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

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Overview of Invited Talks and Sessions
(lecture rooms HSZ01, HSZ02, GÖR 226, and Poster 2)

Tutorial

SOE 1.1	Sun	16:00–18:00	HSZ 04	**Collective Dynamics of Firms: A Statistical Physics Approach** — •Frank Schweitzer

Focus Session: Swarm Intelligence

SOE 2.1	Mon	10:15–10:45	GÖR 226	**Social Media and Attention** — •Bernardo Huberman
SOE 2.2	Mon	10:45–11:15	GÖR 226	**Mobilizing society with a red balloon** — •Riley Crane
SOE 2.3	Mon	11:15–11:45	GÖR 226	**Collective behaviour and swarm intelligence** — •Jens Krause

Focus Session: GPU-Computing (with DY)

SOE 5.1	Mon	14:00–14:30	GÖR 226	**Applications of GPU-Computing in Statistical Physics** — •Peter Virnau
SOE 5.2	Mon	14:30–15:00	GÖR 226	**Accelerating Monte Carlo Simulations in Statistical Physics with GPU's** — •David Landau

Focus Session: Experimental Methods

SOE 10.1	Tue	13:30–14:00	GÖR 226	**Complex Economic Systems in the Laboratory** — •Cars Hommes
SOE 10.2	Tue	14:00–14:30	GÖR 226	**Multiplicative Cascades: How to model trip within cities** — •Marta C. González
SOE 10.3	Tue	14:30–15:00	GÖR 226	**Human behavior on networks: lessons and perspectives from game theory** — •Angel Sánchez
SOE 10.4	Tue	15:00–15:30	GÖR 226	**Measuring Happiness** — •Peter S. Dodds

Young Scientist Award for Socio- and Econophysics

SOE 8.1	Mon	17:00–17:45	HSZ 02	**Dragon-kings versus black swans: diagnostics and forecasts for the on-going world financial crisis** — •Didier Sornette
SOE 8.1	Mon	18:00–18:30	HSZ 02	**Community structure in networks and statistical physics of social dynamics** — •Santo Fortunato

Joint Symposium on Foundations and Perspectives of Climate Engineering (with AKE, UP)
See SYCE for the full program of the symposium.

SYCE 1.1	Tue	10:30–11:00	HSZ 01	**Oceanic carbon-dioxide removal options: Potential impacts and side effects** — •Andreas Oschlies
SYCE 1.2	Tue	11:00–11:30	HSZ 01	**Climate Engineering through injection of aerosol particles into the atmosphere: physical insights into the possibilities and risks** — •Mark Lawrence
SYCE 1.3	Tue	11:30–12:00	HSZ 01	**Geoengineering - will it change the climate game?** — •Timo Goeschl
SYCE 1.4	Tue	12:00–12:30	HSZ 01	**The gamble with the climate - an experiment** — •Manfred Milinski

Sessions

SOE 1.1–1.1	Sun	16:00–18:00	HSZ 04	**Tutorial**
SOE 2.1–2.3	Mon	10:15–11:45	GÖR 226	**Focus Session: Swarm Intelligence**
SOE 3.1–3.2	Mon	12:00–12:30	GÖR 226	**Focus Session: Swarm Intelligence - Contributed Talks**
SOE 4.1–4.1	Mon	13:30–14:00	GÖR 226	**Special Announcement: Funding Opportunities**
SOE 5.1–5.2	Mon	14:00–15:00	GÖR 226	**Focus Session: GPU Computing (with DY)**
SOE 6.1–6.3	Mon	15:00–15:45	GÖR 226	**Focus Session: GPU Computing (with DY) - Contributed Talks**
SOE 7.1–7.3	Mon	16:00–16:45	GÖR 226	**Social Systems, Opinion and Group Dynamics I**
SOE 8.1–8.2	Mon	17:00–18:30	HSZ 02	**Award Ceremony: Young Scientist Award for Socio- and Econophysics**
SOE 9.1–9.4	Tue	10:30–13:00	HSZ 01	**Joint Symposium SYCE: Foundations and Perspectives of Climate Engineering (with AKE, UP)**
SOE 10.1–10.4	Tue	13:30–15:30	GÖR 226	**Focus Session: Experimental Methods**
SOE 11.1–11.19	Tue	18:00–18:45	P2	**Poster Session**
SOE 12	Tue	18:45–19:30	GÖR 226	**Annual General Meeting of SOE**
SOE 13.1–13.1	Wed	10:15–10:45	GÖR 226	**Networks: From Topology to Dynamics I (with BP, DY)**
SOE 14.1–14.9	Wed	10:45–13:15	GÖR 226	**Networks: From Topology to Dynamics II (with BP, DY)**
SOE 15.1–15.5	Wed	14:00–15:15	GÖR 226	**Economic Models and Evolutionary Game Theory I (with BP, DY)**
SOE 16.1–16.6	Wed	15:30–17:00	GÖR 226	**Networks: From Topology to Dynamics III (with BP, DY)**
SOE 17.1–17.3	Wed	17:15–18:00	GÖR 226	**Socio-Economic Systems**
SOE 18.1–18.11	Thu	10:15–13:15	GÖR 226	**Financial Markets and Risk Management I**
SOE 19.1–19.4	Thu	14:00–15:00	GÖR 226	**Economic Models and Evolutionary Game Theory II (with BP, DY)**
SOE 20.1–20.8	Thu	15:00–17:15	GÖR 226	**Networks: From Topology to Dynamics IV (with BP, DY)**
SOE 21.1–21.3	Fri	10:15–11:00	GÖR 226	**Traffic Dynamics, Urban and Regional Systems**
SOE 22.1–22.6	Fri	11:15–12:45	GÖR 226	**Social Systems, Opinion and Group Dynamics II**

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

Tuesday March, 15 18:45–19:30 GÖR 226

SOE 1: Tutorial

Time: Sunday 16:00–18:00 Location: HSZ 04

Tutorial SOE 1.1 Sun 16:00 HSZ 04

Collective Dynamics of Firms: A Statistical Physics Approach — •Frank Schweitzer — Chair of Systems Design, ETH Zurich, Kreuzplatz 5, 8032 Zurich, Switzerland

The dynamics of individual firms is hard to predict and depends on many firm specific factors, ranging from location and taxes to managerial talent. The collective dynamics observed on the aggregate level of a system of firms, however, shows some remarkable regularities, e.g. in the skewed distribution of firm sizes, or the Laplacian distribution of growth rates. We derive these regularities from analyzing data sets of real firms. The focus is then on explaining the dynamics by agent-based stochastic models of different complexity. Starting from simple multiplicative stochastic processes, we incorporate economic concepts such as entry and exit dynamics, competition and cooperation, adoption of behavior, or path dependence, to highlight different aspects of industrial organization.

SOE 2: Focus Session: Swarm Intelligence

Time: Monday 10:15–11:45 Location: GÖR 226

Invited Talk SOE 2.1 Mon 10:15 GÖR 226

Social Media and Attention — •Bernardo Huberman — Social Computing Lab, HP Labs

The past decade has witnessed a momentous transformation in the way people interact and exchange information with each other. Content is now co-produced, shared, classified, and rated by millions of people, while attention has become the ephemeral and valuable resource that everyone seeks to acquire.

This talk will describe the ways through which social attention determines the production and consumption of content within both the scientific community and social media, how its dynamics can be used to predict the future, and its role in affecting the public agenda.

Invited Talk SOE 2.2 Mon 10:45 GÖR 226

Mobilizing society with a red balloon — •Riley Crane — MIT Media Lab, Cambridge, MA, USA

Last December DARPA – the US Defense Advanced Research Projects Agency – unveiled ten red balloons at undisclosed locations around the United States and offered a $40,000 reward to anyone in the world who could find them. Our team found all ten in 8 hours and 52 minutes with a crowdsourcing solution that allowed us to effectively build and query a human sensor network. This talk will discuss problems such as these that require coordination beyond the typical scope of crowdsourcing.

Invited Talk SOE 2.3 Mon 11:15 GÖR 226

Collective behaviour and swarm intelligence — •Jens Krause — IGB & Humboldt University, Berlin, Germany

Many group-living species exhibit complex and coordinated spatio-temporal patterns from the motion of locust swarms and fish schools to bird flocks, ungulate herds and human crowds. The common property of these seemingly unrelated biological phenomena is that of inter-individual interaction, by which individuals can influence the behaviour of others. Individual-based models provide predictions regarding collective processes which we tested in a set of experiments that explore human crowd dynamics and fish schooling behaviour. In particular we designed a robotic fish that can be used to manipulate decision-making processes in live shoals of fish. Finally, I will discuss the phenomenon of swarm intelligence using examples from both humans and animals.

SOE 3: Focus Session: Swarm Intelligence - Contributed Talks

Time: Monday 12:00–12:30 Location: GÖR 226

SOE 3.1 Mon 12:00 GÖR 226

Emergence of coherent motion in flocks of deterministics walkers: a coupled maps evolving network perspective — •Garcia Cantu Ros Anselmo[1], Antonopoulos Chris[2], and Basios Vasileos[2] — [1]Potstdam Institute for Climate Impact Research PIK, Potsdam, Germany — [2]Free University of Brussels ULB, Brussels, Belgium

The emergence of coherence in collective motion described by a system of interacting motiles is analyzed. By means of a nonlinear adaptative coupling, the system elements are able to swing along the route to chaos. Thereby, each motile can display different types of behavior, i.e. from ordered to fully erratic motion, accordingly with its surrounding conditions. The appearance of patterns of collective motion is shown to be related to the emergence of interparticle synchronization and the degree of coherence of motion is quantified by means of a network representation. It is shown that the highest degree of coherence of motion is attained when the system self-drives towards the border between order and chaos. The effect of both particles' density and of considering different weights for the interparticle distances is explored.

SOE 3.2 Mon 12:15 GÖR 226

Complex dynamics of our economic life on different scales: insights from search engine query data — •Tobias Preis[1,2,3], Daniel Reith[3], and H. Eugene Stanley[1] — [1]Center for Polymer Studies, Department of Physics, 590 Commonwealth Avenue, Boston, MA 02215, USA — [2]Artemis Capital Asset Management GmbH, Gartenstrasse 14, 65558 Holzheim, Germany — [3]Institute of Physics, Johannes Gutenberg University Mainz, Staudingerweg 7, 55128 Mainz, Germany

Search engine query data deliver insight into the behaviour of individuals who are the smallest possible scale of our economic life. Individuals are submitting several hundred million search engine queries around the world each day. We study weekly search volume data for various search terms from 2004 to 2010 that are offered by the search engine Google for scientific use, providing information about our economic life on an aggregated collective level. We ask the question whether there is a link between search volume data and financial market fluctuations on a weekly time scale. Both collective swarm intelligence of Internet users and the group of financial market participants can be regarded as a complex system of many interacting subunits that react quickly to external changes. We find clear evidence that weekly transaction volumes of S&P 500 companies are correlated with weekly search volume of corresponding company names. Furthermore, we apply a recently introduced method for quantifying complex correlations in time series with which we find a clear tendency that search volume time series and transaction volume time series show recurring patterns.

