable, i.e. a minimization of delay propagation, is an important criterion. Here we study the balance of efficiency and robustness in train connection timetables from the perspective of synchronization, exploiting the fact that a major part of the trains run nearly periodically. We find that synchronization is highest at intermediate-sized stations. We argue that this synchronization perspectives opens a new avenue towards an understanding of train connection timetables by representing them as spatiotemporal phase patterns. Robustness and efficiency can then be viewed as properties

of this phase pattern.

15 min. break

SOE 3.4 Mon 11:15 H44

Optimization of packing problems — •Johannes J. Schneider, Andre Müller, and Elmar Schömer — Center for Computational Research Methods in Natural Sciences, Johannes Gutenberg University of Mainz, Staudinger Weg 7, 55099 Mainz, Germany

Everybody knows this problem: goods just bought in the supermarket have to be packed in the rear trunk of the car, often while considering constraints, like fruit which must not be squashed. Analogously, we face packing problems when we have to pack suitcases when going on holiday. Also in logistics, packing problems occur: the traveling salesperson has to pack the truck in a way corresponding to the sequence of the customers on the tour. Further packing problems occur in textile industry as well as in wood- and metal-working industry.

In this talk, a multidisperse packing problem shall be considered, in which hard disks with different sizes are packed in a circular environment in a way that the radius of the circumcircle around the disks is minimum. We present our packing algorithm, with which we were able to beat and to match all world records established in an international contest in competition between 155 groups from 32 countries. Our packing algorithm was rated by the Time Magazine to be one of the 50 best inventions of the year 2009.

SOE 3.5 Mon 11:30 H44

Network harness: bundles of routes in public transport networks — Bertrand Berche[1], Christian von Ferber[2,3], and •Taras Holovatch[1,2] — [1]Laboratoire de Physique des Matériaux, Université Nancy 1, FR — [2]Applied Mathematics Research Centre, Coventry University, UK — [3]Physikalisches Institut, Universität Freiburg

Public transport routes sharing the same grid of streets and tracks are often found to partly proceed in parallel. Similar phenomena are observed in other networks built with space consuming links such as cables, pipes, neurons, etc. To quantify this behavior we use the notion of network harness described by the harness distribution $P(r, s)$: the number of sequences of s consecutive stations that are serviced by r parallel routes. For certain PTNs that we have analysed we observe that the harness distribution may be described by power laws. These power laws observed indicate a certain level of organization and planning which may be driven by the need to minimize the costs of infrastructure. This effect may be seen as a result of the strong interdependence of the evolutions of both the city and its PTN. To further investigate the significance of the empirical results we have studied one- and two-dimensional models of randomly placed routes modeled by different types of walks. While in one dimension an analytic treatment was successful, the two dimensional case was studied by extensive simulations showing that the empirical results for real PTNs deviate significantly from those of randomly placed routes but can be described by a model of interacting self-avoiding walks.

SOE 3.6 Mon 11:45 H44

Modelling of driver behavior based on Langevin analysis — •Michael Langner and Joachim Peinke — Institut für Physik, Carl von Ossietzky Universität, 26129 Oldenburg, Deutschland

This work is part of the project Integrated Modeling for Safe Transportation (IMoST). In this project we develop models for driver behavior in selected situations. Our goal is to develop advanced driver assistance systems (ADAS) for the automotive domain. The first investigated scenario covers the merging while entering an autobahn. We made different experiments with test subjects in a simulator to gain the necessary data for our analysis. We present different ways how a stochastic model of the driver behavior can be estimated directly from the given data by using the Langevin analysis. The aim is to generate a drift and diffusion based stochastic model directly from the data, which is equivalent to a potential based model.

SOE 4: Focus Session: Science of Science

Time: Monday 13:30–15:45 Location: H44

Invited Talk SOE 4.1 Mon 13:30 H44

Following the actors: individual and collective behavior in epistemic landscapes — •Andrea Scharnhorst — The Virtual Knowledge Studio for the Humanities and Social Sciences, Royal Netherlands Academy of Arts and Sciences (KNAW), Cruquiusweg 31, 1019AT Amsterdam, The Netherlands

Models of science can take very different forms from conceptual models based on historical and ethnographic observations to mathematical descriptions of measurable phenomena. In these models, scholars and science itself become 'research objects'. [1]

All decades have seen their 'models of science'. At the interface between mathematics, physics and a "science of science" we see traces of stochastic models, epidemic models, system dynamics models and complex network models applied to scholarly activity.

Referring to more recent encounters between information science and complexity research this paper present a specific model of (re)-searchers in "epistemic landscapes" based on insights from evolutionary theories.

Departing from this specific model we show how models can be linked to data gathering, to qualitative observations, and to new ways of visualization beyond the narrow cycle of validation and prediction.

[1] Boerner, Katy, and Andrea Scharnhorst. 2009. Editorial: Visual conceptualizations and models of science. Journal of Informetrics: 'Science of Science: Conceptualizations and Models of Science' (special issue) 3 (3): 161-172.

Invited Talk SOE 4.2 Mon 14:00 H44

Tracking science in real-time from large-scale usage data. — •Johan Bollen — Indiana University, Bloomington, USA

Science is of significant importance to our society, but we understand very little of the processes that lead to scientific innovation. In this presentation I will provide an overview of our work on large-scale usage data as an early indicator of scientific activity. The MESUR project has in the past 2 years collected a large-scale collection of the usage data recorded by some of the world's most significant publishers, aggregators and institutional consortia. The resulting data set has been analyzed to reveal the structural properties of scientific activity in real-time. I will highlight some of our recent work on producing detailed maps of science that reveal how scientists navigate between online scholarly resources. The results indicate that it may be possible to detect or predict the emergence of innovation from temporal changes in the structure of scientific activity. This work underpints efforts to arrive at a more accurate, pro-active evaluation of scientific impact.

15 min. break

Invited Talk SOE 4.3 Mon 14:45 H44

Mapping change in science — •Martin Rosvall[1] and Carl Bergstrom[2] — [1]Umeå University, Sweden — [2]University of Washington, USA

Change is a fundamental ingredient of interaction patterns in biology, technology, the economy, and science itself: Interactions within and between organisms change; transportation patterns by air, land, and sea all change; the global financial flow changes; and the frontiers of scientific research change. Networks and clustering methods have become important tools to comprehend instances of these large-scale structures, but without methods to distinguish between real trends and noisy data, these approaches are not useful for studying how networks change. Only if we can assign significance to the partitioning of single networks can we distinguish meaningful structural changes from random fluctuations. Here we show that bootstrap resampling accompanied by significance clustering provides a solution to this problem. To connect changing structures with the changing function of networks, we highlight and summarize the significant structural changes with alluvial diagrams and realize de Solla Price's vision of mapping change in science: studying the citation pattern between about 7000 scientific journals over the past decade, we find that neuroscience has transformed from an interdisciplinary specialty to a mature and standalone discipline.

Invited Talk SOE 4.4 Mon 15:15 H44

Statistical physics of citation behavior — •Santo Fortunato — ISI Foundation, Torino, Italy

Citation behavior has been subject of intense investigations over the last years. The availability of detailed databases and of modern computers enables one to perform careful statistical analyses of citation data and their patterns. One of the results of these investigations is the fact that pure citation scores are not reliable to provide fair rankings between papers and/or scientists, for several reasons. One of these reasons is the role played by the specific scientific discipline of a paper/author. Here I show that the citation patterns of papers of different disciplines are actually identical, provided the citation scores are properly normalized. This provides a criterion for an objective comparison of papers and scientists belonging to different disciplines. Another improvement may come from a self-consistent weighing of citations, based on the role of scientists in the spreading of reputation to their peers, alike to Google's PageRank process.

SOE 5: Award Ceremony: Young Scientist Award for Socio- and Econophysics

Time: Monday 16:00–18:00 Location: H44

Invited Talk SOE 5.1 Mon 16:00 H44

Tying the double knot: Robustness of interconnected networks — •Shlomo Havlin — Bar-Ilan University, ramat-Gan, Israel

After a decade of intense study on networks, almost all the research done has been concentrated on the case of a single network which does not interact with other networks. Such situations rarely, if ever, occur. Modern systems are coupled together and should be modeled by multiple interdependent networks. For example, a power station network and a computer communication network, are interdependent, since the comunication nodes rely for power supply on the power stations, while the power stations depend for their control on the proper functioning of the communication network. In interdependent networks, when nodes in one network fail, they cause dependent nodes in another network to also fail. This may happen iteratively and can lead to a cascade of failures. In fact, a failure of a very small fraction of nodes in one network may lead to the complete fragmentation of a system of many interdependent networks. We provide an analytical framework for understanding the robustness of interacting networks subject to such cascading failures. Surprisingly, analyzing complex systems as a set of interdependent networks may alter a basic assumption that network theory has relied on: while for a single network a broader degree distribution of the network nodes results in the network being more robust to random failures, for interdependent networks, the broader the distribution is, the more vulnerable the networks become. These findings pose a significant challenge to the future design of robust modern interdependent networks.

Presentation of the Young Scientist Award for Socio- and Econophysics to Dr. Dirk Brockmann, Northwestern University

Prize Talk SOE 5.2 Mon 17:00 H44

Unveiling the patterns of human mobility and global disease dynamics — •Dirk Brockmann — Northwestern University, Chicago

We are on the move. Every year, more than 3 billion passengers use the international air transportation network; our world is covered with a dense web of roads and highways, frequently operating at their maximum capacity; millions of commuters travel on an intricate system of railroads and public transportation services. Given the sheer complexity of human mobility patterns and transportation networks it may seem bold if not audacious to ask if basic underlying principles govern the evolution of these networks, whether mobility as a whole may follow fundamental laws, and what types of regularities are hidden within the complex way we travel. Nonetheless, a comprehensive understanding of human mobility is of fundamental importance in the development of models for the global spread of emergent infectious diseases, such as the recent H1N1 pandemic of 2009. I will report on our efforts to understand human mobility networks employing mobility proxies such as the geographic circulation of money, recent results on effective communities encoded in these networks and conclude with a discussion of our recent forecast of the time course of the HN1 pandemic in the United States.

After the awardee's talk, there will be a social gathering with beer and pretzels around the poster area C1.

SOE 6: Poster Session

Time: Monday 18:00–20:00 Location: Poster C

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

SOE 6.1 Mon 18:00 Poster C

Employment, Production and Consumption Model: Patterns of Phase Transitions — •Hynek Lavička[1,2,3], Lin Lin[4], and Jan Novotný[1,5,6] — [1]Department of Physics, Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague, B\v{r}ehov\' a 7, 115 19 Praha 1, Czech Republic — [2]Doppler Institute for Mathematical Physics and Applied Mathematics, Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague, B\v{r}ehov\' a 7, 115 19 Praha 1, Czech Republic — [3]Bogolyubov Laboratory of Theoretical Physics, Joint Institute of Nuclear Research, 141980 Dubna, Russia — [4]Department of Economics, University of Kiel, Olshausenstrasse 40, 24118 Kiel, Germany — [5]CERGE-EI, Charles University, Politick\' ych v\v ez\v n\r u 7, 111 21, Praha 1, Czech Republic — [6]Nuclear Physics Institute, p.r.i., \v{R}e\v{z} near Prague, 250 68 \v{R}e\v{z}, Czech Republic

We have simulated the model of Employment, Production and Consumption (EPC) using Monte Carlo. The EPC model is an agent-based model that mimics very basic rules of industrial economy. From perspective of physics, the nature of the interactions in the EPC model represents multi-agent interactions where the relations among agents follow the key laws for circulation of capital and money. Monte Carlo simulations of the stochastic model reveal phase transition. The two phases are the phase with full unemployment and the phase with nearly full employment.

SOE 6.2 Mon 18:00 Poster C

Patterns of cooperation — •Anne-Ly Do and Thilo Gross — MPI for the Physics of Complex Systems, Dresden

We study the self-assembly of a complex network of cooperative interactions among rational, self-interested agents. The agents can maintain different levels of cooperation with different, self-chosen partners. Further, they continuously, selectively, and independently adapt the amount of resources allocated to each of their interactions in order to maximize the obtained payoff. We show analytically that the system approaches a state in which the agents make identical investments, and links produce identical benefits. Despite this high degree of social coordination some agents manage to secure privileged topological positions in the network enabling them to extract high payoffs.