SOE 4: Special Announcement: Funding Opportunities

Time: Monday 13:30–14:00 Location: GÖR 226

Topical Talk SOE 4.1 Mon 13:30 GÖR 226

The FuturICT Knowledge Accelerator: Introduction to a EU Flagship project on techno-socio-economic systems — •Dirk Helbing — ETH Zürich, Switzerland

The ultimate goal of the FuturICT flagship project is to understand and manage complex, global, socially interactive systems, with a focus on sustainability and resilience. Revealing the hidden laws and processes underlying societies probably constitutes the most pressing scientific grand challenge of our century and is equally important for the development of novel robust, trustworthy and adaptive information and communication technologies (ICT), based on socially inspired approaches.

Integrating ICT, Complexity Science and the Social Sciences will create a paradigm shift, facilitating a symbiotic co-evolution of ICT and society. Data from our complex globe-spanning ICT system will be leveraged to develop models of techno-socio-economic systems. In turn, insights from these models will inform the development of a new generation of socially adaptive, self-organized ICT systems.

FuturICT as a whole will act as a Knowledge Accelerator, turning massive data into knowledge and technological progress. In this way, FuturICT will create the scientific methods and ICT platforms needed to address planetary-scale challenges and opportunities in the 21st century. Specifically, FuturICT will build a sophisticated simulation, visualization and participation platform, called the Living Earth Platform. This platform will power Crisis Observatories, to detect and mitigate crises, and Participatory Platforms, to support the decision-making of policy-makers, managers, and citizens.

SOE 5: Focus Session: GPU Computing (with DY)

Time: Monday 14:00–15:00 Location: GÖR 226

Invited Talk SOE 5.1 Mon 14:00 GÖR 226

Applications of GPU-Computing in Statistical Physics — •Peter Virnau — Institut für Physik, Staudinger Weg 7, Uni Mainz

Although simulations and data analysis on Graphic Processing Units require additional programming efforts, and even though not all problems are well-suited for this particular environment, GPU-computing has emerged as a viable low-cost complement to conventional supercomputers in the past three years. In this talk I will highlight recent applications which focus on classical problems of statistical physics and related fields. I will present an extremely fast, freely available Ising code based on multispin coding concepts, which is able to run on multi-GPU clusters, as well as recent results from large-scale molecular dynamics simulations of polymer loops and melts. I will also present interdisciplinary research on econophysics, which focuses on analysis of financial market time series, and discuss future challenges of GPU-computing.

Invited Talk SOE 5.2 Mon 14:30 GÖR 226

Accelerating Monte Carlo Simulations in Statistical Physics with GPU's — •David Landau and Junqi Yin — University of Georgia, Athens, GA 30622, U.S.A.

High resolution Monte Carlo simulations are often limited by available resources. This is because long sampling times and large systems are often needed to overcome long correlation times and finite size effects for the systems under study. We will describe how GPU's can be used to formulate multi-threaded algorithms that dramatically accelerate performance of Monte Carlo simulations of condensed matter systems. We give examples of the application to parallel tempering simulation of magnetic lattice models and Wang-Landau sampling of water clusters in the continuum. In both cases a speedup of more than a factor of \$50\$ was achieved compared to a single, current generation CPU; moreover, our implementation scales nearly linearly with the number of GPU's.

SOE 6: Focus Session: GPU Computing (with DY) - Contributed Talks

Time: Monday 15:00–15:45 Location: GÖR 226

SOE 6.1 Mon 15:00 GÖR 226

GPU-accelerated analysis of high frequency financial data — •Florian Dittrich[1], Simon Weisseno[1], Lucas Schabhüser[1], and Tobias Preis[2,3] — [1]Spline Consulting e.V., Johannes Gutenberg University Mainz, Staudinger Weg 9, 55099 Mainz, Germany — [2]Center for Polymer Studies, Department of Physics, 590 Commonwealth Avenue, Boston, MA 02215, USA — [3]Artemis Capital Asset Management GmbH, Gartenstr. 14, 65558 Holzheim, Germany

We apply the concept of general-purpose computing on graphics processing units (GPGPU) to the analysis of time series. We use the recently introduced pattern formation conformity [T. Preis et al., New Journal of Physics 11 (2009) 093024], which quantifies pattern-based complex short-time correlations in a time series, for analyzing high-frequency financial data sets. In addition, we evaluate the predictive power for time series using such pattern-based correlations.

SOE 6.2 Mon 15:15 GÖR 226

Interacting many-body simulations using graphics processing units — •Tobias Kramer — Institute for Theoretical Physics, Uni Regensburg

Already the solution of the interacting classical many-body problem is difficult to achieve, since the integration of the equations of motions couples all positions of the particles contained in the system. Transport calculations in nanodevices require to include the contacts within the simulation and to study the effect of interactions there.

Classical and quantum-mechanical equations of motions can be related by the time-dependent variational principle as we detail for Coulombic interacting electrons in a magnetic field (1). Interacting systems require to carefully consider the questions of self-consistency, since all particles must be linked together and it is not possible to run one particle trajectory after each other. The emergence of an mean-field potential out of a large (10000 electrons!) many-body calculation is shown in (2). The calculation is only possible due to our usage of graphics processing units, which are ideal tools to study interacting systems.

(1) T. Kramer, Two interacting electrons in a magnetic field: comparison of semiclassical, quantum, and variational solutions, arxiv:1009.6051 (2) T. Kramer, V. Krueckl, E. Heller, and R. Parrott Self-consistent calculation of electric potentials in Hall devices, Phys. Rev. B, 81, 205306 (2010)

SOE 6.3 Mon 15:30 GÖR 226

Lattice-Boltzmann Simulations on GPUs — •Dominic Roehm — Institute for Computational Physics Universität Stuttgart

In coarse-grained Molecular dynamics (MD) simulations of large macromolecules, the number of solvent molecules is normally so large that most of the computation time is spent on the solvent. For this reason one is interested in replacing the solvent by a lattice fluid using the Lattice-Boltzmann (LB) method. The LB method is well known and on large length and timescales it leads to a hydrodynamic flow field that satisfies the Navier-Stokes equation. If the lattice fluid should be coupled to a conventional MD simulation of the coarse-grained particles, it is necessary to thermalize the fluid. While the MD particles are easily coupled via friction terms to the fluid, the correct thermalization of the lattice fluid requires to switch into mode space, which makes thermalized LB more complex and computationally expensive.

However, the LB method is particularly well suited for the highly parallel architecture of graphics processors (GPUs). We present a fully thermalized GPU-LB implementation which is coupled to a MD that is running on a conventional CPU using the simulation package ESPResSo (http://www.espressomd.org). This implementation is on a single NVIDIA GTX480 about 50 times faster than on a recent AMD Athlon IIX4 quadcore, therefore replacing a full compute rack by a single desktop PC with a highend graphics card.

SOE 7: Social Systems, Opinion and Group Dynamics I

Time: Monday 16:00–16:45 Location: GÖR 226

SOE 7.1 Mon 16:00 GÖR 226

An Agent-Based Model of Collective Emotions in Online Communities — •Frank Schweitzer and David Garcia — Chair of Systems Design, ETH Zurich, Kreuzplatz 5, 8032 Zurich, Switzerland

We develop a agent-based framework to model the emergence of collective emotions, which is applied to online communities. Agents individual emotions are described by their valence and arousal. Using the concept of Brownian agents, these variables change according to a stochastic dynamics, which also considers the feedback from online communication. Agents generate emotional information, which is stored and distributed in a field modeling the online medium. This field affects the emotional states of agents in a non-linear manner. We derive conditions for the emergence of collective emotions, observable in a bimodal valence distribution. Dependent on a saturated or a superlinear feedback between the information field and the agent's arousal, we further identify scenarios where collective emotions only appear once or in a repeated manner. The analytical results are illustrated by agent-based computer simulations. Our framework provides testable hypotheses about the emergence of collective emotions, which can be verified by data from online communities. (Eur. Phys. J. B 77, 533-545 (2010), http://arxiv.org/abs/1006.5305)

SOE 7.2 Mon 16:15 GÖR 226

Negative emotions as a fuel for discussion in cyber communities — •Anna Chmiel[1], Julian Sienkiewicz[1], Georgios Paltoglou[2], Kevan Buckley[2], Mike Thelwall[2], and Janusz A. Hołyst[1] — [1]Faculty of Physics, Warsaw University of Technology, Warsaw, Poland — [2]School of Computing and IT, University of Wolverhampton, Wolverhampton, UK

We focus on the influence of emotion on the behavior of Internet forum users and the vitality of online debates. We collected a large set of records describing comments expressed in diverse cyber communities such as blogs, fora and the Digg community. The text was then evaluated using classifiers that were able to estimate emotional valence values. We show that affective interactions do exist in Internet communities and they lead to attractive forces. As a result of collective behaviour there are clusters of comments possessing a similar level of emotional valence that are much longer than they would be if they were created by a random process. The presence of longer clusters of coherent emotional expressions therefore increases the possibility of attaching to this cluster a comment with the same emotion. At BBC Forum the majority of comments possess a negative emotional valence and threads starting from a larger number of negative comments last longer so negative emotions can be treated as a kind of discussion fuel. Users can take part in many threads, thus their local and global activities and corresponding emotions can be very different. We show that an increase in activity in the discussion of a particular thread is connected with more negative emotions from the user in the thread.

SOE 7.3 Mon 16:30 GÖR 226

Dissemination of words in online discussion groups — •Eduardo G. Altmann — Max-Planck-Institut für Physik komplexer Systeme, Dresden

Statistics of word usage provide quantifiable measures that can lead to a deeper understanding of different social systems. For instance, when analyzing large-scale databases of human interactions (mobile phone calls, e-mails, etc.) the content of the messages is a key element (often neglected) to understand the underlying social network. Furthermore, vocabulary change is itself a fascinating complex system that can nowadays be analyzed with an unprecedent precision. Here I will report on our investigation of word usage in Usenet groups, a database spanning decades that has detailed user information and interesting historical data (e.g., of the exogenously-driven rise of products and of the endogenously-driven rise of Internet slangs). To deal with the strong fluctuations in word frequency, we introduce a measure of word dissemination in respect to users and topics. We observe that most words are less disseminated than a random marker with same frequency and that dissemination is positively correlated with frequency change, meaning that words concentrated in a small "niche" are more probable to decay in frequency or get "extinct". Finally, we show that users are more important than topics in determining the usage of words, suggesting that the heterogeneity of people is the single strongest factor in lexical diversity.

[1] E. G. Altmann, J. B. Pierrehumbert, and A. E. Motter, "Niche as a determinant of word fate in online groups", arXiv:1009.3321 (2010).

SOE 8: Award Ceremony: Young Scientist Award for Socio- and Econophysics

Time: Monday 17:00–18:30 Location: HSZ 02

Invited Talk SOE 8.1 Mon 17:00 HSZ 02

Dragon-kings versus black swans: diagnostics and forecasts for the on-going world financial crisis — •didier Sornette — ETH Zurich, Department of Management, Technology and Economics, Kreuzplatz 5, 8032 Zurich, Switzerland

Extreme fluctuations or events are often associated with power law statistics. Indeed, it is a popular belief that "wild randomness" is deeply associated with distributions with power law tails characterized by small exponents. Here, we document in many different systems that there is life beyond power law tails: power laws can be superseded by "dragon-kings", monster events that occur beyond the power law tail. Dragon-kings reveal hidden mechanisms that are only transiently active and that amplify the normal power law fluctuations. Evidence of the dragon-king phenomenon is found in the statistics of financial losses, economic geography, hydrodynamic turbulence, material rupture, avalanches in random directed polymers, earthquakes, epileptic seizures, and cyber risks. The special status of dragon-kings open a new research program on their predictability, based on the hypothesis that they belong to a different class of their own and express specific amechanisms amplifying the normal dynamics via positive feedbacks. The dragon-king approach allows us to understand the present World financial crisis as underpinned by two decades of successive financial and economic bubbles. We will demonstrate how market risk management can be enlarged by combining strategic, tactical and time-varying risk analysis (see www.er.ethz.ch/fco)

Presentation of the Young Scientist Award for Socio- and Econophysics to Dr. Santo Fortunato, Institute for Scientific Interchange, Torino, Italy

Prize Talk SOE 8.2 Mon 18:00 HSZ 02

Community structure in networks and statistical physics of social dynamics — •Santo Fortunato — ISI Foundation, Torino, Italy

This seminar is a brief excursion across some problems I have been investigating over the last few years. Networks are the simplest representations of complex systems and their investigation may shed light on the structure and function of many systems. Here I will discuss the problem of graph clustering, i.e. of finding subgraphs with a high density of internal edges, whereas the density of edges between sub-

graphs is comparatively low. I will focus on the issues of resolution of global optimization methods and of testing methods against each other. Next, I will enter the realm of sociophysics, i.e. of how statistical physics can help to uncover the collective dynamics of large-scale social systems. The main weakness of this field is the absence of a quantitative phenomenology, as little attention is paid to the relationship between models and real systems and models are usually studied for their own sake. Here I have mainly tried to search for empirical regularities in social data, like scaling and universality, that could somehow inspire and validate a statistical physics modeling of social dynamics. I will introduce recent results on election and citation behavior

After the awardee's talk, there will be a social gathering with beer and pretzels in front of the lecture hall HSZ 02.

SOE 9: Foundations and Perspectives of Climate Engineering (with AKE and UP)

Time: Tuesday 10:30–13:00 Location: HSZ 01

Invited Talk SOE 9.1 Tue 10:30 HSZ 01

Oceanic carbon-dioxide removal options: Potential impacts and side effects — •Andreas Oschlies — IFM-GEOMAR, University of Kiel, Germany

Ocean fertilization and alkalinity enhancement by accelerated weathering of limestone or silicate rocks have been suggested as possible options for sequestering atmospheric CO_2. These methods would have intended and unintended, local and remote impacts on marine ecosystems and biogeochemical cycles. An overview is given on current estimates of the CO_2 sequestration potential of various fertilization and alkalinity-enhancement techniques. Impacts and possible side effects are discussed in a quantitative manner based on results of small-scale field studies and global Earth System model simulations for a business-as-usual CO_2 emission scenario. According to these results, the sequestration potential of the individual oceanic CO_2 removal methods is limited to a small fraction of current anthropogenic emissions. While it is obvious that all methods have undesired side effects, these have to be evaluated against the side effects resulting from an unabated rise in atmospheric CO_2 levels.

Invited Talk SOE 9.2 Tue 11:00 HSZ 01

Climate Engineering through injection of aerosol particles into the atmosphere: physical insights into the possibilities and risks — •Mark Lawrence — Max Planck Institute for Chemistry, Atmospheric Chemistry Department, Mainz, Germany

Climate Engineering (CE) is the intentional manipulation of the Earth's climate in order to counteract the effects of unintended global change due to greenhouse gases and other climate forcing agents, such as reflecting and absorbing aerosol particles. Numerous CE measures have been proposed as cost-effective means to either bypass the slow international actions towards reducing emissions of climate-active gases and particles, or as a solution for potentially impending "climate emergencies" (rapid, irreversible transitions caused by exceeding certain thresholds of climate change). Though often discussed as highly promising possibilities, each proposed CE measure of course harbors large uncertainties and significant potential side effects. The CE measures can mostly be divided into two categories: accelerated removal of carbon dioxide (CO_2, the primary greenhouse gas) from the atmosphere, and "solar radiation management" (SRM), i.e., increasing the amount of solar radiation reflected back to space. This talk gives an overview of the latter, focusing particularly on the current state of knowledge of proposed SRM measures through injection of aerosol particles, which either directly reflect solar radiation, or enhance the reflectivity of clouds.

Invited Talk SOE 9.3 Tue 11:30 HSZ 01

Geoengineering - will it change the climate game? — •Timo Goeschl — Dept. of Economics, Heidelberg University, Heidelberg, Germany

Emissions reductions aimed at mitigating climate change are - from an economic point of view - an almost perfect example of a global public good. The scale of the public good is determined by aggregate reduction efforts of all countries. The contribution of individual countries to the aggregate effort, however, can - in the absence of a global institution - only arise out of a bargaining process between individual sovereign states. This is the essence of the 'climate game'. Both theoretical analysis and empirical evidence underscore that the climate game provides problematic incentives for the individual states to jointly generate a satisfactory aggregate reduction effort. Geoengineering has the potential to alter these incentives in a radical way. The reason is that geoengineering efforts differ from emissions reduction efforts in many ways. One important difference in bargaining terms is that the actions of a single player can determine the final outcome. Combined with the very different costs and benefits associated with geoengineering activities, the availability of geoengineering option therefore poses an entirely new set of incentives for countries. This presentation weighs the arguments on the likely impacts on the process and outcome of the climate game of geoengineering options becoming available .

Invited Talk SOE 9.4 Tue 12:00 HSZ 01

The gamble with the climate - an experiment — •Manfred Milinski — Max-Planck-Institut für Evolutionsbiologie, Thienemann-Str. 2a, 24306 Plön

Will a group of people reach a collective target through individual contributions when everybody suffers individually if the target is missed? This *collective risk social dilemma* exists in various social scenarios, the globally most challenging one being the prevention of dangerous climate change. Reaching the collective target requires individual sacrifices, with benefits to all but no guarantee that others will also contribute. It even seems tempting to contribute less and save money to induce others to contribute more, hence the dilemma and the risk of failure. Here, we introduce the collective risk social dilemma and simulate it in a controlled experiment: will a group of people reach a fixed target sum through successive monetary contributions, when they know that they will lose all their remaining money with a certain probability if they fail to do so? We find that under high risk of simulated dangerous climate change half of the groups succeed in reaching the target sum, whereas the others only marginally fail. When the risk of loss is only as high as the necessary average investment or even lower, the groups generally fail to reach the target sum. We conclude that one possible strategy to relieve the collective risk dilemma in high risk situations is to convince people that failure to invest enough is very likely to cause grave financial loss to the individual. Our analysis describes the social window humankind has to prevent dangerous climate change.

Panel Discussion 12:30 - 13:00
"Perspectives of Climate Engineering" Andreas Oschlies, Mark Lawrence, Timo Göschl, Manfred Milinski Chair: Thomas Leisner

SOE 10: Focus Session: Experimental Methods

Time: Tuesday 13:30–15:30 Location: GÖR 226

Invited Talk SOE 10.1 Tue 13:30 GÖR 226
Complex Economic Systems in the Laboratory — •Cars Hommes — University of Amsterdam, Netherlands

Expectations and learning play a key role in complex economic systems. In this talk we survey learning to forecast experiments (LtFEs) with human subjects to test theories of expectations and learning. Subjects must repeatedly forecast a market price, whose realization is an aggregation of individual expectations. Emphasis is given to how individual forecasting rules interact at the micro level and which structure they co-create at the aggregate, macro level. In particular, we focus on the question wether the evidence from laboratory experiments is consistent with heterogeneous expectations in complex economic systems.

Invited Talk SOE 10.2 Tue 14:00 GÖR 226
Multiplicative Cascades: How to model trip within cities — •Marta C. González — Massachusetts Institute of Technology, Boston, USA

Our work focuses on developing a model for trip lengths distribution in metropolitan areas, in which the current tendency is set by gravity like models, where trip lengths are fit with empirical OD (origin destination) data. While it is an extensively used method, its main drawback is that it lacks a way to include the spatial statistical variations of population density and services into the model. Depending on fit parameters for a particular region and a particular spatial scale without providing an understanding in the values of the used parameters. As we show in this paper, multiplicative cascade models can be used to generate heterogeneous distribution of populations that compare very well with the best-known resolution data as provided by LandScan. We proposes analytical expressions for trip length distributions that contain the multiplicative cascade parameters obtained from empirical density of population and allows to be adjusted to different scenarios of supply distribution. We present an extensive sensitivity analysis providing an insight in how the shape of the trip length distribution changes on different scenarios.

Invited Talk SOE 10.3 Tue 14:30 GÖR 226
Human behavior on networks: lessons and perspectives from game theory — Jelena Grujic[1], Constanza Fosco[1,4], Lourdes Araujo[5], José A. Cuesta[1], and •Angel Sánchez[1,2,3] — [1]GISC/Matemáticas, Universidad Carlos III de Madrid, Spain — [2]ICMAT, CSIC-UAM-UC3M-UCM, Madrid, Spain — [3]BIFI, Universidad de Zaragoza, Spain — [4]Economía, Universidad Católica del Norte, Antofagasta, Chile — [5]NLP-IR/Lenguajes y Sistemas, UNED, Madrid, Spain

One of the most often invoked mechanisms to explain how cooperation can emerge is the existence of a population structure that determines the interactions among individuals. We present results of the first experiment designed to test the emergence of cooperation when humans play Prisoner's Dilemma on a network whose size is comparable to that of simulations. We find that cooperation is not sustained by the network: the cooperation level declines to an asymptotic state with low but non-zero cooperation. Regarding players' behavior, we observe that the population is heterogeneous, consisting of a high percentage of defectors, a smaller one of cooperators, and a large group that shares features of the conditional cooperators of public goods games. We do not observe significant learning as the experiment progresses. We propose a computational model showing that both heterogeneity and a "moody" conditional ooperation strategy, in which the probability of cooperating also depends on the player's previous action, are needed to explain all our experimental results.

Invited Talk SOE 10.4 Tue 15:00 GÖR 226
Measuring Happiness — •Peter S. Dodds — University of Vermont, Burlington, USA

Individual happiness is a fundamental reflection of societal health. Normally measured through self-report, happiness has often been indirectly characterized and overshadowed by more readily quantifiable economic indicators, such as gross domestic product. In this talk, I will provide motivation for measuring well-being online through non-invasive observation, as a complement to traditional survey methods, and I will outline recent 'big data' efforts that have extracted emotional content from written expression. I will report in particular on a real-time, remote-sensing, non-invasive, text-based approach—a kind of hedonometer—which we have used to uncover collective dynamical patterns of happiness as expressed in the global social network Twitter, song lyrics, blogs, political speeches, and news sources. I will report on global levels of temporal, spatial, demographic, and social variations in happiness and information levels, as well as evidence of emotional synchrony and contagion. I will employ a particular graphical method to show how individual words contribute to changes in average happiness between any two texts. Finally, I will also discuss how natural language appears to contain a frequency-independent positive bias, and how this connects to collective cooperation and evolution.