SOE 6.3 Mon 18:00 Poster C

Evolution of cooperation on dynamical networks: An analytical approach — •Bin Wu[1,2], Arne Traulsen[1], and Long Wang[2] — [1]Max Planck Institute for Evolutionary Biology, August-Thienemann-Str. 2, 24306 Plön, Germany — [2]Center for Systems and Control, College of Engineering Peking University, Beijing 100871, China

We investigate how the dynamics of a social network can change the

cooperativeness of agents in the network. We focus on the fragility of social tie, i.e. the probability to break a link, in the Prisoner*s Dilemma. Individuals either update their strategies by imitating their neighbors or break their social ties and establish new relationships. The pairwise comparison rule [1] is employed for the strategy evolution. For the linking dynamics, a random link is selected and it breaks with a probability that depends on the relationship type. Subsequently, a new link to a random neighbor is established. In contrast to earlier work [2], the total number of links is constant. The model can be solved analytically under time scale separation. This leads to a simple rule for the evolution of cooperation, that is, the more fragile CD links are (or the less fragile CC ones are), the more likely cooperation prevails [3]. Our work may shed light on the ubiquitous cooperation in the real world where social networks are dynamic.

[1] Szabó and Tőke, Phys. Rev. E 58, 69 - 73 (1998).

[2] Pacheco, Traulsen and Nowak, Phys. Rev. Lett. 97, 258103 (2006).

[3] Wu, et al. (submitted).

SOE 6.4 Mon 18:00 Poster C

Interevent times distribution in Voter-like models — •Juan Fernández-Gracia and Víctor M. Eguíluz — IFISC (UIB-CSIC), Palma de Mallorca, Spain

Motivated by the evidence of non-poissonian distributions in human activity patterns[1] and its impact on interactions on a network[2][3] we study the interevent times distribution on voter-like models of opinion formation. The Voter-model has been used for long time for studying out of equilibrium processes of consensus formation. The distribution of times between consecutive changes of state of a node is investigated for various variations of the voter model on different topologies.

[1]On Universality in Human Correspondence activity. R.Dean Malmgren, et al. Science 325,1696 (2009) DOI: 10.1126/science.1174562

[2]Impact of Human Activity Patterns on the Dynamics of Information Diffusion. José L. Iribarren, Esteban Moro. PRL 103, 038702 (2009)

[3]Impact of Non-Poissonian Activity Patterns on Spreading Processes. Alexei Vazquez, Balázs Rácz, András Lukács, Albert-László Barabási. PRL 98, 158702 (2007)

SOE 6.5 Mon 18:00 Poster C

Correlation Network Analysis of Climate Data — •Jakob Runge — Potsdam Institut für Klimafolgenforschung and Humboldt Universität zu Berlin

The contribution has been withdrawn.

SOE 6.6 Mon 18:00 Poster C

Self-organized critical improvidence — •Tobias Tubbenhauer[1], Stefan Bornholdt[1], and Thomas Lux[2] — [1]Institut für Theoretische Physik, Universität Bremen, Otto-Hahn-Allee, 28359 Bremen — [2]Institut für Volkswirtschaftslehre, Universität Kiel, Olshausenstraße 40, 24118 Kiel

Risk is an inherent property of stock markets [1,2]. Motivated by the dynamics of the recent financial crisis, we here study the balance between the willingness to take risks and the desire for security of investors in an agent-based artificial market. In the clash of these two conflicting interests we observe dynamical regimes that are reminiscent of the currently observed risk taking behavior of investors after the recent market crisis. We observe critical behavior in the dynamics of our toy market, indicating that the behavior of the agents quickly leads to new systemic risk, even shortly after a major crash.

[1] E. Samanidou, E. Zschischang, D. Stauffer, and T. Lux, Agent-based Models of Financial Markets, Rep. Prog. Phys. 70, 409 - 450 (2007)

[2] T. Lux, D. Colander, A. Haas, M. Goldberg, K. Juselius, A. Kirman, and B. Sloth, The Financial Crises and the Systemic Failure of Academic Economics, Critical Review 21, 249 - 267 (2009)

SOE 6.7 Mon 18:00 Poster C

Infectious diseases on livestock trade networks — •Hartmut Lentz[1,2], Thomas Selhorst[2], and Igor M. Sokolov[1] — [1]Humboldt University, Berlin — [2]Federal Research Institute for Animal Health, Wusterhausen

The spread of animal diseases is encouraged by trading of livestock. This might cause enormous economic losses. In Germany, veterinary authorities are obliged to report every movement of pigs to the central database (HI-Tier database). The database contains a network of all holdings belonging to the pork chain of production consisting of about 120.000 holdings (nodes) and and 3.5 million trade transactions. This yields a static weighted and directed network with about 300.000 edges. The geographical proximity between all holdings is known and can be used to model the disease spread by e.g. rodents. The dynamic of the spread of infectious diseases on networks is still not well understood. It is commonly investigated using stochastic agent based models. In these models it is difficult to obtain an understanding of the disease on a global level. To address this problem we introduce a time continuous SIR model and investigate its solutions. We consider the temporal behavior of the total number of infected and their dispersal.

SOE 6.8 Mon 18:00 Poster C

Individualized Trust in Social Networks — •Oliver Richters and Tiago P. Peixoto — TU Darmstadt, Fakultät für Physik

Non-centralized recommendation based decision making is a central feature of several social and technological processes, such as market dynamics, peer-to-peer file-sharing, and webs of trust of digital certification. We propose a metric for calculating transitive trust in social networks, based on the direct trust among agents. Our metric fully captures the individualized nature of trust, and does not rely on any specific topological characteristic of the network, contrary to similar methods proposed in the literature. Further, we investigate the general properties of trust in random networks, according to different strategies of choice of direct trust between agents.

SOE 7: Evolutionary Game Theory I (with BP)

Time: Tuesday 9:30–11:00 Location: H44

Invited Talk SOE 7.1 Tue 9:30 H44

Humans playing spatial games — •Arne Traulsen — Max-Planck-Institute for Evolutionary Biology, 24306 Plön, Germany

Probably the most thoroughly studied mechanism that can explain the evolution and maintenance of costly cooperation among selfish individual is population structure. In the past years, hundreds of papers have mathematically modeled how cooperation can emerge under various dynamical rules and in more and more complex population structures [1]. However, so far there is a significant lack of experimental data in this field. We have conducted an experimental test to address how humans are playing a particularly simple spatial game on a regular lattice [2]. The data shows that the way humans choose strategies is different from the usual assumptions of theoretical models. Most importantly, spontaneous strategy changes corresponding to mutations or exploration behavior is more frequent than assumed in many models. This can decrease the influence of some spatial structures. This experimental approach to measure properties of the update mechanisms used in theoretical models may be useful for mathematical models of evolutionary games in structured populations.

[1] Szabó and Fáth, Evolutionary games on graphs, Physics Reports 446:97-216 (2007)

[2] Traulsen, Semmann, Sommerfeld, Krambeck, and Milinski, submitted

SOE 7.2 Tue 10:00 H44

Coordination with switching costs: A case for percolation in socioeconomic networks — •Carlos P. Roca[1], Moez Draief[2], and Dirk Helbing[1,3] — [1]Chair of Sociology, in particular of Modeling and Simulation, ETH Zurich, Switzerland — [2]Intelligent Systems and Networks Group, Imperial College London, UK — [3]Santa Fe Institute, USA

Coordination is ubiquitous in social and economic interactions [1,2]. An important but not much studied issue is the influence of the costs

involved in the switching of strategy, which however can be very relevant to important situations such as inefficient norms [3] or competition in technological markets [4]. We propose an extension of a binary coordination game to investigate this problem. We study it on degree-homogeneous random networks, observing that the outcome is greatly influenced by the underlaying network. The dependence on the network degree is highly non-trivial and extremely large degrees are needed to recover the mean field results. The explanation of this unexpected behavior resides in a particular kind of percolation process that takes place in the networked population. These results strongly suggest that percolation phenomena may be crucial in social and economic networks when coordination interactions are in play.

[1] Lewis, Convention: A Philosophical Study, Harvard University Press, 1969 [2] Harsany and Selten, A General Theory of Equilibrium Selection in Games, MIT Press, 1988 [3] Mahoney, Theory and Society 29, 507-548, 2000 [4] Klemperer, The Review of Economic Studies, 62, 515-539, 1995

SOE 7.3 Tue 10:15 H44

Rock-papers-scissors dynamics on complex networks — Markus Schütt and •Jens Christian Claussen — Inst. f. Neuro- und Bioinformatik, Universität zu Lübeck

Cyclic coevolutionary dynamics of three cyclically dominating strategies have been found in Prisoner's Dilemma conflicts (with AllC, AllD and TFT) as well as in bacteria (E.coli) and the lizards (Uta stansburiana). The simplest payoff matrix resembling this cyclicity is that of the rock-papers-scissors (RPS) game. The meanfield dynamics of such cyclic coevolutionary dynamics in finite population has been analyzed in previous work for the RPS game [1] as well as for a bimatrix game played between two populations [2]. Here we investigate the fixation time for the RPS game on different types of regular, random, small-world and scale-free graphs [2].

[1] JC Claussen and A Traulsen, Phys. Rev. Lett (2008)
[2] JC Claussen, Eur. Phys. J. (2007)
[3] M Schütt and JC Claussen (in preparation)

SOE 7.4 Tue 10:30 H44

Evolutionary games in the multiverse — •Chaitanya S. Gokhale and Arne Traulsen — Max-Planck-Institute for Evolutionary Biology, August-Thienemann-Straße 2, 24306 Plön, Germany

Evolutionary game dynamics of two players with two strategies has been studied in great detail. These games have been used to model many biologically relevant scenarios, ranging from social dilemmas in mammals to microbial diversity. Some of these games may in fact take place between a number of individuals and not just between two. Here, we address one-shot games with multiple players. As long as we have only two strategies, many results from two player games can be generalized to multiple players. For games with multiple players and more than two strategies, we show that statements derived for pairwise interactions do no longer hold. For two player games with any number of strategies there can be at most one isolated internal equilibrium. We show that for any number of players d with any number of strategies n, there can be at most $(d-1)^{n-1}$ isolated internal equilibria. Thus, multiplayer games show a great dynamical complexity that cannot be captured based on pairwise interactions. Our results hold for any game and can easily be applied for specific cases, e.g. public goods games or multiplayer stag hunts.

SOE 7.5 Tue 10:45 H44

Social Dilemmas for Players with Complex Personality Profiles — Tadeusz Platkowski and •Jan Zakrzewski — Deparment of Mathematics, Informatics and Mechanics, University of Warsaw

We develop a theory of evolution of social systems based on the imitation rule which generalizes the standard proportional fitness rule of the evolutionary game theory. The formalism is applied to describe the dynamics of various types of social dilemma games played in infinite populations. In particular the theory predicts the non-zero level of cooperation in the long run for the Public Good games, the existence of the nonunique stable polymorphism for particular classes of the Prisoner's Dilemma games, and stable asymptotic cooperation level for coordination games in the N-person setting, for which the standard replicator dynamics approach predicted the instable polymorphism.

SOE 8: Evolutionary Game Theory II (with BP)

Time: Tuesday 11:15–12:30 Location: H44

SOE 8.1 Tue 11:15 H44

Evolutionary dynamics, intrinsic noise and cycles of co-operation — •Alex Bladon, Tobias Galla, and Alan J McKane — Theoretical Physics, School of Physics and Astronomy, The University of Manchester, Manchester M13 9PL, United Kingdom

The puzzle of how co-operation emerges in evolving populations subject to natural selection is unsolved, and the dynamic interaction of co-operation and defection is a current topic of wide interest in game theory. Periodic cycles between co-operation, defection and retaliation have been reported in numerical simulations of the iterated prisoner's dilemma in small populations of evolving agents [PNAS, 102, 31, 10797-10800, 2005]. Using tools from statistical mechanics and nonlinear dynamics we here provide an analytical underpinning of these numerical observations and show that such cycles are the signature of amplified coherent oscillations sustained by demographic noise. We derive effective Langevin equations describing these oscillations and compute their power spectra analytically in the limit of large, but finite populations and in excellent agreement with numerical simulations. Our analytical theory reveals that the amplitude of these stochastic oscillations is, to a large degree, set by the inverse real part of the relevant eigenvalue of the deterministic dynamics, and that it can hence become singular near a Hopf bifurcation. Macroscopic oscillations are then observed even at large system sizes. Our analysis extends to cases in which errors of the 'trembling hand' type are considered, and where the strategy space includes a win-stay, lose-shift action.