SOE 11: Poster Session

Time: Tuesday 18:00–18:45 Location: P2

Please note: To ensure maximum attendance, the poster session will only start after the conclusion of the Prize Ceremony.

SOE 11.1 Tue 18:05 P2
Ageing in the 3D random-bond Ising model along the ferromagnetic - spin glass transition line — •Markus Manssen and Alexander Hartmann — Institut für Physik, Carl-von-Ossietzky-Universität Oldenburg

Spin glasses, magnetic alloys showing disorder and frustration, are prototypical models of disordered systems and during the last decades they have been one of the main research topics in statistical physics. Since finite-dimensional spin glass models cannot be solved analytically, they are usually studied by computer simulations[1]. Yet the investigation of their main characteristic, their slow glassy behavior, demands long computation times and thus spawned dedicated specialized computing systems[2]. Using the huge computational resources on graphic cards promises noticeable speedups for largely parallel problems compared to common CPUs at a reasonable cost. Simulations of simple Ising models have already been realized[3].
Building on this we turn our attention to the random-bond $\pm J$ Ising model which allows us to investigate ageing effects when crossing from the ferromagnetic to the spin-glass phase by measuring two-time correlation functions.
[1] A.K. Hartmann, *Practical Guide to Computer Simulations*, World Scientific, 2009
[2] F. Belletti et al., *Ianus: An Adaptive FPGA Computer,* Computing in Science and Eng., vol. 8, no. 1, 2006, pp. 41-48.
[3] M. Weigel, *Simulating spin models on GPU*, Preprint arXiv:1006.3865v1

SOE 11.2 Tue 18:05 P2
Adaptive network models of swarm dynamics — Cristián Huepe[1], •Gerd Zschaler[2], Anne-Ly Do[2], and Thilo Gross[2] — [1]unaffiliated, C. Huepe Labs Inc., Chicago — [2]Max-Planck-Institut für Physik komplexer Systeme, Dresden

A simple adaptive network model describing recent swarming experiments is introduced. By exploiting an analogy with human decision-making models, its dynamics is captured using a low-dimensional system of equations permitting analytical investigation. The model reproduces several characteristic features of swarms, including spontaneous symmetry breaking, noise- and density-driven order-disorder transitions that can be of first or second order, intermittency, and metastable configurations displaying memory effects. By considering only minimal components of the swarming dynamics, it highlights the essential elements required to reproduce the observed behavior.

SOE 11.3 Tue 18:05 P2

Investigating the topology of interacting networks - Theory and application to coupled climate networks — •Jonathan F. Donges[1,2], Hanna C.H. Schultz[1,3], Norbert Marwan[1], Yong Zou[1], and Jürgen Kurths[1,2] — [1]Potsdam Institute for Climate Impact Research, P.O.Box 60 12 03, 14412 Potsdam, Germany — [2]Department of Physics, Humboldt University of Berlin, Newtonstr. 15, 12489 Berlin, Germany — [3]Department of Physics, Free University Berlin, Arnimallee 14, 14195 Berlin, Germany

Network theory provides various tools for investigating the structural or functional topology of many complex systems found in nature, technology and society. Nevertheless, it has recently been realised that a considerable number of systems of interest should be treated, more appropriately, as interacting networks or networks of networks. Here we introduce a novel graph-theoretical framework for studying the interaction structure between subnetworks embedded within a complex network of networks. This framework allows us to quantify the structural role of single vertices or whole subnetworks with respect to the interaction of a pair of subnetworks on local, mesoscopic and global topological scales.

Climate networks have recently been shown to be a powerful tool for the analysis of climatological data. Applying our general framework, we introduce coupled climate networks to represent and investigate the topology of statistical relationships between the fields of distinct climatological variables. This yields interesting insights into the atmosphere's general circulation structure.

SOE 11.4 Tue 18:05 P2

Epidemiological investigation of time-dependent complex networks — •Mario Konschake[1], Hartmut H K Lentz[1,2], and Thomas Selhorst[1] — [1]Friedrich-Loeffler-Institut, Institute of Epidemiology, Seestr. 55, 16868 Wusterhausen, Germany — [2]Department of Physics, Humboldt University, Newtonstr. 15, 12489 Berlin, Germany

The trade of live animals is a major route of infection. Therefore, in Germany every movement of live pigs is registered in the HI-Tier database. These data (121.287 premises with 3.5 million trade connections) form a special case of a time-dependent network with heavy-tail degree distribution and community structure [1].

We investigate the maximum size of epidemic as a function of infection date and infectious period. A threshold behavior for the infectious period and a strong dependency on the date of infection is found.

Furthermore, a confinement of epidemics to communities can be shown. Our results show that structure and time dependency are integral to the epidemiological investigation of real-world networks.

[1] Lentz, H.H.K., et al., Trade communities and their spatial patterns in the German pork production network. PREVET (2010), doi:10.1016/j.prevetmed.2010.10.011

SOE 11.5 Tue 18:05 P2

Graph-theoretic analysis of material flow layouts in packaging industry — Kristian Götze[1], •Reik V. Donner[1,2], and Thomas Seidel[1,3] — [1]Institute for Transport and Economics, Dresden University of Technology, Germany — [2]Potsdam Institufe for Climate Impact Research, Potsdam, Germany — [3]AMC Managing Complexity GmbH, Monheim am Rhein, Germany

We present a detailed analysis of the material flow systems of six different factories of a packaging manufacturer from a complex network perspective. For this purpose, the functional factory layout is interpreted as a directed graph, the vertices of which correspond to material handling and processing stations, while edges represent transportation devices such as conveyors, forklifts, or similar objects. The resulting networks are of sufficient size (between 134 and 334 vertices) to allow meaningfully studying graph properties on both local and global scale. Centrality measures such as degree and betweenness reveal vertices that are particularly crucial for the function of the overall system and should therefore be designed in a redundant way in order to avoid high economic risks in case of failures. Regarding the meso-scale network properties, the observed motif distributions are found to differ considerably from those of known superfamilies of networks, which is mainly due to a very low abundance of closed 3-loops. Possible implications of our findings for the design of efficient and robust material flow infrastructures are discussed.

SOE 11.6 Tue 18:05 P2

Effects of rapid evolution of connectivity on epidemic dynamics — •Amir Akbari Kalhor, Gerd Zschaler, and Thilo Gross — Biological Physics Section, Max-Planck Institute for the Physics of Complex Systems, Nöthnitzer Straße 38, 01187 Dresden, Germany

In epidemic dynamics on networks the most connected nodes play crucial role for spreading and prevention strategies. Recent empirical results on large social networks has revealed that the effective connectivity evolves rapidly so that at different times different nodes are most connected. We investigate how dynamic contact structure affects epidemic spreading. Further we explore in this framework how social distancing reduces the prevalence of the epidemic.

SOE 11.7 Tue 18:05 P2

Identifying damage functions through density transformation — •Diego Rybski[1], J. Micha Steinhäuser[1,2], and Jürgen P. Kropp[1] — [1]Potsdam Institute for Climate Impact Research (PIK), P.O. Box 60 12 03, 14412 Potsdam, Germany — [2]University of Oldenburg, 26129 Oldenburg, Germany

In order to estimate future damage caused by natural disasters, it is desirable to know the damage caused by single events. So called damage functions provide – for a natural disaster of certain magnitude – a specific damage value. However, in general, the functional form of such damage functions is unknown. We study the distributions of recorded damage values and deduce which damage functions lead to such distributions when the natural disasters obey Generalized Extreme Value statistics. We find broad damage distributions and investigate two possible functional forms to characterize the data. In the case of Gumbel distributed extreme events, (i) a power-law distribution density with an exponent close to 2 (Zipf's law) implies an exponential damage function. (ii) Stretched exponential distribution densities imply power-law damage functions. In the case of Weibull (Frechet) distributed extreme events we find correspondingly steeper (less steep) damage functions.

SOE 11.8 Tue 18:05 P2

A percolation model for trust in financial markets — •Tobias Tubbenhauer and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen, Otto-Hahn Allee, 28359 Bremen

Trust is an important feature of real markets. Motivated by the financial crisis in 2007, we want to study the building and evaporation of trust in an agent-based toy market, where agents are connected by their commercial relationships. The evolution of trust takes place in the clash between a necessity to take risk by having as much business partners as possible and a desire for security from losses received by bankrupt business partners. Between these two conflicting interests our toy market shows self organized critical behavior.

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

[2] B. Drossel, F. Schwabl, Phys. Rev. Lett. A 69, 1629 (1992)

SOE 11.9 Tue 18:05 P2

Regional clustering of automotive stocks revealed by linear and nonlinear multivariate analysis — Richard Neuberg[1] and •Reik V. Donner[2,3] — [1]Faculty of Economics, Dresden University of Technology, Germany — [2]Institute for Transport and Economics, Dresden University of Technology, Germany — [3]Potsdam Institute for Climate Impact Research, Potsdam, Germany

Stock markets are extremely dynamic systems with fluctuations on a broad range of different time scales. In this work, we study mutual interrelationships between the 10-day returns of stocks from a set of globally acting car manufacturers recorded for about the last decade. By applying linear as well as nonlinear dimensionality reduction techniques, we find a non-trivial regional clustering in the respective leading-order components, which allows splitting the mean sectoral market evolution into well-defined regional components. The robustness of the respective results obtained with the different multivariate analysis methods is systematically assessed. Finally, we study the temporal changes in the correlation structure between the different stocks and discuss our results in the light of varying global economic conditions.

SOE 11.10 Tue 18:05 P2

relationship between ARCH model and stochastic dealer model — •Kenta Yamada[1], Sidney Redner[2], Hideki Takayasu[3], and Misako Takayasu[1] — [1]Tokyo Institute of Technology, Japan — [2]Boston University, USA — [3]Sony CSL, Japan

In order to understand statistical properties of time series of market

prices from the viewpoint of microscopic dealers' action, we clarify a relationship between ARCH model and stochastic dealer models. ARCH model is an autoregressive type of time series model developed in the field of financial technology which reproduces the empirically known power law distribution of price changes, and there are many derived models such as GARCH model. On the other hand stochastic dealer model, which is studied mostly by physicists, is consisted of minimal configuration of dealers in an artificial market, and by tuning the parameters the models reproduce most of empirically stylized facts of financial markets including the power law distribution of price changes.

A. Sato and H. Takayasu showed that ARCH model can be derived from a deterministic dealer model in the special case that dealers have tendency of following trends of price changes. In this presentation we pay attention to the dealer's spread, that is, the price difference between the dealer's buying and selling prices, which has been set as a constant in the dealer model. By taking into account a feedback effect of volatility to the dealer's spread, we can theoretically derive ARCH model from the dealer model with fluctuation of spread.

SOE 11.11 Tue 18:05 P2

Agent based reasoning of the nonlinear stochastic models — •Aleksejus Kononovičius, Vygintas Gontis, and Bronislovas Kaulakys — Institute of Theoretical Physics and Astronomy, Vilnius University, A. Gostauto 12, LT-01108 Vilnius, Lithuania

Recently we introduced a double stochastic process driven by the nonlinear scaled stochastic differential equation reproducing the main statistical properties of the return, observed in the financial markets [1,2]. The proposed model is based on the class of nonlinear stochastic differential equations, providing the long-range processes, the power-law behavior of spectra and the power-law distributions of the probability density [3]. Stochastic framework mainly gives only a macroscopic insight into the modeled system, while microscopic behavior currently is also of big interest. In this contribution we will provide a version of agent based herding model with transition to the nonlinear stochastic equations of trading activity and return in financial markets.

[1] V. Gontis, J. Ruseckas and A. Kononovicius, Physica A 389, 100 (2010).

[2] V. Gontis, J. Ruseckas and A. Kononovičius, A Non-Linear Double Stochastic Model of Return in Financial Markets, Stochastic Control, Chris Myers (Ed.), ISBN: 978-953-307-121-3, Sciyo, (2010), http://www.intechopen.com/articles/show/title/a-non-linear-double-stochastic-model-of-return-in-financial-markets

[3] B. Kaulakys, J. Ruseckas, V. Gontis and M. Alaburda, Physica A 365, 217 (2006); J. Ruseckas and B. Kaulakys, Phys. Rev. E 81, 031105 (2010).

SOE 11.12 Tue 18:05 P2

Universal behavior in the dynamics of finanical markets — •Josef Ludescher[1], Constantino Tsallis[1,2], and Armin Bunde[1] — [1]Institut fur Theoretische Physik, Justus-Liebig-Universitat Giessen, 35392 Giessen, Germany — [2]present address: Centro Brasileiro de Pesquisas Fisicas 22290-180 Rio de Janeiro-RJ, Brazil

In financial markets, the central quantity are the relative losses or gains of an asset in a certain fixed period of time. The time evolution of these returns can be characterized by the set of interoccurence times r between losses below a negative threshold Q, in particular by their mean interoccurence time R_Q and their distribution function $P_Q(r)$. Here we consider daily losses in 16 representative financial records (stocks, indices, commodities and exchange rates). We find that in all cases $P_Q(r)$ follows the q-exponential form $P_Q(r) = 1/(1 + (q-1)\beta_Q r)^{1/(q-1)}$, where β is a monotonously decreasing function for small R_Q and becomes a constant for $R_Q > 10$. A is a normalization constant. The q-value appearing in the exponent of P_Q decreases logarithmically with decreasing R_Q, such that for $R_Q \to 2$, q tends to 1 and thus $P_Q(r)$ becomes a simple exponential. The fact that P_Q does not scale with R_Q is due to the multifractality of financial markets. The analytic form of the distribution allows also to estimate both the functional form of the risk function as well as the value-at-risk, and thus to improve estimation of the financial risk.

SOE 11.13 Tue 18:05 P2

Study of persistence in the foreign exchange market: analysis of the Hurst exponent — •Marcus Fernandes da Silva[1] and José Garcia Vivas Miranda[2] — [1]Brazil — [2]Brazil

This paper uses concepts of persistence to describe the behavior of currency fluctuations between the regimes of fixed Exchange rates and floating Exchange. Therefore, we used the Hurst exponent, which is a tool that can characterize the persistence of a particular profile. The first objective of this work is observes the behavior of the Hurst exponent in the switching between regimes of fixed exchange rates and floating exchange rate for the developing countries: Brazil, Mexico and Argentina. The second is to observe, also from the Hurst analysis, if there is a pattern behavior of floating exchange rate regime for the developed countries Canada and Australia if this happens, we will associate the efficiency of the foreign exchange market with the Hurst exponent. We observed a pattern behavior for the developed countries in the shift between the two exchange rate regimes. This pattern was characterized by persistence, followed by a rapid decrease antipersistentes values for and followed by a rapid increase to persistent values. It was observed that the Hurst exponent values for the developing countries distance themselves from 0.5 (ordinary Brownian motion) then the developed ones. This corroborates the hypothesis that the exchange market efficiency is associated with the ordinary Brownian motion.

SOE 11.14 Tue 18:05 P2

Emotional agents at the square lattice — •Agnieszka Czaplicka, Anna Chmiel, and Janusz A. Hołyst — Faculty of Physics Warsaw University of Technology, Warsaw, Poland

We introduce and investigate by numerical simulations a number of models of emotional agents at the square lattice. Our models describe the most general features of emotions such as the spontaneous emotional arousal, emotional relaxation, and transfers of emotions between different agents. Group emotions in the considered models are periodically fluctuating between two opposite valency levels and as result the mean value of such group emotions is zero. The oscillations amplitude depends strongly on probability p_s of the individual spontaneous arousal. For small values of relaxation times τ we observed a stochastic resonance, i.e. the signal to noise ratio SNR is maximal for a non-zero p_s parameter. The amplitude increases with the probability p of local affective interactions while the mean oscillations period increases with the relaxation time τ and is only weakly dependent on other system parameters. Presence of emotional antenna can enhance positive or negative emotions and for the optimal transition probability the antenna can change agents emotions at longer distances. The stochastic resonance was also observed for the influence of emotions on task execution efficiency.

SOE 11.15 Tue 18:05 P2

Language change in a multiple group society — •Cristina-Maria Pop and Erwin Frey — Arnold Sommerfeld Center and CeNS, Ludwig-Maximilians-Universität München, Theresienstr. 37, 80333 München, Germany

The use of language in society serves several purposes. On the one hand, the necessity to communicate meaning leads to agreement on a conventional sign for a recurring problem. On the other hand, there is the wish to identify with different social groups depending on the situation. This promotes the use of various linguistic variants. Through innovations in language and the influence of other social groups, novel forms are spread across the speech community, resulting in a competition between variant forms.

A mathematical formulation of the linguistic interactions inside an isolated social group is offered by the Utterance Selection Model [1], which explains the mechanisms inducing variant fixation and analyzes the distribution of variant frequencies.

In the attempt of describing language change in a society consisting of multiple groups, we take the Utterance Selection Model beyond the one-group boundary. The interactions between groups counterbalance the formation of consensus in the individual groups and thus offer a further mechanism for the propagation of linguistic changes.

[1] G. J. Baxter, R. A. Blythe, W. Croft, Phys. Rev. E **73**, 046118 (2006)

SOE 11.16 Tue 18:05 P2

Contact processes on directed adaptive networks — Michael Seissinger, •Gerd Zschaler, Güven Demirel, and Thilo Gross — Max-Planck-Institut für Physik komplexer Systeme, Dresden

We propose the application of directed adaptive networks in models of opinion formation and epidemic spreading to capture the effect of asymmetry in real-world relationships. In our approach, agents can rewire their out-going connections while leaving the network's out-degree distribution fixed. Thus, the influence of different realistic out-

degree distributions on the adaptive network dynamics can be investigated. As the out-degree distribution remains constant in time, it can be taken into account in a low-dimensional approximate ODE description in terms of its moments. Here we discuss the case of the voter model on directed adaptive networks. In this example, we observe a transition between an active and an absorbing phase at a critical rewiring rate, which depends on the first moments of the out-degree distribution.

SOE 11.17 Tue 18:05 P2

The effect of the forget-remember mechanism on spreading — •JIAO GU and WEI LI — Max-Planck-Institute for Mathematics in the Sciences

We introduce a new mechanism, the forget-remember mechanism, into the spreading process. Equipped with such a mechanism an individual is prone to forget the message received and remember the one forgotten, namely switching his state between active (with message) and inactive (without message). The probability of state switch is governed by linear or exponential forget-remember functions of history time which is measured by the time elapsed since the most recent state change. Our extensive simulations reveal that the forget-remember mechanism has significant effects on the saturation of message spreading, and may even lead to a termination of spreading under certain conditions. This finding may shed some light on how to control the spreading of epidemics. It is found that percolation-like phase transitions can occur. By investigating the properties of clusters, formed by connected, active individuals, we may be able to justify the existence of such phase transitions.

SOE 11.18 Tue 18:05 P2

Biochemical reaction networks meet Coalitional Game Theory: The importance of not being single — •MAX SAJITZ-HERMSTEIN[1] and ZORAN NIKOLOSKI[1,2] — [1]Max-Planck Institute of Molecular Plant Physiology — [2]Institute of Biochemistry and Biology, University of Postdam, Potsdam, D-14476 Germany

A fundamental question in the analysis of complex biological networks is how to determine which components (e.g. reactions) are most important regarding specific function. Virtually all existing approaches for establishing the importance of a reaction in a biological network are based on vitality-like indices. The importance of a reaction is then specified by the effect of its removal, emulating single knockout experiments in biology. However, such technique neglects topological features, like bypassing pathways, which are crucial for network robustness. Coalitional game theory provides a framework for extending the vitality-like indices by considering the contribution of single network elements with respect to all of its interactions in the network, based purely on the network topology. Here we propose a method combining cooperative game theory with flux balance analysis, a standard technique in the investigation of metabolic networks. We employ the method to rank reactions in metabolic networks with respect to a biologic function, in particular biomass production. Furthermore, our method is used in the design of a novel approach for determining network robustness to changes imposed by gene knock-outs.

SOE 11.19 Tue 18:05 P2

Causality & Stability: The Basis of Physics – Principles of Everything? — •ALEXANDER AN HAACK, PAUL FLACHSKAMPF, and SABINA JESCHKE — Institute for Management Cybernetics e. V., Associate Institute of RWTH Aachen University, Germany

The basis for any physical consideration lies in the fundamental assumption that a real system behaves on the basis of cause and effect and always develops towards a maximum of stability: A System, residing in the stable state X will never shift without plausible cause to the otherwise adiabatically inaccessible state Y. Judging the importance of these principles, Helmholtz even is said to have considered their formal agents – the laws of thermodynamics – as "the laws of the world". On the level of socioeconomic systems however, neither is their validity proven nor are their consequences systematically elaborated. "How correct" was Laplace's famous assumption ("Laplace's demon") for example? Does the Heisenberg uncertainty principle have a practical effect on this level? As a first step in this process of enlarging the fundamental understanding of socioeconomic systems, we present our research on the scientific work of the past that has touched this specific question. Ultimately, our goal as management cybernetics scientists is to attain the ability to deduce well-founded and practically relevant insights on the behavior and development of real complex systems.

SOE 12: Annual Members' Assembly of SOE

Time: Tuesday 18:45–19:30 Location: GÖR 226

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

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

Time: Wednesday 10:15–10:45 Location: GÖR 226

Invited Talk SOE 13.1 Wed 10:15 GÖR 226

Impact of Single Links in Growing Networks — •JAN NAGLER[1,2] 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

How a complex network is connected crucially impacts its dynamics and function. Until recently, random percolation processes were thought to exhibit continuous transitions in general. Numerical evidence for discontinuous changes of the order parameter in certain percolation processes, however, has triggered an ongoing scientific controversy about the conditions for discontinuous phase transitions in percolation [Achlioptas, D'Souza, and Spencer, Science 323, 1453 (2009); Nagler, Levina, and Timme, Nature Physics, in press; see also references therein.]. We study both numerically and analytically under which conditions certain "competitive" percolation processes exhibit macroscopic jumps in the order parameter.