SOE 8.2 Tue 11:30 H44

Evolutionary adaptation of a social norm optimizes node degree and investments on an adaptive network — •Johannes Hoefener and Thilo Gross — Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden, Germany

Humans established complex networks of cooperation, which are essential for our modern society. Cooperating with just a single person is not efficient and cooperating with everyone is not even possible. Thus every individual has to decide if and how much it should invest into a certain cooperation. Because the payoff provided by a cooperation is usually not known when the investments have to be done, individuals may base their decision on heuristics or social norms. These, for instance may follow the statement: "Get more. Give more." Here we study a continuous prisoner's dilemma game on an adaptive network, where the investment into cooperation is determined by a social norm function. We assume that the general form of the function is fixed, but allow the function to be modified by evolutionary adaptation of it's parameters. We show that this adaptation not only establishes stable cooperation but also optimizes the node degree as well as the investments in the remaining cooperations.

SOE 8.3 Tue 11:45 H44

A Homclinic Route to Full Cooperation in the Snowdrift Game on Adaptive Networks — •Gerd Zschaler[1], Arne Traulsen[2], and Thilo Gross[1] — [1]Max-Planck-Institut für Physik komplexer Systeme, Dresden, Germany — [2]Max-Planck-Institut für Evolutionsbiologie, Plön, Germany

We consider the evolutionary dynamics of a cooperative game on an adaptive network, where the strategies of agents, cooperation or defection, feed back on their local interaction topology. While mutual cooperation is the social optimum, unilateral defection yields a higher payoff and undermines the evolution of cooperation. Although no a priori advantage is given to cooperators, an intrinsic dynamical mechanism can lead asymptotically to a state of almost full cooperation. In finite systems, this state is characterized by long periods of strong cooperation interrupted by sudden episodes of predominant defection, suggesting a possible mechanism for the systemic failure of cooperation in real-world systems.

SOE 8.4 Tue 12:00 H44

Deterministic evolutionary game dynamics in finite populations — •Philipp M. Altrock and Arne Traulsen — MPI f. Evolutionary Biology, Plön, Germany

Evolutionary game dynamics describes the spreading of successful strategies in a population of reproducing individuals. Typically, the microscopic definition of strategy spreading is stochastic, such that the dynamics becomes deterministic only in infinitely large populations. Here, we introduce a new microscopic birth–death process that has a fully deterministic strong selection limit in well–mixed populations of any size. Additionally, under weak selection, from this new process the frequency dependent Moran process is recovered. This makes it a natural extension of the usual evolutionary dynamics under weak selection. We analytically find simple expressions for the fixation probabilities and average fixation times of the new process in evolutionary games with two players and two strategies. For cyclic games with two players and three strategies, we show that the resulting deterministic dynamics crucially depends on the initial condition in a non–trivial way.

[1] Goel & Richter-Dyn, *Stochastic Models in Biology*, Academic Press, NY, (1974).

[2] Altrock & Traulsen, Phys. Rev. E **80**, 011909 (2009).

SOE 8.5 Tue 12:15 H44

Evolutionary Quantum Game Theory — •Matthias Hanauske[1] and Jennifer Kunz[2] — [1]Institute of Information Systems — [2]Chair of Controlling and Auditing, Goethe-University, Frankfurt/M.

Quantum game theory is a mathematical and conceptual amplification of classical game theory. The space of all conceivable decision paths is extended from the purely rational, measurable space in the Hilbertspace of complex numbers. Trough the concept of a potential entanglement of the imaginary quantum strategy parts, it is possible to include corporate decision path, caused by cultural or moral standards. If this strategy entanglement is large enough, then, additional Nash-equilibria can occur and previously present dominant strategies could become nonexistent. The main equation of evolutionary game theory, the Replicator equation, gets a more complex structure and other evolutionary stable strategies can appear. In addition to a detailed introduction in evolutionary quantum game theory several examples of applications will be presented during this talk. The current financial crisis will be discussed using a quantum extension of an anti-coordination game, the different publication patterns of scientist will be studied and the evolution of social norms in firms will be explained using a quantum coordination game.

(http://evolution.wiwi.uni-frankfurt.de/Lyon2009/, ArXiv: 0904.2113, arXiv: physics/0612234)

SOE 9: Social Systems, Opinion and Group Dynamics I

Time: Tuesday 12:30–13:30 Location: H44

SOE 9.1 Tue 12:30 H44

Towards Simulating the Foundations of Society - A Multi-Agent Game-Theoretical Approach — •Dirk Helbing and Anders Johansson — ETH Zurich, Swiss Federal Institute of Technology, Switzerland

To study social interactions, we propose an agent-based model with spatial interactions that can be analytically treated within a evolutionary game-theoretical framework. In order to understand social systems, it is essential to identify the circumstances under which individuals spontaneously start cooperating or developing shared behaviors, norms, and culture. In this connection, it is important to study the role of social mechanisms such as repeated interactions, group selection, network formation, costly punishment and group pressure, and how they allow to transform social dilemmas into interactive situations that promote the social system. Furthermore, it is interesting to study the role that social inequality, the protection of private property, or the on-going globalization play for the resulting "character" of a social system (cooperative or not). It is well-known that social cooperation can suddenly break down, giving rise to poverty or conflict. The decline of high cultures and the outbreak of civil wars or revolutions are well-known examples. The more surprising is it that one can develop an integrated, analytical game-theoretical description of phenomena as different as the outbreak and breakdown of cooperation, the formation of norms or subcultures, and the occurrence of social polarization.

SOE 9.2 Tue 13:00 H44

Agent-based modelling of nest-site choice by honeybee swarms — •Tobias Galla — Theoretical Physics, School of Physics and Astronomy, University of Manchester, Manchester M13 9PL, UK

In a recent paper List, Elsholtz and Seeley [Phil. Trans. Roy. Soc. B 364 (2009) 755] devised an agent-based model of the the nest-choice dynamics in swarms of honeybees. Using tools from statistical physics we here present a simplified version of their model, and confirm analytically that both interdependence and independence are needed for the bees to reach a consensus on the best nest site. Based on our analytical theory it is possible to characterize the co-ordination outcome exactly on the deterministic level, and to a good approximation if stochastic effects are taken into account. The model applies more generally to decision making processes in humans, and can be used to address questions of consensus formation in committees or groups.

Reference: Tobias Galla, Journal of Theoretical Biology Volume 262 (2010) 186-196

SOE 10: Evolutionary Game Theory III (with BP)

Time: Tuesday 14:00–16:00 Location: H44

Invited Talk SOE 10.1 Tue 14:00 H44

Stochasticity and specificity in DNA repair — •Thomas Höfer[1], Martijn Luijsterburg[2], Gesa von Bornstaedt[1], and Roel van Driel[3] — [1]Deutsches Krebsforschungszentrum, Heidelberg, Germany — [2]Karolinska Institute, Stockholm, Sweden — [3]University of Amsterdam, The Netherlands

To understand how multi-protein complexes assemble and function on chromatin, we have combined quantitative analysis of a mammalian DNA repair machinery in living cells with mathematical modeling. We found that the individual components exchange rapidly at the repair sites whereas their net accumulation evolved on a much slower timescale. Based on the experimental data, we developed a predictive kinetic model of how multi-protein repair complexes assemble. Complex formation is orchestrated by progressive enzymatic modifications of the chromatin substrate, leaving considerable freedom for the binding mode of individual proteins. We demonstrate that the faithful recognition of DNA lesions is a time-consuming process, while subsequently repair complexes form rapidly through random and reversible assembly. Our analysis reveals a fundamental conflict between specificity and efficiency of chromatin-associated protein machineries and shows how a trade-off is negotiated through reversibility of protein binding.

SOE 10.2 Tue 14:30 H44

Predicting correlated mutations of amino acids from protein structure — •Jonas Minning[1], Ugo Bastolla[2], and Markus Porto[1] — [1]Technische Universität, Darmstadt, Germany — [2]Centro di Biología Molecular, 'Severo Ochoa', CSIC-UAM, Madrid, Spain

Even though the average sequence similarity for homologous proteins sharing the same fold can reach the threshold of randomness, amino acid sequences maintain the fingerprint of selective pressures on structure and function. We have previously developed an analytical method for computing the probability to observe a given amino acid at a given site in a protein with known native structure, based on an independent site approximation of protein evolution subject to selective constraints on unfolding and misfolding stabilities [1]. However, substitutions at

different sites are known to be correlated, and these correlated mutations may give important information for reconstructing native contacts, protein interaction interfaces, or clusters of functionally important residues. Here, we present a model which allows to quantitatively predict the correlated mutations that arise from selective constraints on unfolding and misfolding stabilities. Our model is verified against simulated data of protein sequence evolution and statistical data of proteins in the Protein Databank.

[1] U. Bastolla *et al.*, Proteins **73**, 872 (2008).

SOE 10.3 Tue 14:45 H44

Stability of an underdominant polymorphism in the presence of migration — •Philipp M. Altrock, Arne Traulsen, R. Guy Reeves, and Floyd A. Reed — MPI f. Evolutionary Biology, Plön, Germany

In population genetics, underdominance refers to natural selection against individuals with a heterozygous genotype [1]. Here, we analyse a single–locus underdominant system of two large local populations that exchange individuals at a certain migration rate and can be characterized by fixed points in the joint allele frequency space. We specifically address the conditions under which underdominance can be applied to stably and reversibly transform a local population that is receiving untransformed migrants, where an exact relationship between the rate of migration and the degree of selection against heterozygotes, that allows stable local transformations, exists [2]. We also approximate the critical minimum frequency required to result in a stable population transformation. For doubly asymmetric configurations, i.e. different homozygote fitness and unequal migration rates, there is a regime where a stable transformation is only possible in one of the two populations. The stability of the system is robust to the migration of gravid females. We also address the relative influence of various forms of stochasticity (migration versus genetic drift).

[1] Hartl & Clark, *Principles of Population Genetics*, 2nd Edition. Sinauer Associates, Inc., Sunderland, MA. (1989).

[2] Karlin & McGregor, Theor. Pop. Biol. **3**, 186 (1972).

SOE 10.4 Tue 15:00 H44

Recombination suppresses peak escape in rugged fitness landscapes — •Joachim Krug and Su-Chan Park — Institut für Theoretische Physik, Universität zu Köln, Germany

The adaptive value of recombination is at the heart of the long-standing debate about the evolutionary role of sex. Intuitively one might expect recombination to aid the escape of a population from sub-optimal fitness peaks and hence to accelerate the adaptive process. Here we show that the converse is true. For a deterministic, haploid two-locus model with two fitness peaks of unequal height, a stationary low-fitness solution concentrated at the lower peak emerges beyond a critical value of the recombination rate. The bifurcation giving rise to this solution is formally equivalent to an Ising-like phase transition. Numerical simulations show that the phenomenon persists in more complex multilocus landscapes derived from experimental fitness measurements for the asexual fungus *Aspergillus niger*.

SOE 10.5 Tue 15:15 H44

Chemical Evolution in Simulating Experiments — •Eva Wollrab and Albrecht Ott — Biologische Experimentalphysik, Saarbrücken, Deutschland

In 1953 Stanley Miller and Harold Urey made a pioneering experiment, simulating possible primitive earth conditions. In a sealed apparatus they boiled water in an atmosphere of methane, ammonia and hydrogen circulating these compounds past an electric discharge during periods of the order of a week. The resulting samples contained several organic molecules among them also amino acids. In the following decades several experiments were made to test the spontaneous formation of the most important biomolecules under possible primitive earth conditions.

We have performed Miller's experiment. The resulting samples were analyzed by HPLC and mass spectroscopy. Our analysis performed following different run-times gives us information about the composition of the reaction products. It reveals an evolution of the emerging substances and their compositions towards increased complexity as well as a (universal?) distribution of molecular masses.

This is a first step in order to determine conditions, which ultimately allow for the birth of autocatalytic chemical cycles.

SOE 10.6 Tue 15:30 H44

Evolutionarily stable demographics — •Oskar Hallatschek — Biological Physics and Evolutionary Dynamics, MPI DS, Goettingen

It has long been noticed that demographic stochasticity can seriously interfere with Darwin's evolutionary principles of heritable variation and selection. Avantageous genes are sometimes lost accidentally. These chance effects are considered as major retardation of Darwinian evolution. Here, we show that, in spatial systems, they can sometimes accelerate adaptive evolution. We describe a whole class of demographic parameters for which demographic stochasticity actually drives adaptive evolution. Among these traits are dispersal rates and carrying capacities, for which evolutionary optimal values (ESS's) can be given. These new class of noise driven adaptations suggests that demographic stochasticity must be considered also as an important creative Darwinian force, not only as a disrupting one.