SOE 14: Networks: From Topology to Dynamics II (with BP, DY)

Time: Wednesday 10:45–13:15 Location: GÖR 226

SOE 14.1 Wed 10:45 GÖR 226

Stem Diseases: Efficient Immunization Strategies — •CHRISTIAN M. SCHNEIDER[1], TAMARA MIHALJEV[1], SHLOMO HAVLIN[2], and HANS J. HERRMANN[1,3] — [1]Computational Physics, IfB, ETH Zurich, Schafmattstrasse 6, 8093 Zurich, Switzerland — [2]Minerva Center and Department of Physics, Bar-Ilan University, 52900 Ramat-Gan, Israel — [3]Departamento de Fisica, Universidade Federal do Ceara, 60451-970 Fortaleza, Ceara, Brazil

The spreading of diseases in social networks is crucial to the potential danger of the disease. We quantitatively analyze the effect of immunization strategies on the susceptibility to diseases. We introduce a novel immunization strategy and find for all studied networks that the

spreading of diseases can be significantly suppressed compared to the known immunization strategies. As an example we show the results for the international airport network.

SOE 14.2 Wed 11:00 GÖR 226

Vaccination Decisions with Limited Information — •Olivia Woolley Meza, Daniel Grady, and Dirk Brockmann — Northwestern University, Evanston, USA

Widely practiced vaccination can eradicate a disease from a population. However, if rational, self-interested individuals believe there is any risk associated with the vaccine, their strategic vaccination decisions can lead to insufficient aggregate vaccination. In fact, recent work has shown that in a well-mixed population with perfect information the disease will not be eradicated. We consider a finite-size stochastic system,where each individual has both a contact neighborhood, the group of others who can contact the individual, and an information neighborhood, the group of others about whom the individual can obtain information. We find that in this setting strategic vaccination decisions can lead to disease eradication. We further investigate how the likelihood of eradication changes with the extent of information on which individuals base their decisions. We find that when information is very limited, increasing the extent of information helps to eradicate the disease. However, as more information becomes available we find a second regime where additional information reduces the effectiveness of vaccination.The information region with high disease extinction is larger when the underlying topology is highly clustered. The cause of suboptimal behavior as we approach global information also depends on the underlying topology. We use simulations and analytical models to explain this behavior.

SOE 14.3 Wed 11:15 GÖR 226

Optimal vaccination strategies in metapopulation networks — •Vitaly Belik — Massachusetts Institute of Technology, Cambridge, MA, USA — Max-Planck-Institut für Dynamik und Selbstorganisation, Göttingen, Germany

Human infectious diseases remain a profound challenge for the humankind. Recently a lot of attention is devoted to theoretical modeling of geographical epidemic spread taking into account human mobility patterns obtained from the ubiquitous real data. This considerably advances the design of effective preventive and containment strategies. We investigate a problem of optimal vaccine distribution in a metapopulation network employing game theoretical approaches. We answer such an important question, as to what extent different regions are interdependent and where vaccination need to be subsidized to minimize the overall impact of the epidemic. In our extensive numerical simulation we employ the real data on human mobility in the USA.

SOE 14.4 Wed 11:30 GÖR 226

What is the front velocity in wave propagation without fronts? - Epidemics on complex networks provide an answer — •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

The spatiotemporal patterns of infectious diseases that spread nowadays typically lack a well defined wave front as human mobility is multi-scale. The structure of emergent patterns is difficult to assess quantitatively, in particular spreading speeds are difficult to define and compare in different scenarios. We present a novel way to look at contagion phenomena on complex networks using the underlying topological structure of the network. Shortest-path distances and arrival times are used to redefine the velocity of spreading patterns. We extend the idea of a wavefront that can be directly observed in simple networks like a regular lattice to the class of complex networks which in traditional views exhibit complicated patterns. This method substantially simplifies the way dynamics are analyzed and explains why patterns in complex modeling approaches share many similarities. Disease dynamics on various complex networks ranging from artificial to real human mobility networks show the benefit of representing the spatio-temporal patterns based on topological features of the network.

SOE 14.5 Wed 11:45 GÖR 226

Limiting factors for the spread of infectious diseases in complex networks — •Hartmut H K Lentz[1,2], Mario Konschake[2], and Igor M Sokolov[1] — [1]Department of Physics, Humboldt University, Newtonstr. 15, 12489 Berlin, Germany — [2]Friedrich-Loeffler-Institut, Institute of Epidemiology, Seestr. 55, 16868 Wusterhausen, Germany

Epidemics are expected to spread rapidly in networks with heavy-tail degree distributions. On the other hand, many real world networks comprise complex substructures like modules. Modules are subsets of nodes being densely interconnected. This yields subgraphs which are in the limiting case 'isolated' from each other. Furthermore the directed character of a network might play a role in disease spread. Most social and human networks can be treated as undirected. But many networks, e.g. trade networks, are inherently directed since there is an underlying economic/logistic process. In directed networks the number of possible ways for a pathogen is dramatically reduced. Our results show that direction and community structure are limiting factors for disease spread.

15 min. break

SOE 14.6 Wed 12:15 GÖR 226

Are motifs a myth? — •Jörg Reichardt[1], Roberto Alamino[2], and David Saad[2] — [1]Complexity Sciences Center, UC Davis and Würzburg University — [2]Aston University, Birmingham

Small subgraphs, called network motifs, have received considerable attention in network research over the last years and are suggested as simple building blocks of complex networks. Motifs are attributed functional significance due to their strong over- or underrepresentation when compared to random null models. However, the link randomized null models used for such comparisons generally match the observed networks only in terms of their microscopic structure, destroying all mesoscopic features and hence give biased estimates of the statistical significance of motif counts in real world networks.

We present a generative probabilistic model based on Exponential Random Graphs plus an algorithm to infer model parameters from a given network. This model allows to generate an ensemble of random null models that matches the observed network with respect to both its microscopic *and* mesoscopic structural features.

We show that such random null models may result in a much more conservative estimation of the statistical significance of motif counts in real world networks. Further, they maintain the parsimonious explanation of complex networks as a collection of conditionally independent edges.

SOE 14.7 Wed 12:30 GÖR 226

Is there a bias in the generation of simple random graphs with the configuration model? — •Hendrike Klein-Hennig and Alexander K. Hartmann — Institute of Physics, University of Oldenburg

The configuration model is an often used and well known procedure to generate random graphs with an arbitrary degree sequence. The basic idea is to assign a fixed degree to each vertex, which create edges emerging from the vertex called stubs. In a second step random pairs of stubs are connected until there are no stubs left. This procedure generates every possible graph realization with the same probability. In this work two generation procedures are compared how to deal with self-loops and multiple edges (forbidden edges) to generate undirected simple graphs. In the first procedure the entire graph is disregarded and the generation process is restarted from the beginning as soon as a forbidden edge is encountered. Another method, which is frequently applied [1], is to disregard only the forbidden edge, restoring the stubs and drawing a new pair, while keeping the rest of the graph. An analysis of small example graphs shows that for the second generation procedure the graphs are not necessarily created with equal probability. For large graph sizes the behavior is studied using statistical tests on computer generated graphs [2].

[1] M.Catanzaro, M.Boguñá and R. Pastor-Satorras, *Generation of uncorrelated random scale-free networks*, Phys. Rev. E *71* 027103 (2005)

[2] A.K. Hartmann, *Practical Guide to Computer Simulations*, (World Scientific, 2009)

SOE 14.8 Wed 12:45 GÖR 226

Surrogates and significance testing for spatially embedded complex networks — •Jonathan F. Donges[1,2], Reik V. Donner[1], Norbert Marwan[1], and Jürgen Kurths[1,2] — [1]Potsdam Institute for Climate Impact Research, P.O.Box 60 12 03, 14412 Potsdam, Germany — [2]Department of Physics, Humboldt University of Berlin, Newtonstr. 15, 12489 Berlin, Germany

The analysis of spatially embedded complex networks, i.e., networks

with vertices embedded in a metric space, is of increasing interest in many fields of science. Examples are power grids in electrical engineering, the internet and world wide web in computer science or social networks in social science. In many cases, there is some degree of uncertainty about the network structure, e.g., edges might be missing in the network that exist in the system under study (the opposite may also be true). This is particularly relevant for networks constructed from multivariate data using the tools of time series analysis. Given this uncertainty, it is very important to evaluate the significance of measured network properties such as clustering coefficient, average path length, degree distribution or various vertex centrality sequences with respect to a given null hypothesis. Here we present different types of surrogates for spatially embedded networks, i.e., random networks with prescribed spatial constraints such as fixed edge distance distribution or a fixed average edge distance sequence, and show how to use them for testing the associated null hypotheses. The method is illustrated using diverse example networks, e.g., the european power grid or a climate network representing correlation structure of the surface air temperature field.

SOE 14.9 Wed 13:00 GÖR 226

Backbones and borders from shortest-path trees — •Daniel Grady, Christian Thiemann, and Dirk Brockmann — Northwestern University, Evanston, IL, USA

One of the most important tasks in complex network research is to distinguish between vertices and edges that are topologically essential and those that are not. To this end, a variety of vertex and edge centrality measures have been introduced, ranging from measuring local properties (degree, strength) to quantities that depend on the global structure of the graph (betweenness). Here we introduce a novel technique based on the family of shortest-path trees, which is applicable to strongly heterogeneous networks. This approach can identify significant edges in the network, distinct from conventional edge betweenness, and these edges make up a network backbone relevant to dynamical processes that evolve on such networks. We will show that important network structures can be extracted by investigating the similarity and differences of shortest-path trees and show that tree dissimilarity in combination with hierarchical clustering can identify communities in heterogeneous networks more successfully than ordinary reciprocal-weight distance measures. We demonstrate the success of this technique on complex multi-scale mobility networks.

SOE 15: Economic Models and Evolutionary Game Theory I (with BP, DY)

Time: Wednesday 14:00–15:15 Location: GÖR 226

SOE 15.1 Wed 14:00 GÖR 226

When does a professional foul in soccer pay off? — •Metin Tolan — Fakultät Physik, TU Dortmund, metin.tolan@tu-dortmund.de

In soccer, a professional foul is a deliberate act of foul play to prevent an opponent's goal. Such a professional foul is punished by a mandatory red card and the team is thus reduced by one player for the rest of the time. This reduction in the number of players obviously reduces the performance of the team. However, if this reduction happens during the last minute of the game it is almost certain that it pays off since the opponent will not score two goals or more in the remaining time. On the other hand, if the professional foul happens in the first minute then it is likely that the opponent scores more than one goal in the 89 minutes to follow since it is a game 11 vs. 10 for a rather long time. Therefore, there must be a certain minute t_{pf} so that a professional foul pays off for $t > t_{pf}$ and not for $t < t_{pf}$. This minute will be calculated with a simple model based on the scoring rates of professional soccer teams. The result will be discussed and compared with famous actual and past professional fouls.

SOE 15.2 Wed 14:15 GÖR 226

Rating Team Strength in Soccer Leagues by Elo Numbers — •Oliver Rubner and Andreas Heuer — Institute of Physical Chemistry, University of Muenster, Germany

Measuring the relative performance in sports where opponents are playing matches against each other is a diffcult and often unsatisfactory task. This is mainly due to the restricted number of matches played and the influence of chance on the outcome of each match. In many sports there is a system of points which are attributed to the teams according to a won, lost or draw match. From these points a table is constructed that should reflect the relative fitnesses of the teams. These approaches are by no means unique and often simlpy historically motivated. An example where the ranking follows a mathematically elaborate computational scheme is the Elo ranking in chess[1]. The key of this scheme is the computation of a win probability function from the so called Elo number which is changed after every match by taking into account the relative strength of the opponent. In this scheme enter two or three parameters which need to be determined.

We will present an iterative procedure to determine the win probability function for soccer leagues and derive a method to compare different measures of team strength such as Elo numbers, points or goal differences.

[1] Elo, Arpad, The Rating of Chessplayers, Past and Present, Arco Pub. 1978.

SOE 15.3 Wed 14:30 GÖR 226

Soccer between the 1st and the 90th minute: is it a Markov process? — •Andreas Heuer and Oliver Rubner — Institute of Physical Chemistry, University of Muenster

In previous work we have developed a theoretical understanding of the fitness of a team and its influences on the outcome of a specific match [1,2]. Here we analyse whether or not non-Markovian effects are present *within* a single match. Does the future course of a soccer match depend on the present score, on the time when the last goal was scored, on the team which scored the last goal? If all these and similar questions find a negative answer one can indeed speak of a Markovian process. In this case soccer would be very similar to tossing a coin, at least from a statistical point of view.

Studying all matches during the last 20 seasons of the German Bundesliga we find that most but not all questions find a negative answer. A simple psychological explanation is suggested which may account for the observed deviation from Markovian behavior.

[1] A. Heuer, O. Rubner, Eur. Phys. J. B **67**, 445 (2009).

[2] A. Heuer, C. Müller, O. Rubner, Europhys. Lett. **89**, 38007 (2010).

SOE 15.4 Wed 14:45 GÖR 226

The value of information in strategic interaction — •Eckehard Olbrich[1], Nils Bertschinger[1], David Wolpert[2], and Jürgen Jost[1] — [1]Max Planck Institut für Mathematik in den Naturwissenschaften, Leipzig — [2]NASA Ames Research Center

In games against nature information always has a positive value, i.e. knowing more increases the single player's utility. However in situations with more than one strategic player having more information can be disadvantageous to a player, if the other players know about this extra information. Games with a first mover advantage are a simple example. However, Bagwell [1] showed that this effect of extra information on player behavior and payoffs could be destroyed by an infinitesimal amount of observational noise when players are fully rational. We study the effects of information in a more general setting, by using the Quantal Response Equilibria (QRE) as the (bounded rationaity) solution concept. By using the QRE we can exploit tools from information theory to rephrase the problem of the value of information in terms of rate distortion theory. In particular, we can analyze how the position of the QRE's depend on the capacity of the information channels connecting the players and Nature variables, and on the rationalities of the players. We focus on hysteresis effects in this dependence, and its impact on social welfare.

[1] K. Bagwell, Commitment and Observability in Games, Games and Economic Behavior 8, 271-280 (1995) [2] D. H. Wolpert, M. Harre, E. Olbrich, N. Bertschinger, J. Jost, Hysteresis effects of changing parameters of noncooperative games, arXiv:1010.5749v1 [cs.GT]

SOE 15.5 Wed 15:00 GÖR 226

The Overlooked Effect of Stating One's Own Risk Preferences on Subsequent Decision Choices: Evidence of Inherent Indeterminacy of Risk Preferences from a Laboratory Experiment — •Lora Todorova and Bodo Vogt — Otto-von-Guericke

Universität Magdeburg, Faculty of Economics and Management, P. O. Box 4120, D-39016 Magdeburg, Deutschland

With the help of a laboratory experiment we try to test the predictions of quantum game theory. We show that answering a questionnaire about one's own risk preferences before playing a 2x2 coordination game changes subjects' strategy choices as compared to the case when the 2x2 coordination game is directly played. We argue that the act of answering the questionnaire alters subjects' risk preferences which further induce a change in their strategic behavior. The mathematical formalism of quantum mechanics is used to explain our findings. It is shown that the quantum game theory framework is a more powerful tool for analyzing strategic behavior than standard economic theories.

SOE 16: Networks: From Topology to Dynamics III (with BP, DY)

Time: Wednesday 15:30–17:00 Location: GÖR 226

SOE 16.1 Wed 15:30 GÖR 226

Traveling Salesman Problem with Clustering — •Johannes Josef Schneider[1], Thomas Bukur[2], and Antje Krause[2] — [1]Department of Physics, Mathematics, and Computer Science, Johannes Gutenberg University of Mainz, Staudinger Weg 7, 55099 Mainz, Germany — [2]Fachhochschule Bingen – University of Applied Sciences, 55411 Bingen, Germany

In the original traveling salesman problem, the traveling salesman has the task to find the shortest closed tour through a proposed set of nodes, touching each node exactly once and returning to the initial node at the end. For the sake of the tour length to be minimized, nodes close to each other might not be visited one after the other but separated in the tour. However, for some practical applications, it is useful to group nodes to clusters, such that all nodes of a cluster are visited contiguously. Here we present an approach which leads to an automatic clustering with a clustering parameter governing the sizes of the clusters.

[1] Johannes J. Schneider, Thomas Bukur, and Antje Krause, Traveling Salesman Problem with Clustering, J. Stat. Phys. 141, 767-784, 2010.

SOE 16.2 Wed 15:45 GÖR 226

Importance of Industrial Sectors within the Overall Economy — •Christian Hirtreiter[1] and Johannes Josef Schneider[2] — [1]Faculty of Physics, University of Regensburg, 93040 Regensburg, Germany — [2]Department of Physics, Mathematics, and Computer Science, Staudinger Weg 7, 55099 Mainz, Germany

We have a look at the overall economy of a state focussing on the exchange of goods and services between the various sectors of that economy. Depending on the market theory, either the best seller (the sector selling the largest value of goods and services to other sectors) or the best buyer (the sector buying the largest value of goods and services from other sectors) is the most important sector within the overall economy. We generate a sequence of sectors depending on their importance using the exchange matrix between these sectors. Furthermore, we show that this problem is an extreme case of the Traveling Salesman Problem with Clustering, which was recently introduced by us [1].

[1] Johannes J. Schneider, Thomas Bukur, and Antje Krause, Traveling Salesman Problem with Clustering, J. Stat. Phys. 141, 767-784, 2010.

SOE 16.3 Wed 16:00 GÖR 226

Emergent bipartiteness in an adaptive social network — •Charo Del Genio and Thilo Gross — Max-Planck-Institut für Physik komplexer Systeme – Nöthnitzer Straße 38 – D-01187 Dresden – Deutschland

Representing complex systems as adaptive networks has become a very important method for analysing the properties of many real-world networks, with fields of application ranging from epidemiology to the Internet to social sciences.

We present a model of a social network in which the nodes belong to two different species, which we call "truthfuls" (T) and "liars" (L) and the existence or permanence of a link between next-neighbouring nodes is determined by the "advice" of the common neighbour. In particular, an agent node connects to one of its next-neighbours, or maintains a link with it, if the common neighbour reports the target node as truthful. Vice versa, the link is removed if the common neighbour reports the target node as a liar. Also, truthfuls always state the real species of a target node, while liars always report the false.

We show that if the fractions of truthfuls and liars are close enough, the network self organizes in a perfectly bipartite graph. On the other hand, if the excess of one of the two species is greater than a size-dependent critical value, the network splits into two components, of which one is bipartite and the other contains only the excess species and is densely connected.

SOE 16.4 Wed 16:15 GÖR 226

The emergence of critical behavior in evolving economies — João da Cruz[1,2] and •Pedro Lind[1,3] — [1]Departamento de Física, Faculdade de Ciências da Universidade de Lisboa, 1649-003 Lisboa, Portugal — [2]Closer Consultoria Lda, Avenida Engenheiro Duarte Pacheco, Torre 2, 14º-C, 1070-102 Lisboa, Portugal — [3]Center for Theoretical and Computational Physics, University of Lisbon, Av. Prof. Gama Pinto 2, 1649-003 Lisbon, Portugal

We address the controversy in the study of financial systems, sometimes taken as brownian-like processes and other as critical systems with fluctuations of arbitrary magnitude, by introducing a model of financial networks which reproduces critical behavior. The model considers a collection of economical agents which establish trade connections among them according to basic economical principles properly translated into physical properties and interaction. Agents accumulate asset or liability by means of internal energy storage, as a product of energy balance that takes into account the labor performed by the agent and the payment it gets in return. With such model we are able to reproduce the evolution of macroscopic quantities, namely the logarithmic return of the total internal energy taken as a financial index. Furthermore, we correctly retrieve the common exponent value characterizing several indices in financial markets.

SOE 16.5 Wed 16:30 GÖR 226

Evolutionary dynamics and conditional cooperation in the iterated prisoner's dilemma — •Jelena Grujić, José A. Cuesta, and Angel Sánchez — Grupo Interdisciplinar de Sistemas Complejos (GISC), Departamento de Matemáticas, Universidad Carlos III de Madrid, Leganés, Madrid, Spain,

We have recently performed an experiment to test the emergence of cooperation in the presence of an underlying structure [Grujic et al., PLoS ONE 5(11): e13749 (2010)]. Human subjects played a PD with each of their neighbors in a 13x13 square lattice. The results show that the population consisted of cooperators and defectors, who respectively cooperate or defect with high probability regardless of their and their neighbors' previous actions, and conditional cooperators, whose behavior does depend on those previous actions.

Here we take a first step towards an evolutionary explanation of the experimental results. Specifically, we use replicator dynamics to describe the evolution of a set of strategies that mimics the observations, in a simplified context consisting of a well-mixed population of players confronted in iterated Prisoner's Dilemma games. The dynamics exhibits two attractors: one for a population consisting only of defectors, and an interior point with population frequencies comparable to those observed in the experiment. The former has a much smaller basin of attraction than the latter, which therefore becomes the most probable evolutionary outcome. This is the first hint that the experiment may be amenable to an evolutionarily explanation.

SOE 16.6 Wed 16:45 GÖR 226

The role of short-cuts for the emergence of cooperation in random topologies. — •Daniele Vilone[1], Angel Sánchez[1], and Jesús Gómez-Gardeñes[2] — [1]GISC - Mathematics Department, Universidad Carlos III de Madrid, Spain — [2]Biocomputation and Complex Systems Institute, Universidad de Zaragoza, Spain

We present a detailed study about the role of the short-cuts of a network in promoting the emergence of cooperation in a population of agents playing the Prisoner's Dilemma Game (PDG). We introduce a model which allows to tune the topology of the system from the

one-dimensional euclidean lattice (a ring) to the complete graph just changing the value of one parameter (the probability p to add a link between two nodes not already connected in the euclidean configuration). We show that there is a region of values of p in which cooperation is largely enhanced, whilst for smaller values of p only a few cooperators are present in the final state, and for p->1 cooperation is totally suppressed. We present analytical arguments that provide a very plausible interpretation of the simulation results. Our work makes it clear how short-cuts can be decisive in promoting (or suppressing) cooperation in the absence of other mechanisms such as clustering. Implications for other dynamics are also drawn.