SOE 10.7 Tue 15:45 H44

Sexual and asexual reproduction in iteroparous species — •Yixian Song[1], Barbara Drossel[1], and Stefan Scheu[2] — [1]Institut für Festkörperphysik, Technische Universität Darmstadt, Deutschland — [2]J.F. Blumenbach Institute of Zoology and Anthropology, University of Goettingen, Germany

The evolution of sex has been discussed intensively since Charles Darwin. By considering explicitely the important fact of limited and structured resources, we explore the conditions for the maintenance of sex in spite of the cost of producing males. In this model, asexual species win over sexual species only when mortality rates are large, resources regrow quickly, many different genotypes are allowed to coexist at the same place, or when resource diversity is small. Here, we modify the limited structured resource model of Scheu and Drossel (Proc. Roy. Soc. B. 2007) such that it applies to iteroparous species, which reproduce more than once during their life. We therefore include age and size of individuals into the model, with the corresponding metabolic rate, mortality and fecundity. Metabolic rate per biomass and mortality decrease with increasing body weight, while the fecundity increases. Therefore, phenotypes with smaller size at maturity have a higher mass dependent metabolic rate, a higher mortality, and a lower fecundity. However, they reach maturity earlier with the same growth rate and increase thereby the chance of survival until reproduction. We determine the optimum size at reproduction and the optimum offspring size under different environmental conditions, and we evaluate the parameter range for which sexual reproduction wins over asexual reproduction.

SOE 11: SOE Members' Assembly

Time: Tuesday 16:00–16:30 Location: H44

Tuesday evening, there will be a social get-together in one of Regensburg's many restaurants. Details will be announced at the meeting.

SOE 12: Social Systems, Opinion and Group Dynamics II

Time: Wednesday 9:30–10:15 Location: H44

Invited Talk SOE 12.1 Wed 9:30 H44

The hidden complexity of open source software — •Frank Schweitzer — Chair of Systems Design, ETH Zurich, Kreuzplatz 5, 8032 Zurich, Switzerland

Open source software (OSS) can be seen as a evolving complex network. On the structural level the nodes are given by software modules (such as classes), whereas the links between nodes may describe the type of connection (such as usage or inheritance). This network is highly dynamic because of the addition/deletion of nodes or links and the propagation of changes. Understanding the development of OSS puts a challenge on different sciences: physics, to reveal the structural features and the abstract dynamics of the network; computer science, to elucidate the software engineering principles underlying OSS; economics/management sciences, to understand the social interaction of developers and users. In this talk, using a highly data driven approach, we analyse the community dynamics in more than 100 projects, the dependency structure and the change records of 35 Java projects and the evolution of the dependency network. Our investigations show remarkable regularities in the structure and dynamics of OSS which can be reproduced by simple models, this way challenging established paradigms in software engineering.

SOE 13: Networks: From Topology to Dynamics I (with BP, DY)

Time: Wednesday 10:15–12:45 Location: H44

SOE 13.1 Wed 10:15 H44

Stability of continuous vs. Boolean dynamics — •Fakhteh Ghanbarnejad and Konstantin Klemm — Department of Bioinformatics, University of Leipzig, Germany

Boolean networks are time- and state-discrete models of dynamical systems with many variables and quenched disorder in the couplings. The use of such discrete models makes large systems amenable to detailed analysis. The discretization, however, may bring about "artificial" behavior not found in the continuous description with differential equations. The usual definition of Boolean attractor stability is based on flipping the state of single nodes and checking if the system returns to the attractor, similar to a damage spreading scenario. This stability concept, however, does not reflect the stability of limit cycles in the corresponding continuous system of delay differential equations. Here we have a fresh look at the correspondence of stability definitions in continuous and discrete dynamics. We run extensive numerical simulations to test stability on various system architectures (networks). We establish a criterion for assessing stability of the continuous dynamics by probing the discrete counterpart.

SOE 13.2 Wed 10:30 H44

Reliable Boolean networks with threshold functions — •Manuel Ross, Tiago Peixoto, and Barbara Drossel — Institut für Festkörperphysik, TU Darmstadt

Boolean networks are used to model biological networks, such as gene regulatory networks. The nodes of the networks are in this case interpreted as genes, and the state is taken as activity, discretised to Boolean values. An attractor trajectory of the Boolean network is equivalent to a periodic time evolution of the respective network. The usual approach to analyzing these models consists in studying the dynamics of a given network or ensemble. The reverse approach, which we take here, is to deduce the structure of a network from dynamical properties, done for instance by Lau et al. [1]. The dynamical property considered here is a robust sequence of states, i.e., the dynamical trajectory shall not change under perturbations in the update times. We consider the extreme case where the dynamics is reliable under any update sequence, so only one node can possibly change its state at any given moment in time. Such reliable networks were introduced recently in our group [2]. We now extend this work by permitting only threshold functions as update functions. This imposes severe restrictions on the possible reliable trajectories, in contrast to the original study, where all Boolean functions were permitted. We explore the consequences of this restriction for the statistical properties of the possible dynamical trajectories. These statistical properties are finally compared to microarray data. References: [1] K. Y. Lau et al. Phys. Rev. E, 75(5):051907, 2007. [2] T. Peixoto and B. Drossel. arXiv:0905.0925v1, 2009.

SOE 13.3 Wed 10:45 H44

Contact networks and the spread of MRSA in hospitals — Lisa Brouwers[1], •Andrzej Jarynowski[1,2,3], Fredrik Liljeros[1], and Xin Lu[1] — [1]Stockholm University, S106 91 Stockholm, Sweden — [2]Department of Physics, Cologne University, Zülpicher Str. 77. 50937 Köln, Germany — [3]The UNESCO Chair of interdisciplinary studies, Wroclaw University, pl. M. Borna 9 50-204 Wrocław, Poland

The bacterium meticillin resistant Staphylococcus aureus(MRSA)is known to be the largest care related the infection problem. We investigated the Common Care Registry containing information about all patient visits within Stockholm County during the outbreak period with registry over diagnosed MRSA cases. Methods to analyze the contact network of persons visiting the same care unit is developed within the project as well as methods to analyze in what way network structure affects the transmission of MRSA. We study matrixes of disease transition in hospitals population(infected versus people, who could sent infection). In stationary case:(a)We have matrixes of estimators of that probabilities and other statisical properties of contact networks. In time evolution case:(b)We divided outbreak in smaller, periodical intervals and looked at how MRSA was spreading in time. Quasi-MCMC(Markov chain Monte Carlo) method and artificial networks(main parameter is number of contacts during specific time interval)help us to understand real- and simulated-paths of disease transition. Matrixes of probabilities(b)were used to find mechanism of change states(vectors of all population 0-health or 1-ill)and we can run quasi-MCMC to get most likely paths.

SOE 13.4 Wed 11:00 H44

A novel threshold mechanism for epidemics on complex networks — •Vitaly Belik[1] and Theo Geisel[1,2] — [1]Max-Planck-Institut für Dynamik und Selbstorganisation — [2]Georg-August-Universität Göttingen

Recently much effort was devoted to modeling of spatial spread of infectious diseases, triggered by latest pandemics, such as SARS and H1N1 influenza. Theoretical understanding of different modeling frameworks and taken assumptions are substantial factors determining reliability of predictions based on the models. We investigate on an epidemiological model explicitly taking into account such an important factor of human mobility as tendency to move frequently among several most preferred locations rarely undertaking long trips. We considered complex network topologies as an underlying mobility network and discovered new threshold behavior of the global epidemic outbreak in terms of time spent on distant location. Our results are supported by extensive stochastic numerical simulations. We believe our findings contribute to understanding of epidemiological dynamics and development of effective control and preventive measures.

SOE 13.5 Wed 11:15 H44

Stochastic load-redistribution model for cascading failures in interconnected systems — •Jörg Lehmann and Jakob Bernasconi — ABB Switzerland Ltd., Corporate Research, Segelhofstrasse 1K, CH-5405 Baden-Dättwil, Switzerland

We present a new class of stochastic models for cascading failure propagation in interconnected systems [1]. These models take into account, in a statistical sense, important physical characteristics of realistic load-redistribution mechanisms: (i) the load increments after a failure depend on the load of the failing element; (ii) the failed load is redistributed non-uniformly among the remaining elements. Within a Markov approximation, we are able to describe the cascading failure dynamics of these models in terms of a generalized branching process.

This yields an analytical solution for the breakdown probability in the limit of large system sizes. The application to blackouts in power grids is discussed.
[1] J. Lehmann and J. Bernasconi, arXiv:0909.4185.

15 min. break

SOE 13.6 Wed 11:45 H44

Synchronization in laser networks: From motifs to complex topologies with multiple delays. — •Thomas Dahms and Eckehard Schöll — Institut f. Theo. Physik, Sekr. EW 7-1, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

We investigate networks of delay-coupled lasers. These include small network motifs, i.e. uni- and bidirectional rings and linear chains, as well as complex topologies including random and small-world networks. The nodes of the networks are described by the widely used Lang-Kobayashi model. By extending the well-known master stability function to networks with time-delay and non-vanishing coupling terms, we are able to separate the local dynamics from the topology. This way we can predict stability of synchronization for any network topology simply by calculating the eigenvalues of the corresponding adjacency matrix. Besides in-phase synchronization, we also observe alternating anti-phase synchronization, where only the next-nearest neighbors are synchronized. Our approach provides deep insight and understanding of the connection between topology and stability of synchronization. While our results are obtained for laser networks, we stress that the results are applicable to a wider range of systems, since only the local dynamics in terms of the master stability function will differ for other models.

SOE 13.7 Wed 12:00 H44

Dynamics of neural networks with delay — •Judith Lehnert, Thomas Dahms, Philipp Hövel, and Eckehard Schöll — Institut f. Theo. Physik, Sekr. EW 7-1, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

We investigate synchronization in networks of delay-coupled FitzHugh-Nagumo systems. The paramater values are chosen such that an uncoupled element operates in the excitable regime. However, the coupling acts as a noninvasive control force (Pyragas control) stabilizing the unstable periodic orbit of the synchronized oscillation of all elements. We calculate the master stability function, which denotes the maximum transverse Lyapunov exponent of the synchronization manifold as a function of the eigenvalues of the coupling matrix. Hereby we are able to demonstrate that all network topologies realized by excitatory coupling terms show stable synchronization in a wide range of coupling strengths and delay times.
Furthermore, we investigate small-world-like networks: In a regular network of neurons with excitatory coupling we randomly interpose additional inhibitory links. We show that this introduces a phase transition from the synchronized state to a desynchronized one as the number of these additional inhibitory links approaches a critical value.

SOE 13.8 Wed 12:15 H44

Criticality in models of evolving neural networks — •Matthias Rybarsch and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen, Otto-Hahn-Allee, 28359 Bremen

We investigate self-organization mechanisms in models of evolving neural networks. Already simple spin models can exhibit self-regulated evolution towards a critical state and are used as toy models for self-tuning in biological neural networks [1]. Recent models as, for example, ref. [2] are defined closer to the biological details, resulting in more complex node dynamics and link evolution. Here, we study a correlation-dependent mechanism for self-organized connectivity evolution as introduced in ref. [1]. In particular we focus on a model that is biologically motivated, yet keeping the dynamics as simple as possible. We find that independently from initial connectivity, the network evolves to an average connectivity close to criticality in terms of damage spreading.

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

[2] A. Levina, J.M. Hermann, and T. Geisel: Dynamical Synapses Causing Self-Organized Criticality in Neural Networks, Nature Physics 3, 857-860 (2007)

SOE 13.9 Wed 12:30 H44

Spreading Synchrony in Neural Networks with Non-Additive Interactions. — •Sven Jahnke[1,2,3], Raoul-Martin Memmesheimer[4], and Marc Timme[1,2,3] — [1]Network Dynamics Group, Max-Planck-Institute for Dynamics & Self-Organization, Germany — [2]Bernstein Center for Computational Neuroscience, Germany — [3]Georg-August-University, Göttingen, Germany — [4]Center for Brain Science, Faculty of Arts and Sciences, Harvard University, USA

Recent neuro-physiological experiments [1] revealed that the response of cortical neurons to simultaneous pre-synaptic stimulation may be supra-additively enhanced. This enhancement is due to active nonlinear waves on the dendrite of a neuron (dendritic spikes) and offers a mechanism to synchronize neural spiking activity. Here we study the impact of nonlinear coupling on the dynamics of large neural circuits provide evidence that nonlinear dendritic enhancement is capable of inducing propagation of synchrony [2]. This yields the possibilty to generate patterns of precisely timed spiking activity, as observed in several neuro-physiological experiments. Our results indicate that and explains why densely connected feed-forward anatomy, as so far assumed in model studies [3], is not required for synchrony propagation but much more sparser connectivity is sufficient.

[1] Polsky, A., Mel, BW. and Schiller, J., Nature Neurosci. 7 (2004).

[2] Memmesheimer, RM. and Timme, M., Frontiers Comput. Neurosci., doi: 10.3389/conf.neuro.10.2008.01.009 (2008).

[3] Diesmann, M., Gewaltig, MO and Aertsen, A., Nature 402 (1999); Kumar, A., Rotter, S., and Aertsen, A., J.Neurosci. 28 (2007).

SOE 14: Social Systems, Opinion and Group Dynamics III

Time: Wednesday 14:00–16:00 Location: H44

SOE 14.1 Wed 14:00 H44

Why is women football less attractive ? — •Metin Tolan — TU Dortmund, Fakultät Physik & DELTA

It will be shown that the final table of the German (men's!) football Bundesliga and the distribution of the results may be explained by simple statistical distributions. From this observation, one may conclude that the differences in the performance of the teams are not very large although certain teams from the southern part of Germany perform significantly better than others over the years. With such an analysis large-scale manipulations in the German Bundesliga, the English Premier League, and the Italian Serie A may be ruled out.

The same analysis reveals a completely different picture for the German women football Bundesliga and the Word Cup women football teams. The respective goal distributions can not be explained with simple statistical models because the difference in the performance of the teams is too large. The reason for this finding is simple and will be discussed at the end of the talk.

SOE 14.2 Wed 14:15 H44

The Utility of Dismissing the Coach in Professional Soccer — •Andreas Heuer[1], Christian Müller[1], Oliver Rubner[1], Bernd Strauss[2] und Norbert Hagemann[2] — [1]WWU Münster, Inst. f. Phys. Chemie — [2]WWU Münster, Institut f. Sportwissenschaften

A frequent response to a series of lost matches in team sports is to change the coach mid-season. The empirical data (German Premier Soccer League; 1963-2008) show in qualitative agreement with a previous study [1] that immediately before the dismissal the results became worse. After the dismissal one observes a significant improvement of the results for that team even as compared to the average results in the whole season before the dismissal. In this contribution these data are interpreted on a quantitative basis. We make use of our previous results about the underlying statistical properties of a soccer league [2]. Of particular relevance is the well-defined concept of the team fitness. In qualitative agreement with [1] a careful application of these concepts allows us to show that the team fitness is not(!) improved as a consequence of the dismissal of a coach. The apparent improve-

ment of the results is just a consequence of the "regression towards the mean" and thus just a merely statistical effect since it would have also occurred without the dismissal of the coach. [1] Breuer, C. & Singer, R. (1996). Leistungssport, 26 (4), 41-46. [2] Heuer, A. & Rubner, O. (2009). European Physics Journal B, 67, 445-458.

SOE 14.3 Wed 14:30 H44

The Personnel Portfolio: An Application for Agent based Models — •Magda Schiegl — Fachhochschule Köln, Claudiusstr. 1, 50678 Köln

The personnel portfolio of a company can be described by 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, number of years working with the company and level of education. Depending on these quantities the employees will (with some probability) lose their motivation, leave the company, retire or stay (with more or less chanced internal parameters) with the company. The model is calibrated by the help of empirical statistics from human resource data. We investigate the dynamics of the personnel portfolio: The number of employees and the level of motivation. We compare the results of the model with empirical data and knowledge of human resources department. Interesting questions in this regard are: What role does the organisational structure of a company play? Is there an influence by the class of business?

Possible applications of the model are: detecting and removing inefficiencies in companies arising from the personnel portfolio and its development over time; objective inclusion of soft facts in company rating systems; investigation of prosperous employing strategies for the future development of the company.

SOE 14.4 Wed 14:45 H44

Climate Change and Societal Instability: Modeling Conflict and Cooperation of Agents in Complex Social Networks — •Jürgen Scheffran — Institut für Geographie, KlimaCampus, Universität Hamburg, Bundesstr.53, 20146 Hamburg

Global warming has significant potential implications for security and conflict. Various studies suggest that climate change aggravates environmental degradation and resource scarcity which may contribute to environmental conflicts and mass migrations. On the other hand, more cooperation may emerge to address the problems and risks. This contribution analyses the potential for climate-induced societal instabilities within a conceptual framework of conflict and cooperation of multiple agents in complex social networks. A macro-level analysis of regional impacts of climate change will be integrated with micro-level analysis of potential environmental conflicts and the possibility of cooperation and coalition formation to address the challenges, with a focus on regional cases in the Mediterranean region.

SOE 14.5 Wed 15:00 H44

Optimization of the distribution of students to universities in Germany — •Christian Hirtreiter[1] and Johannes J. Schneider[2] — [1]Faculty of Physics, University of Regensburg, 93040 Regensburg, Germany — [2]Center for Computational Research Methods in Natural Sciences, Johannes Gutenberg University of Mainz, Staudinger Weg 7, 55099 Mainz, Germany

For some subjects to study, the number of students being allowed to study this subject is restricted, due to finite capacities of universities. While formerly a central agency called ZVS was solely responsible for the distribution of students applying for a place to study at one of their desired universities, nowadays, a decentralized approach is used in which students apply directly at universities for a place to study. Both approaches fail partially: the ZVS often sent students to universities at which they did not want to study in the first place. The current method leads to a large administration overhead, students not being able to take up their studies in time, and on the other hand free places still available when the semester starts.

Based on multi agent system simulations, we present various approaches of how to distribute students, e.g., by allowing elite universities to perform a preselection. We will show that an optimized centralized approach leads to the best results, decreasing the factor of frustrated students by a factor of 2, if compared to the old ZVS approach.

SOE 14.6 Wed 15:15 H44

Information Theory as a Basis for Iustitia Distributiva — •Jörg Becker — ICAS e.V., Starnberg

It is still an open question how to distribute justly the fruits of economic activities in society. The French Revolution has left us with three competing terms: Liberté, Egalité, Fraternité. Today, speaking in philosophical terms, the discussion is about liberalism (capitalism?) and egalitarianism (communism?). However, there is a third way in philosophy: it is intuitionism. Asking a large number of individuals and taking the averages in concrete cases results in a clear distribution. We argue that there must be a principle behind such a distribution, and that information theory provides a natural basis for understanding it. We also consider some instructive examples.

SOE 14.7 Wed 15:30 H44

Emergence of collective memories — Sungmin Lee[1] and •Petter Holme[1,2] — [1]Department of Physics, Umea University, 90187 Umea, Sweden — [2]Department of Energy Science, Sungkyunkwan University, Suwon 440-746, Korea

Causality is intimately linked with understanding. Understanding an event is semantically almost equal to identifying its causes. A causal link is a mental pairing, ordered in time, between two events. Understanding an episode of history is to identify a chain, or web, of such causal relationships. Our mental picture of history, at all levels, takes the form of such directed causal networks. In this work we investigate how people collectively understands history and how communication affects this understanding. As a starting point, we analyzed anthropological data collecting the life stories of 14 villagers in northern China. We characterize the network topology, including a skewed distribution of both in- and out-degree (the number of events leading to another event, and the number of events caused by an event, respectively). We also find cycles (inconsistencies in the aggregate picture of history). We make an agent-based model investigating the stability of collective memories like this data set. This model shows a tendency for disjoint clusters to form, a cluster being defined as a set of agents having a similar mental pictures of history, which echoes observations from cultural groups in conflict with different ways of narrating the same historical episode.

SOE 14.8 Wed 15:45 H44

Stochastic model of group affiliation for an online community — •Przemyslaw A. Grabowicz[1], Dario Taraborelli[2], and Víctor Eguíluz M.[1] — [1]IFISC, Campus Universitat de les Illes Balears, E-07122, Palma de Mallorca, Spain — [2]Centre for Research in Social Simulation, University of Surrey, Guildford GU2 7XH, United Kingdom

Flickr is an image and video hosting website and online community platform [1]. It is one of the earliest Web 2.0 applications. Members of the Flickr create its contents which are photos, tags, comments and groups. Users interact between themselves forming network of contacts, creating groups of common interests and producing collaborative contents for those groups. It has already been shown that social network formed in such a systems plays important role in information diffusion processes [2]. In this contribution we focus on the interaction between social network topology and group affiliation patterns. It is being predicted that homophily play important role in such a systems [3]. Using the data collected for the Flickr we quantify the importance of homophily in a real system. We introduce a stochastic model of groups and social ties dynamics in Flickr accounting for the findings.

[1] www.flickr.com [2] M. Cha, A. Mislove, B. Adams, K.P. Gummadi, Characterizing Social Cascades in Flickr, (2008) [3] Geard, N. and Bullock, S. Homophily and competition: a model of group affiliation, (2009)

SOE 15: Financial Markets and Risk Management I

Time: Wednesday 16:00–18:00 Location: H44

SOE 15.1 Wed 16:00 H44

Default risk in insurance and reinsurance companies. Finding efficient regulation guidelines — •Christoph Hamer and Ralf Engelshove — Fabrik, Dürener Straße 295, 50935 Köln

Recent issues and discussion on financial markets and supervision show a need for smart regulation on market members. Our approach focuses mainly on the relations between insurances and reinsurances, especially on the correlation of defaults on the probability of further default risks and its implications on regulation. Driven by the bilateral dependencies and external ratings we deduce rules to optimise markets security in terms of cascading effects due to dependencies on network topologies.

SOE 15.2 Wed 16:30 H44

Some considerations on portfolios built by agents with insufficient information — Uli Spreitzer[1] and •Vladimir Reznik[2] — [1]Bonus Pensionskassen AG, Traungasse 14-16, 1030 Vienna, Austria — [2]Watson Wyatt Heissmann GmbH, Abraham-Lincoln-Str. 22, 65189 Wiesbaden, Germany

In the well known CAPM model [1] and the standard optimization the portfolio is optimized with some optimization process, e.g. rate of return minus volatility. How good this can be done, depends on how well informed agents on these assets are. Assuming a market of two agents, who assume wrong assumptions of the assets - nevertheless both agents together are in accordance with the market - we investigate the portfolios, being built from these wrong assumptions. Assuming, that the two agents represent a market, we investigate this wrong portfolio of the market compared to a portfolio, which is built (according to CAPM and) using correct assumptions on the assets. We will investigate these portfolios in dependence from, how wrong assumptions of this agents are. We will expand the results for two utility functions, one using a coherent and one a non coherent measure of risk. Some examples for pension funds of year 2008 and 2009 will ge given, also. [1] Sharpe, W.F.: Capital Asset Prices: A Theory of Market Equilibrium under conditions of risk. The Journal of finance. Vol. 19. p. 425ff, 1964

SOE 15.3 Wed 17:00 H44

Some considerations on dependency of measures of risk on frequency and granularity and consequences for pension funds — •Uli Spreitzer[1] and Vladimir Reznik[2] — [1]Bonus Pensionskassen AG, Traungasse 14-16, 1030 Vienna, Austria — [2]Watson Wyatt Heissmann GmbH, Abraham-Lincoln-Str. 22, 65189 Wiesbaden, Germany

Beside the well known discussion on what is the most reasonable measure of risk (e.g. not VaR, Artzner [1]) most pensions funds (or Pensionskasse in Austria) must face the problem that: their investment horizont isn't infinite, they must reinvest with a certain granularity, they have cash flow with a certain granularity, and they must publish results for performance and risk at certain points in time to compete against other competitioners and to inform customers and financial authorities, also. The frequency of all these processes is different and often scaling of measures of risk according to Brown movement is used. Considering coherent and non coherent measures of risk and optimization processes using these measures of risk, we show, how frequency dependence can be estimated much better. Using these results, we will show, how pension fund investment processes, which must consider events with at least two different granularities (investment and payment) can be optimized. [1] P. Artzner, F. Delbaen, J.M. Eber, and D. Heath. Coherent measures of risk. Mathematical Finance, 9: 203ff,1999.

SOE 15.4 Wed 17:30 H44

Macro- Econophysics: The first and second law of banking — •Jürgen Mimkes — Physics Department, Paderborn University

The first law of economics states that profits come from capital and labor. The second law confirms the existence of a production function. Both laws may be interpreted as bank rules:

1. a) The Stokes integral of the exact differential of capital is zero, capital cannot create capital. Capital can only be redistributed. b) Winning strategies of banks correspond to strategies of roulette, like doubling the stake after losing. Probability may force the player to pay his complete stock for doubling. The time for bankruptcy depends on the relation of stake and stock. In the financial world this time was 80 years, between 1929 and 2009. c) Profits can only come from long term investment in production e.g. at the stock market. d) Proper laws and tax policies will change the situation at banks and stock markets.

2. a) The production function of econophysics (entropy) is a measure of portfolio security. b) The product of returns and security is determined by the profit of the companies in the portfolio. Banks prefer the term risk, the inverse of security: high returns, high risk.

SOE 16: Plenary Talk Barabasi

Time: Thursday 8:30–9:15 Location: H1

Plenary Talk SOE 16.1 Thu 8:30 H1

Complex Networks: From Statistical Physics to the Cell — •Albert-Laszlo Barabasi — Northeastern University/Harvard Medical School

Highly interconnected networks with amazingly complex structure describe systems as diverse as the World Wide Web, our cells, social systems or the economy. In the past decade we learned that most of these networks are the result of self-organizing processes governed by simple but generic laws, resulting in architectural features that makes them much more similar to each other than one would have expected by chance. I will discuss the statistical mechanics of our interconnected world and its implications to network robustness and spreading processes. Much of these advances were inspired by maps of real networks, informing the modeling and analytical efforts. Yet, in the past few years the richness of data has improved considerably, allowing us to look deeper into the role of the nodes and links that shape the network topology and function. My goal is to move beyond the topology and to potentially review a few recent results, from the role of distance in shaping our social networks to controllability in biological and technological networks.

SOE 17: Networks: From Topology to Dynamics II (with BP, DY)

Time: Thursday 9:30–10:15 Location: H44

Invited Talk SOE 17.1 Thu 9:30 H44

Wave localization in complex networks — •Jan W. Kantelhardt[1], Lukas Jahnke[1], Richard Berkovits[2], and Shlomo Havlin[2] — [1]Institut für Physik, Fachgruppe Theoretische Physik, Martin-Luther-Universität Halle-Wittenberg, 06099 Halle (Saale), Germany — [2]Minerva Center and Department of Physics, Bar-Ilan University, Israel

Complex networks can show transitions from phases with propagating modes to localized phases without transport. In the simplest case such a transition is caused by breaking the network, a classical percolation transition. Wave-like excitations, on the other hand, can exhibit a quantum phase transition (Anderson-like transition) already when the network is still intact. We suggest that this type of localization-delocalization transition could become experimentally observable in

optical networks composed of fibers and beam splitters on an optical table. We study the phase transition numerically by level statistics of the eigenvalues for coherent waves in scale-free networks. We show that a strong clustering of the links, i. e., a high probability of closed triangles in the network structure, can induce the transition to localized states. Clustering thus represents a new degree of freedom that can be used to induce and study phase transitions in complex networks.

SOE 18: Networks: From Topology to Dynamics III (with BP, DY)

Time: Thursday 10:15–13:00 Location: H44

SOE 18.1 Thu 10:15 H44

Detection of Mesoscopic Role-Structure in Complex Networks — •Joerg Reichardt[1], Roberto Alamino[2], and David Saad[2] — [1]UC Davis, CA — [2]Aston University, Birmingham

Not all nodes are created equal in complex networks. Rather, they play diverse roles in the functioning of a network and their role is reflected in the network's link structure. Hence, structural analysis can be used to infer the latent roles and functions of nodes purely based on connectivity data. Currently, network structure is studied at three different levels. At the macro level, global network properties such as degree distributions, path-lengths, diameters or clustering coefficients are investigated. At the micro level, properties of individual nodes and edges such as centrality indices or rank functions such as page-rank are studied. The study of the meso-scale, which aims at studying joint properties of groups of nodes, so far has mainly been focussed on the detection of cohesive subgroups of nodes, so-called communities.

The talk will show that, though important, communities are only one special case of a much wider class of mesoscopic structures called "stochastic block structures". This name comes from the fact that latent classes of roles and their resultant patterns of connectivity in a network account for salient block structure in the adjacency matrix of a network when the rows and columns are ordered according to these latent roles.

We present an effective and accurate algorithm that performs this task employing a purely Bayesian approach, show that it outperforms competing approaches and present applications to real world data sets that open new frontiers of research in the study of both structure, function and evolution of complex networks from a mesoscopic perspective.

SOE 18.2 Thu 10:30 H44

Structuring k-partite networks by decomposition into overlapping communities — •Florian Blöchl[1,3], Mara L. Hartsperger[1,3], Volker Stümpflen[1], and Fabian J. Theis[1,2] — [1]Institute for Bioinformatics and Systems Biology, Helmholtz Zentrum München — [2]Department of Mathematics, TU München — [3]Equal contributors

With increasing availability of large-scale networks we face the challenge to interpret these data in a comprehensive fashion. A common solution is a decomposition into modular building blocks, so–called communities. Prominent examples are functional modules in protein interactions. However, the integration of heterogeneous resources results in networks with nodes of multiple colors. Although existing algorithms address this issue, they identify separated, disjoint clusters by assigning each node to exactly one cluster. This is far from reality, where e.g. proteins are commonly part of many complexes or pathways.

We present a novel algorithm for detecting overlapping communities in k-partite graphs. It determines for each node a fuzzy degree-of-membership to each community. Moreover, we additionally estimate a weighted backbone graph connecting the extracted communities. The method is fast and efficient, mimicking the multiplicative update rules employed in algorithms for non-negative matrix factorization.

Results on a disease-gene-protein complex graph show significantly higher homogeneity within the complex and disease clusters than expected by chance. However, the algorithm is readily applicable to other domains with similar problems.

SOE 18.3 Thu 10:45 H44

Large-deviation properties of random graphs — •Alexander K. Hartmann — Institut of Physics, University of Oldenburg

The large-deviation properties of different types of random graphs are studied using numerical simulations. In particular the number of components and the graph diameter are considered. The distributions of these quantities are obtained down to very small probabilities like 10^{-700} using finite-temperature Monte Carlo and Wang Landau simulations. Different graphs ensembles as Erdös-Renyi, small-world and scale-free graphs are studied as a function of suitable control parameters. The parameter-dependend changes of the distributions are recorded, indicating the presence of non-standard transitions.

In particular, the distributions of the diameter are often given by Gumbel distributions, except right at a percolation transition, or are very close to Gumbel distributions.

SOE 18.4 Thu 11:00 H44

Coupled Order Parameter Systems on Scale-free Networks — •Christian von Ferber[1,2], Reinhard Folk[3], Vasyl Palchykov[4], and Yurij Holovatch[3,4] — [1]Applied Mathematics Research Centre, Coventry University, UK — [2]Physikalisches Institut, Universität Freiburg — [3]Institut für Theoretische Physik, Universität Linz, AT — [4]Institute for Condensed Matter Physics, Lviv, UA

We analyse a system of two scalar order parameters on a complex scale-free network in the spirit of Landau theory. To add a microscopic background to the phenomenological approach we also study a particular spin Hamiltonian that leads to coupled scalar order behavior using the mean field approximation. This set up may describe a model of opinion formation where e.g. opinions on a party a candidate are coupled. Our results show that the system is characterised by either of two types of ordering: either one of the two order parameters is zero or both are non-zero but have the same value. While the critical exponents do not differ from those of a model with a single order parameter on a scale free network there are notable differences for the amplitude ratios and susceptibilities. Another peculiarity of the model is that the transverse susceptibility is divergent at all $T < T_c$ when $O(n)$ symmetry is present. This behavior is related to the appearance of Goldstone modes.

SOE 18.5 Thu 11:15 H44

Discontinuous Phase Transitions in Random Network Percolation — •Jan Nagler[1,2], Anna Levina[1,3], and Marc Timme[1,2,3] — [1]Max Planck Institute for Dynamics and Self-Organization, Göttingen — [2]Institute for Nonlinear Dynamics, Faculty of Physics, University of Göttingen — [3]Bernstein Center for Computational Neuroscience (BCCN) Göttingen

The transition to extensive connectedness upon gradual addition of links, known as the percolation phase transition, provides a key prerequisite for understanding networked systems [1]. Until recently, random percolation processes were thought to exhibit continuous transitions in general, but now there is numerical evidence for discontinuities changes of the order parameter in certain percolation processes [2]. Here we present the concepts of weakly and strongly discontinuous percolation transitions and explain the microscopic mechanisms underlying them. We study both numerically and analytically under which conditions the order parameter may change discontinuously and classify the type of transition in dependence on the dynamics of cluster joining [3].

[1] G. Grimmett, Percolation (Springer Verlag, Heidelberg,1999).
[2] D. Achlioptas, R. M. D'Souza, J. Spencer, Explosive Percolation in Random Networks, Science 323: 1453 (2009); R. M. Ziff, PRL 103, 045701 (2009); F. Radicchi and S. Fortunato, PRL 103, 168701 (2009); Y. Cho et al., PRL 103, 135702 (2009).
[3] J. Nagler, A. Levina, and M. Timme, unpublished (2009).

15 min. break

SOE 18.6 Thu 11:45 H44

Evidence for power-law anti-correlations in complex networks — •Diego Rybski[1], Hernán D. Rozenfeld[2], and Jürgen P. Kropp[1] — [1]Potsdam Institute for Climate Impact Research, 14412 Potsdam, Germany — [2]Levich Institute, City College of New York, New York, NY 10031, USA

We propose a degree analysis to quantify spatial correlations in com-

plex networks. The approach considers the degrees along shortest paths in the networks and quantifies the correlations. In this work, the Barabasi-Albert (BA) model, a fractal network model, and examples of real-world networks are studied. While for the BA model the correlations show exponential decay, in the case of the fractal networks the correlations show a power-law behavior indicating long-range correlations. The results suggest that the analysis provides complementary information to the fractal dimension as measured with box covering.

SOE 18.7 Thu 12:00 H44

What scales in multiscale human mobility networks? — •Rafael Brune[1,2], Christian Thiemann[1,2], and Dirk Brockmann[1] — [1]Northwestern University, Evanston, USA — [2]Max-Planck-Institut für Dynamik und Selbstorganisation, Göttingen, Deutschland

Although significant research effort is currently devoted to the understanding of complex human mobility and transportation networks, their statistical features are still poorly understood. Specifically, to what extent geographical scales impose structure on these networks is largely unknown. Statistical properties of these networks have been obtained either for large scale networks or on small scale systems, indicating significant differences between the two. We will present a systematic investigation of various single scale mobility networks extracted from a comprehensive multiscale proxy network, covering sequential length scales of a few to a few thousand kilometers. We will report that certain properties such as mobility flux distribution are universal and independent of length scale, whereas others vary systematically with scale. Furthermore we investigate the relation of a series of network characteristics as a function of scale and analyze how the different length scales interact in the embedding multiscale network.

SOE 18.8 Thu 12:15 H44

The tomography of human mobility – what do shortest-path trees reveal? — •Christian Thiemann[1,2], Daniel Grady[1], and Dirk Brockmann[1] — [1]Eng. Sci. & Appl. Math, Northwestern University, Evanston, IL, USA — [2]Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany

Similar to illustrating the anatomy of organs using pictures of tissue slices taken at various depths, we construct shortest-path trees of different nodes to create tomograms of large-scale human mobility networks. This tomography allows us to measure global properties of the system conditioned on a reference location in the network to gain a fuller characterization of a node. It also suggests a canonical coordinate system for representing complex networks and dynamical processes thereon in a simplified way, revealing a new symmetry in the human mobility networks we investigated. Furthermore, introducing the notion of tree similarity, we devised a new technique for clustering nodes with similar topological footprint, yielding a unique and efficient method for community identification and topological backbone extraction. We applied these methods to a multi-scale human mobility network obtained from the dollar-bill-tracking site wheresgoerge.com and to the U.S. and world-wide air transportation network.

SOE 18.9 Thu 12:30 H44

Fusion in complex networks — •Carlus Deneke, Angelo Valleriani, and Reinhard Lipowsky — Max-Planck-Institut für Kolloid- und Grenzflächenforschung, Department of Theory and Bio-Systems, Potsdam, Germany

In real world networks, part of the information about the nodes and edges is often missing or unaccessible and single nodes might in reality consist of several nodes or subgraphs. Since these hidden structures may have a strong impact on the dynamical processes, it is important to investigate how the network properties change at different levels of resolution.

In this contribution, we investigate scale-free networks, in which randomly chosen couples of neighboring nodes are iteratively integrated or fused into single nodes. We introduce different fusion mechanisms and compare their effects on simple network properties such as the degree distribution and the degree correlations. By means of numerical simulations and analytical calculations, we show that the network properties change steadily under the iterated fusion steps.

We finally discuss possible connections to real world networks.

SOE 18.10 Thu 12:45 H44

Properties of transport networks need to be invariant under coarse graining — •Fabian J. Theis[1,2], Florian Blöchl[1], and Dirk Brockmann[3] — [1]Helmholtz Zentrum München, Germany — [2]Department of Mathematics, TU Munich, Germany — [3]Engineering Sciences and Applied Mathematics, Northwestern University, USA

Transport networks can rarely be observed directly, especially not across many scales. Instead, the flow between two locations can now only be estimated from proxy data. This results in the need for spatial averaging, so we commonly only observe a histogram of the actual distributions. We denote this process as coarse graining.

In this contribution we analyze which network properties are invariant under coarse graining, following the rationale that we can only infer such properties of the true underlying transport network from the proxy data. We show that shortest-path distances, which cannot take self-loops into account, are a poor distance measure in such networks. Instead we illustrate that a distance based on random walks, namely mean fast hitting time (MFHT), is much more adequate for such type of networks. Moreover, we show that community measures are coarse-graining invariant.

Taken together, we can develop a coarse graining method that leaves MFHT fully invariant: we first cluster the nodes into communities via hierarchical clustering of the mean commute time matrix. We then reconstruct a weighted graph connecting our communities, solving a distance realization problem, which we recently addressed in (Wittmann et al., TCS 2009). We illustrate the method on toy and real networks.

SOE 19: Networks: From Topology to Dynamics IV (with BP, DY)

Time: Thursday 14:00–16:00 Location: H44

SOE 19.1 Thu 14:00 H44

A sequence-based framework for simulating the evolution of gene regulatory networks — •Thimo Rohlf — Programme d'Epigenomique, Genopole Campus 1 - Genavenir 6, 5 rue Henri Desbruères, F-91030 Évry cedex, France — Max-Planck-Institute for Mathematics in the Sciences, Inselstr. 22, D-04103 Leipzig, Germany

An increasing amount of experimental data on global properties of genome organization across various species and phyla is becoming available, suggesting general principles as, e.g., scaling relationships or spatial regularities of gene distribution on DNA. A second level of information is accessible with gene regulatory networks, that control the space-time pattern of gene expression; here, similar (statistical) patterns of conserved regularities are observed. What can Statistical Physics contribute to tackle the question, which of these properties arose from combinatorial and architectural constraints, and which may have been shaped primarily by evolution? I will introduce and discuss a sequence-based artificial genome model that allows an integrative approach to model the emergence of genomic information at the levels of DNA sequence, regulatory networks and phenotype evolution. In particular, the following questions will be addressed: (1) Which types of network properties could be explained from combinatorial/statistical properties of genomes (random genome model), (2) how do they change in evolving genomes, in particular when (3) selective pressure is present, e.g. stabilizing selection for certain patterns of gene activity (phenotypes).

SOE 19.2 Thu 14:15 H44

Evolution based on centrality: Bistability between hierarchical and destructured networks — •Claudio J. Tessone[1], Matteo Marsili[2], and Michael König[1] — [1]Chair of Systems Design, D-MTEC ETH Zürich — [2]International Centre for Theoretical Physics Abdus Salam

We study a model of network evolution in which agents attempt to become the most central ones in a network. Considering purely strategic interactions, when agents try to maximise their centrality in the network, the best strategy for them is to create links with the most central agent among those they are not still connected to. Conversely, for link removal, the most efficient strategy is to remove a link to the least central node, among the neighbours. This condition leads to a

self-reinforcing mechanism signalled by the emergence of highly centralised networks. These networks have the property of nestedness: for any two agents i and j, if the degree of agent i is lower than that of j, the neighbourhood of i is contained within the neighbourhood of j. Moreover, this mechanism simplifies the computational effort needed by the agents to identify their best strategy.

Interestingly, such structures only can appear if all the agents have been developing it. If disturbances, –such as decay of edges, introduced by finite of link life-time– are in place, we show that ergodicity in the system disappears. Under these conditions two equilibrium states can coexist for a given set of parameters: one where such hierarchical structure emerges; another where a completely random network prevails.

SOE 19.3 Thu 14:30 H44

Network evolution driven by spectral profile — •Sebastian Weber[1] and Markus Porto[2] — [1]Freiburg Institute For Advanced Studies (FRIAS), University of Freiburg, Germany — [2]Institut für Festkörperphysik, Technische Universität Darmstadt, Germany

A large class of real world networks evolve over time, constantly changing and adapting their topology with respect to criteria imposed on the dynamics they mediate. The properties of the dynamics is ultimately determined by its spectral profile, which is the eigenvalue spectrum of the associated operator. This operator inevitably involves the network's adjacency matrix, establishing the connection between topology and dynamics. Using the graph Laplacian or Kirchhoff matrix and its spectral profile as an example, the former being central in a wide class of physical processes (random walks, harmonic interaction networks, etc.) on networks, we show that a network evolution scheme recently developed by us is able to successfully evolve networks to display a given spectral profile's essential features [1].
[1] S. Weber and M. Porto, submitted.

15 min. break

SOE 19.4 Thu 15:00 H44

Adaptive network approach to the collective motion of self-propelled agents — •Anne-Ly Do[1], Cristian Huepe[2], Gerd Zschaler[1], and Thilo Gross[1] — [1]MPI for the Physics of Complex Systems, Dresden — [2]unaffiliated National Science Foundation grantee

Swarming is a showcase example of emergent behavior in complex many-particle systems. Previous modeling approaches rely on continuum theories or on individual based simulations and are difficult to study analytically as emergent-level equations are either complicated or not available at all. Here we propose an analytically tractable approach that bases on an adaptive network formulation. The nodes of this network represent individual animals while the links represent mutual awareness and therefore potential interaction between the linked individuals. Over time links are constantly created and broken as the movement of agents reshapes the network of contacts. Simultaneously the direction of movement can change as a result of the interactions with neighbors in the contact network. By means of moment closure approximation we derive an emergent-level description of the system and study it with the tools of nonlinear dynamics. We show that the system exhibits a phase transition from an unpolarized state, where no order motion occurs, to a state of collective motion, thus reproducing the results of recent swarming experiments.

SOE 19.5 Thu 15:15 H44

The backbone of the climate network — •Jonathan Friedemann Donges[1,2], Yong Zou[1], Norbert Marwan[1], and Jürgen Kurths[1,2] — [1]Potsdam Institute for Climate Impact Research, P.O. Box 601203, 14412 Potsdam, Germany — [2]Department of Physics, Humboldt University Berlin, Newtonstr. 15, 12489 Berlin, Germany

We propose a method to reconstruct and analyze a complex network from data generated by a spatio-temporal dynamical system, relying on the nonlinear mutual information of time series analysis and betweenness centrality of complex network theory. We show, that this approach reveals a rich internal structure in complex climate networks constructed from reanalysis and model surface air temperature data. Our novel method uncovers peculiar wave-like structures of high energy flow, that we relate to global surface ocean currents. This points to a major role of the oceanic surface circulation in coupling and stabilizing the global temperature field in the long term mean (140 years for the model run and 60 years for reanalysis data). We find that these results cannot be obtained using classical linear methods of multivariate data analysis, and have ensured their robustness by intensive significance testing.

SOE 19.6 Thu 15:30 H44

Personalized recommendation in Collaborative Tagging Systems — •Zi-Ke ZHANG — chemin du musee, CH1700, Fribourg, Switzerland

Personalized recommender systems are confronting great challenges of accuracy, diversification and novelty, especially when the data set is sparse and lacks accessorial information, such as user profiles, item attributes and explicit ratings. Collaborative tags contain rich information about personalized preferences and item contents. We are trying to find an efficient yet simple way to make use of tags to provide better recommendations.

SOE 19.7 Thu 15:45 H44

What network analysis can tell us about car-scrap bonus: the linchpins of modern economy — •Florian Blöchl[1], Fabian J. Theis[1,2], and Eric O'N. Fisher[3] — [1]Institute for Bioinformatics and Systems Biology, Helmholtz Centre Munich — [2]Department of Mathematics, TU Munich — [3]California Polytechnic State University

An input-output matrix collects good flows between different economic sectors, structural units of the economy like "Agriculture" or "Pharmaceuticals". This matrix can be viewed as a directed weighted network. We analyze input-output graphs for a wide set of countries collected by the OECD. These networks contain only 40 nodes, but are almost fully connected and have quite strong self-loops.

We apply two measures of node centrality, both relying on different properties of random walks on the graphs: random walk centrality and a new measure we called count-betweenness. The latter is similar to Newman's random walk betweenness, but allows for directed graphs and incorporates self-loops. Both measures give similar and reasonable results. For instance, we find that in Luxembourg the most central sector is "Finance and Insurance", in Brazil "Food Products", and in Germany "Motor Vehicles". Thus, car-scrap bonus really aimed at the linchpin of Germany's economy.

The sectors' rankings are quite different, however some sectors are important in most countries while others are never. We therefore additionally structure the data by hierarchically clustering countries. Thereby we achieve clusters that well coincide with geographical proximity or developmental status.

SOE 20: Networks: From Topology to Dynamics V (with BP, DY)

Time: Thursday 16:00–17:15 Location: H44

SOE 20.1 Thu 16:00 H44

Eat the specialist: Some results on the stability of 100 billion food webs — •Thilo Gross — Max-Planck Institut für Physik komplexer Systeme, Nöthnitzer Straße 38, 01187 Dresden

Ecological food webs are complex networks of feeding interactions, describing who-eats-who in an ecosystem. Previous theoretical results suggest that the dynamical stability of these webs should decrease with increasing number of species and network connections. Yet, large and densely-linked webs found in nature are highly stable. Identification of the properties promoting stability is therefore an important goal of ecological research. The approach of generalized modeling enables us to investigate the local stability of steady states in these webs with a higher degree of generality and efficiency than previous simulative approaches. Because of the complexity of the problem, a general food web model contains several thousand unknown parameters. However, the numerical efficiency of the generalized models is such that tens of billions of different realizations of plausible webs can be analyzed in reasonable computational time. This provides a sound basis for the statistical exploration of the high-dimensional parameter space. In this talk I will demonstrate the application of generalized modeling, in simple examples and in large food webs. The latter reveals certain

topological properties having a strong impact on network stability.

SOE 20.2 Thu 16:15 H44

Regular graph properties of the plasmodial vein network of the slime mould *Physarum polycephalum* — Werner Baumgarten and •Marcus Hauser — Otto-von-Guericke-Universität Magdeburg, Abteilung Biophysik, Institut für Experimentelle Physik, Universitätsplatz 2, 39106 Magdeburg, Germany

The plasmodium of the slime mould *Physarum polycephalum* is a single multi-nucleate giant amoeboid cell. It forms a characteristic two-dimensional vein network, where the apical end of the plasmodium extends to search for new food sources, while the dense network of tubular veins is in charge of transport of protoplasm throughout the giant cell.

A graph theoretical analysis of the vein network of the *Physarum polycephalum* strain HU195×HU200 reveals that the nodes have exclusively the degree 3, i.e., each node connects to exactly three veins. This means that the vein network of this slime mould forms a regular cubic graph, and hence does not show small-world properties. The intensities of the edges (the vein segments) connecting a pair of nodes differ, thus forming a weighted graph. The distributions of the lengths and areas of the veins follow exponential distributions, while their widths are distributed either log-normally or normally. Interestingly, these functional dependencies are robust during the entire evolution of the growing plasmodial vein network of *Physarum polycephalum*.

SOE 20.3 Thu 16:30 H44

Feedback-mediated control of a spiral wave in a bidomain model of cardiac tissue — •Ekaterina Zhuchkova, Vladimir Zykov, and Harald Engel — Institut für Theoretische Physik, Technische Universität zu Berlin, Berlin, Germany

At the moment anti-tachycardia pacing (ATP) is the only low-energy therapy for ventricular tachyarrhythmias and it would be desirable since it prevents adverse side effects. However, ATP is not robust since its success/failure depends on many factors [1]. Using realistic bidomain model for simulation of electrical activity in cardiac tissue together with a simplified Fenton-Karma ionic model for a cell, we show that spiral waves in the heart could be eliminated by repetitive extracellular stimulation. A spiral wave core can be guided towards boundaries by feedback forcing along a one-dimensional registering electrode [2]. Every time the spiral wave front is tangent to the registering electrode, an extracellular current is applied through stimulating electrodes. The amplitude of the stimulation is much less than the single-shock defibrillation threshold, which gives a possibility to use the proposed method as an alternative low-voltage defibrillation strategy.

[1] E. Zhuchkova and H. Engel, Robustness of local forcing in inhibition of reentry, IPACS Open Access Library (2009), accepted.

[2] J. Schlesner, V. S. Zykov, H. Brandtstädter, I. Gerdes and H. Engel, Efficient control of spiral wave location in an excitable medium with localized heterogeneities, NJP 10, 015003 (2008).

SOE 20.4 Thu 16:45 H44

Linking Molecular Simulations and Systemic Modelling — •Tihamer Geyer and Volkhard Helms — Zentrum für Bioinformatik, Universität des Saarlandes, D-66123 Saarbrücken

When modeling biological systems there is a gap of scales between the systemic models that try to describe the metabolism of a complete cell and the molecular biological descriptions focussing on the detailed processes of a single enzyme. We therefore proposed an agent based approch that allows to bridge between the two regimes.

For this, we set up the individual enzymes from their microscopic elementary reactions like the binding of a metabolite molecule to a binding site or the transfer of an electron from one site inside the protein to another. The respective numbers of these protein "building blocks" are then connected to metabolite pools via standardized connectors to set up the metabolic system under consideration. This pools-and-proteins model can thus be used to "convert" detailed molecular biological knowledge into a systems biological model for analyzis of the complete system.

To develop and test our approach we used the bacterial photosynthetic apparatus. But even for the "boringly" well-known system, many of the detailed kinetic constants were unknown. By comparing the behavior of the complete system to time-dependent experiments, we could determine the values and sensitivities of all parameters of our model. The thus parametrized protein modules allowed for new insights into their inner working and can be re-used to set up other, related systems.

SOE 20.5 Thu 17:00 H44

About scaling in the growth of clubs and communities — Lu Xin[1], Diego Rybski[2], and •Fredrik Liljeros[1] — [1]Department of Sociology, Stockholm University, S-106 91 Stockholm, Sweden — [2]Potsdam Institute for Climate Impact Research, P.O. Box 60 12 03, 14412 Potsdam, Germany

Many systems comprise emergent power-laws in the growth rates with respect to the size of the units such as companies or cities. Here we study online communities and investigate the growth properties of clubs and social communities. We find power-law relations for the average growth rate and for the standard deviation. The quality of the data permits to analyze the growth – complementary to (temporal) correlations – on the basis of individuals behaving in a social context.

SOE 21: Financial Markets and Risk Management II

Time: Thursday 10:15–13:30 Location: H46

SOE 21.1 Thu 10:15 H46

Power Law Distribution in High Frequency Financial Data? - An Econometric Analysis — •Lora Todorova[1] and Bodo Vogt[2] — [1]Otto-von-Guericke-University Magdeburg, Faculty of Economics and Management, P.O. Box 4120, D-39016 Magdeburg, Germany — [2]Otto-von-Guericke-University Magdeburg, Faculty of Economics and Management, P.O. Box 4120, D-39016 Magdeburg, Germany

Power law distributions are very common in natural sciences. We analyze high frequency financial data from XETRA and the NYSE using maximum likelihood estimation and the Kolmogorov-Smirnov goodness-of-fit test to test whether the power law hypothesis holds also for that data. We find that the universality and scale invariance property of power law are violated. Furthermore, the returns of Daimler Chrysler and SAP traded simultaneously on both exchanges follow power law at one exchange but not at the other. These results put some questions on the no-arbitrage condition. Finally, we find that the exponential function provides a better fit for the tails of the sample distraibutions than the power law function.

SOE 21.2 Thu 10:45 H46

Optimal estimation of power laws with applications to socioeconomic data — •Faustino Prieto and Jose Maria Sarabia — University of Cantabria, Santander, Spain

Power laws appear widely in many branches of economics, finance, physics, computer science, demography and social sciences. The upper tail of many sets of data, including the size of cities, personal income, earthquakes, forest fires and many other examples all appear to follow power laws. A crucial point in the estimation of these laws is the correct choice of the truncation point. The aim of this paper is to investigate how to choice this truncation point from an optimal point of view. A new methodology based on the Akaike information criterion is proposed. An extensive simulation study is carried out in order to prove the existence of this optimal point, under different assumptions about the underlying population. Several kinds of populations are considered, including lognormal and populations with heavy tails. Finally, the methodology is used to optimal estimation of power laws in socioeconomic data sets, including city and business size data.

SOE 21.3 Thu 11:15 H46

Compensating statistical errors in the calculation of financial correlations — •Michael Christopher Münnix, Rudi Schäfer, and Thomas Guhr — Universität Duisburg-Essen

We present two methods to compensate statistical errors in the calculation of correlations on financial time series. The first method is based on asynchronous time series under the assumption of an under-

lying time series. The second method is based on the information loss due to the finite tick-size. We set up a model and apply it to financial data to examine the decrease of calculated correlations towards smaller return intervals (Epps effect). We show that these statistical effects are a major cause of the Epps effect. Hence, we are able to quantify and to compensate it using only trading prices, trading times and tick-sizes.

15 min. break

SOE 21.4 Thu 12:00 H46

Measurement of correlations in non-stationary financial time series — •Rudi Schäfer and Thomas Guhr — Fakultät für Physik, Universität Duisburg-Essen, Germany

The measurement of correlations between financial time series is of vital importance for risk management. We address an estimation error that stems from the non-stationarity of the time series. A method is introduced which removes local trends and variable volatility from the time series, while preserving correlations between different time series. We test this method in a Monte-Carlo simulation, and apply it to daily returns of the S&P 500 stocks.

SOE 21.5 Thu 12:30 H46

Estimation of the volatility of finance data by multiscale reconstruction — •Arnold Gräbeldinger and Joachim Peinke — Workgroup turbulence, wind energy and stochastic (TWiSt), University of Oldenburg, Department of physics, 26111 Oldenburg, Germany

With the recently developed method for multiscale reconstruction according to [1] it is possible to reproduce correct statistic properties of processes on different scales and to create a decent prediction of the current standard deviation. Based on the multiscale reconstruction, predictions for quasi-equidistant finance data are performed. Comparing to standard methods it shall be tried to obtain an improved measure for the volatility and in particular volatility clusters of finance data. In depth the requirements for this ansatz are reviewed, with a focus on the Markov properties of the underlying data.

[1] A. P. Nawroth. Stochastische Analyse und Modellierung von Finanz- und Turbulenzzeitreihen und ihren Ähnlichkeiten. Dissertation, Oldenburg, 2007.

SOE 21.6 Thu 13:00 H46

Do financial indices benchmark reality? — •Patrick Hedfeld — Markit, International Index Company, Goetheplatz 5, 60385 Frankfurt am Main

Mapping financial markets with indices is an essential need for investors in order to select sources of profit and loss. We seek a better understanding of certain systematic behaviour pattern and desireable properties in indices architecture. Our approach compares different designs and structures of indices in order to find relations between success and peril. This includes tracing, diversification, riskmanagement and modern financial theories.

SOE 22: Social Systems, Opinion and Group Dynamics III

Time: Friday 9:30–10:15 Location: H44

Invited Talk SOE 22.1 Fri 9:30 H44

Hypergraphs and social systems — •Guido Caldarelli — Università "Sapienza", Rome, Italy

Recent years have witnessed the emergence of a new class of social networks, which require us to move beyond previously employed representations of complex graph structures. A notable example is that of the folksonomy, an online process where users collaboratively employ tags to resources to impart structure to an otherwise undifferentiated database. Here we propose a mathematical model that represents these structures as tripartite hypergraphs and define basic topological quantities of interest. Furthermore we can extend our model by defining additional quantities such as edge distributions, vertex similarity and correlations as well as clustering. We then empirically measure these quantities on two real life folksonomies, the popular online photo sharing site Flickr and the bookmarking site CiteULike. We find that these systems share similar qualitative features with the majority of complex networks that have been previously studied. We propose that the quantities and methodology described here can be used as a standard tool in measuring the structure of tagged networks.

SOE 23: Financial Markets and Risk Management III

Time: Friday 10:15–13:00 Location: H44

SOE 23.1 Fri 10:15 H44

Global risks from local behavior in markets — •Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen, Otto-Hahn-Allee, 28359 Bremen

Agent-based models [1] are particularly suited for studying the relationship between local agent behavior in markets and global dynamical consequences from their collective effects. Magnetic spin models [2] are perhaps the simplest such models which can relate to phenomena in real markets, as for example herding dynamics and the origin of stylized facts. I here review the state of the art of spin models in econophysics and discuss their application to modeling risk and crises in financial markets.

[1] E. Samanidou, E. Zschischang, D. Stauffer, and T. Lux, Agent-based models of financial markets, Rep. Prog. Phys. 70, 409 - 450 (2007)

[2] S. Bornholdt, Expectation bubbles in a spin model of markets: Intermittency from frustration across scales, Int. J. Mod. Phys. C, Vol. 12, No. 5 (2001) 667-674.

SOE 23.2 Fri 10:45 H44

Financial crises and the evaporation of trust — •Kartik Anand[1], Prasanna Gai[2], and Matteo Marsili[1] — [1]The Abdus Salam International Centre for Theoretical Physics, Trieste, Italy — [2]The Australian National University, Crawford School of Economics and Government, Canberra, Australia

Trust lies at the crux of most economic transactions, with credit markets being a notable example. Drawing on insights from the literature on coordination games and network growth, we develop a simple model to clarify how trust breaks down in financial systems. We show how the arrival of bad news about a financial agent can lead others to lose confidence in it and how this, in turn, can spread across the entire system. Our results emphasize the role of hysteresis – it takes considerable effort to regain trust once it has been broken. Although simple, the model provides a plausible account of the credit freeze that followed the global financial crisis of 2007/8, both in terms of the sequence of events and the measures taken (and being proposed) by the authorities.

SOE 23.3 Fri 11:15 H44

How to Characterize Trend Switching Processes in Financial Markets — •Tobias Preis[1,2,3], Johannes J. Schneider[2], and H. Eugene Stanley[1] — [1]Center for Polymer Studies, Department of Physics, 590 Commonwealth Avenue, Boston, Massachusetts 02215, USA — [2]Department of Physics, Mathematics, and Computer Science, Johannes Gutenberg University of Mainz, Staudinger Weg 7, 55128 Mainz, Germany — [3]Artemis Capital Asset Management GmbH, Gartenstr. 14, 65558 Holzheim, Germany

Financial market fluctuations are characterized by many abrupt switchings on various time scales from increasing trends to decreasing trends—and vice versa. We ask whether these ubiquitous switching processes have quantifiable features analogous to those present in phase transitions, and find striking scale-free behavior of the time intervals between transactions both before and after the switching occurs. We

interpret our findings as being consistent with time-dependent collective behavior of financial market participants. We test the possible universality of our result by performing a parallel analysis of transaction volume fluctuations.

15 min. break

SOE 23.4 Fri 12:00 H44

Tracking volatility with higher-order-correlation nonlinear filters — •Oliver Grothe — Department of Economic and Social Statistics, University of Cologne, Germany

A challenging task in financial risk management is the real-time estimation and tracking of hidden parameters of stochastic processes such as price processes. The classical way to estimate latent states is to apply the linear Kalman filter. When interested in sequential estimates of parameters, however, the filtering problem turns out to be nonlinear and thus nonlinear filters have to be applied. Developed for problems in physics and engineering, the basic idea of these filters is to linearize the nonlinear problems, leading to approximations of densities and equations. The computationally most attractive filters for real-time applications are the Gaussian filters.

However, Gaussian filters are not able to sequentially estimate parameters that are not linearly correlated with the measurement. In financial applications, such parameters are stock price volatility or variance, which are of central interest for risk management.

In order to nevertheless estimate such parameters, we extend the standard Gaussian filters with a higher-order-correlation update and the propagation of asymmetric dependence structures. We call this filter type higher-order-correlation filter. We show the validity of our approach in applying it to ultra-high frequency stock price data and to estimate parameters of an Ornstein-Uhlenbeck model.

SOE 23.5 Fri 12:30 H44

Simulation of market behaviour by means of a non-equilibrium molecular dynamics set-up. — •Simon Standaert and Jan Ryckebusch — Department of Physics and Astronomy, Ghent University, Proeftuinstraat 86, B-9000 Gent

To understand the non-Gaussianity of markets on an elementary level, we propose to use a Molecular Dynamics (MD) set-up, as this is a very elementary and well understood technique that can analyse the behaviour of interacting agents on a large scale.

In a normal MD simulation, the displacement of the agents is strictly random and Gaussian. To simulate a non-Gaussian random walk in a liquid-like environment, we propose to use out-of-equilibrium dynamics. This dynamics is achieved by a parameter that changes the size of the particles and thus the density of the system. Immediately after such a change, the system enters a period of non-equilibrium behaviour through the addition of kinetic energy.

We investigate this system because it can produce a deeper understanding of the mechanisms in a market that lead to the non-Gaussianity that is observed in real markets. We can reproduce the statistics of the volatility of the markets in our system and we are able to link our time of the simulation to real market-time via the correlation functions.

In our MD set-up we can attribute different characteristics to every single particle to maximize the heterogeneity of the system or we can simulate the behaviour of an index.