SOE 17: Socio-Economic Systems

Time: Wednesday 17:15–18:00 Location: GÖR 226

SOE 17.1 Wed 17:15 GÖR 226

Tipping Points and Cascading Pathways in Climate-Society Interaction — •Jürgen Scheffran and Jasmin Kominek — ZMAW, KlimaCampus, Universität Hamburg

Climate change affects the life of human beings and may have larger societal effects, by undermining the infrastructures of society or by inducing destabilizing human responses and social interaction patterns. An increase in global temperature above a threshold may lead to cascading pathways and tipping points, possibly triggering a cycle of environmental degradation, economic decline, social unrest and political instability. Whether individual agents and social networks are able to cope with the climate impacts will depend on their responses and abilities to adapt to or solve associated problems. To analyse these processes systematically, an integrated assessment framework of climate-society interactions uses concepts and methods of complex systems analysis. The complex causal chains can be constructed through a network of interconnections based on the sensitivities between key variables and actions. Analysis of the dynamic interaction model and its stability provides indications for developing approaches for early warning systems and risk reduction.

SOE 17.2 Wed 17:30 GÖR 226

Correlations between Human Development and CO2 emissions: projections and implications — •Diego Rybski, Luis Costa, and Jürgen P. Kropp — Potsdam Institute for Climate Impact Research (PIK), P.O. Box 60 12 03, 14412 Potsdam, Germany

Although developing countries are called to participate on the efforts of reducing CO2 emissions in order to avoid dangerous climate change, the implications of CO2 reduction targets in human development standards of developing countries remain a matter of debate. We find positive and time dependent correlation between the Human Development Index (HDI) and per capita CO2 emissions from fossil fuel combustion. Based on this empirical relation, extrapolated HDI, and three population scenarios extracted from the Millennium Ecosystem Assessment report, we estimate future cumulative CO2 emissions. If current demographic and development trends are maintained, we estimate that by 2050 around 85% of the world's population will live in countries with high HDI (above 0.8) as defined in the United Nations Human Development Report 2009. In particular, we estimate that at least 300Gt of cumulative CO2 emissions between 2000 and 2050 are necessary for the development of developing countries in the year 2000. This value represents 30% of a previously calculated CO2 budget yielding a 75% probability of limiting global warming to 2°C. Since human development has been proved to be time and country dependent, we plead for future climate negotiations to consider a differentiated CO2 emissions reduction scheme for developing countries based on the achievement of concrete development goals.

SOE 17.3 Wed 17:45 GÖR 226

Measuring Non-Quantitative Parameters - A Source for Enriching Socioeconomic Physics? — •Alexander an Haack, Paul Flachskampf, and Sabina Jeschke — Institute for Management Cybernetics e. V., Associate Institute of RWTH Aachen University, Germany

Over the past two decades, the discipline of socioeconomic physics has spread its reach from analyzing stock market behavior to collective opinion formation to road traffic. One constant within its use cases has been the availability of quantitative data. By applying statistical physics via modern age computation to vast amounts of socioeconomic data, this young discipline has managed to create insights, which were not feasible through the classical methods of econometrics. Yet, socioeconomic systems are by definition based on psychological and social phenomena, which commonly cannot be directly measured on interval or ratio scales. As management cybernetics scientists, with years of experience in interpreting corporate soft facts, we will share our knowledge about the quantitative approximation of non-quantitative socioeconomic parameters with the Phi-SOE community. In order to enrich the existing physical analysis of socioeconomic systems, we present our taxonomy for the evaluation of quantifying measurement methods as well as one of their successful examples (NOWS).

SOE 18: Financial Markets and Risk Management I

Time: Thursday 10:15–13:15 Location: GÖR 226

SOE 18.1 Thu 10:15 GÖR 226

The dynamics of the World Income distribution — Faustino Prieto and •Jose Maria Sarabia — University of Cantabria, Santander, Spain.

In this paper, the dynamics of the World Income distribution is studied. The World Income distribution is considered in terms of the Gross Domestic Product (GDP), GDP per capita, GDP at purchasing power parity power (PPP) and GDP-PPP per capita. The country information data is taken from the International Monetary Fund (IMF) for the period 1980 to 2005.

Six different probabilistic distributions are fitted and compared: lognormal, Singh-Maddala, Dagum, Tsallis, classical Pareto and Pareto positive stable (PPS) distributions.

All of these six models are fitted by maximum likelihood. In order to studied several hypotheses, a rolling sample methodology is implemented. This methodology enables to study the sensitivity of the results with respect to the number of the countries included in the sample as well as to analyze the power-law behavior in the upper tail of the distribution.

The different models are compared using the Akaike information criterion (AIC). The PPS and lognormal distributions provide the best fit. The model validation is done by using different types of graphics, including Q-Q and log-log rank-size plots.

Finally, the PPS distribution is used to analyze the dynamics of the World Income distribution, establishing a comparison with the IMF predictions.

SOE 18.2 Thu 10:30 GÖR 226

Record statistics in financial data — •Gregor Wergen, Miro Bogner, and Joachim Krug — Institut für Theoretische Physik, Universität zu Köln

We consider the occurrence of record-breaking events in asymmetric random walks and compare our results to financial data from the Standard and Poors index. Making use of the Sparre Andersen Theorem we analyze the first-passage probabilities of asymmetric random walks and give some new analytical results on the record statistics of such processes. Most importantly we can quantify the effect of a linear drift in the random walk on the occurrence of records. Our model allows us to explain the statistics of upper records in the daily stock data. However, we find that the number of lower records in the stock prices is significantly decreased. We tentatively explain this effect by performing a detailed analysis of the persistence properties of the stock

prices.

SOE 18.3 Thu 10:45 GÖR 226

Dominating clasp of the financial sector revealed by partial correlation analysis of the stock market — •Dror Kenett[1], Michele Tumminello[2], Asaf Madi[1], Gitit Gur-Gershgoren[3], Rosario Mantegna[2], and Eshel Ben-Jacob[1] — [1]School of Physics and Astronomy, Tel-Aviv University, Israel — [2]Dipartimento di Fisica e Tecnologie Relative, Universit'a di Palermo, Palermo, Italy — [3]Israel Securities Authority, Jerusalem, Israel

What are the dominant stocks which drive the correlations present among stocks traded in a stock market? Can a correlation analysis provide an answer to this question? We introduce a new concept to tackle the above question - the partial correlation network. Partial correlation is a measure of how the correlation between two variables, e.g. stock returns, is affected by a third variable. By using it we define a proxy of stock influence, which is then used to construct partial correlation networks. The empirical part of this study is performed on a specific financial system, namely the set of 300 highly capitalized stocks traded at the New York Stock Exchange, in the time period 2001-2003. By constructing the partial correlation network, unlike the case of standard correlation based networks, we find that stocks belonging to the financial sector and, in particular, to the investment services sub-sector, are the most influential stocks affecting the correlation profile of the system. Our findings shed a new light on the underlying mechanisms and driving forces controlling the correlation profile observed in a financial market.

SOE 18.4 Thu 11:00 GÖR 226

Heterogeneity in individual price impact — •Alex Bladon[1], Tobias Galla[1], and Esteban Moro[2] — [1]Theoretical Physics Dept. University of Manchester, Oxford Road, Manchester, UK, M13 9PL — [2]Departament de Matemáticas, Universidad Carlos III de Madrid, 28911, Leganés, Spain

The study of financial time series has become a substantial area of research thanks to the large amount of available data. However, the majority of this data contains no information about what traders are associated with any one transaction. Hence there is little empirical information on the behaviour of individuals on financial markets. We here present an analysis of data from the Spanish stock market capturing this individual level information, linking each trade to the IDs of the firms involved.

We use this data to investigate how individual firms manage price impact. Price impact describes the change in the price of a stock due to a trades of different sizes - a phenomenon studied at length at the market level. We show that there is a high degree of heterogeneity in the instantaneous price impact functions of individuals and find evidence suggesting the use of selective liquidity taking. We also consider time-dependent price impact, as measured by response functions. Bouchaud et al propose a market-level bare impact function (Quantitative Finance, Vol. 4, 176-190, 2004) describing how markets digest trades over time. We test the applicability of this global model to individual agents and ask how strongly response functions depend on what individuals were involved in the transaction triggering the response.

SOE 18.5 Thu 11:15 GÖR 226

Tobin Tax in Minority Game Market Models — •Josephine Mielke, Felix Patzelt, and Klaus Pawelzik — Institute for Theoretical Physics, Department Neurophysics, University of Bremen, Bremen, Germany

The introduction of the Tobin Tax is discussed as a financial tool to reduce speculation and short-term trading at foreign exchange (FX) markets, to reduce large fluctuations and thereby to protect national currency stability.

Minority Games serve as minimal models of financial markets. In particular, they reproduce the power-law distributed return fluctuations (stylized facts) by operating close to a phase transition.

In order to include the Tobin Tax we propose to extend a Minority Game market model to include a trading mechanism, fundamentalists and speculators ('chartists'). When chartists are endowed with limited resources and subjected to the tax we observe, that FX rate fluctuations decrease. A reduced number of speculators remain in the market exploiting the increased predictability. Fundamentalists with unlimited resources are not affected by the tax as they function as liquidity suppliers. They correspond to investment banks at real FX markets which do not participate in short-term trades. We find an intermediate tax which maximizes tax revenue and noticeably reduces market fluctuations.

15 min. break

SOE 18.6 Thu 11:45 GÖR 226

Solutions of nonlinear stochastic differential equations with long-range power-law distributions — •Julius Ruseckas, Vygintas Gontis, and Bronislovas Kaulakys — Institute of Theoretical Physics and Astronomy, Vilnius University, A. Gostauto 12, LT-01108 Vilnius, Lithuania

A class of nonlinear stochastic differential equations, providing the long-range processes, the power-law behavior of spectra, including $1/f$ noise, and the power-law distributions of the probability density has been proposed [1] and solved [2]. The models involve the Generalized Constant Elasticity of Variance Process, the Bessel Process and the Squared Bessel Process, which are applied for modeling of the financial markets [3].

[1] B. Kaulakys, J. Ruseckas, V. Gontis and M. Alaburda, Physica A **365**, 217 (2006); B. Kaulakys and M. Alaburda, J. Stat. Mech. P02051 (2009).

[2] J. Ruseckas and B. Kaulakys, Phys. Rev. E **81**, 031105 (2010).

[3] V. Gontis, J. Ruseckas and A. Kononovicius, Physica A **389**, 100 (2010).

SOE 18.7 Thu 12:00 GÖR 226

The origin of Pareto law in house price distribution — •Takaaki Ohnishi[1,2], Takayuki Mizuno[3,1], Chihiro Shimizu[4], and Tsutomu Watanabe[3,1] — [1]The Canon Institute for Global Studies, Tokyo, Japan — [2]Graduate School of Economics, The University of Tokyo, Tokyo, Japan — [3]Institute of Economic Research, Hitotsubashi University, Tokyo, Japan — [4]Faculty of Economics, Reitaku University, Chiba, Japan

We empirically investigate the house price distributions in the Greater Tokyo Area by using a unique dataset containing individual listings of 724,416 condominiums from 1986 to 2009 [1]. The house price follows a Pareto (power-law) distribution. On the other hand, the house size follows an exponential distribution, which is explained by maximizing the entropy (the number of variety of house sizes) subject to the constraint of a fixed total size of all houses.

We find a positive linear relationship between the log price and the size. This is justified by the fact that size-adjusted prices follow a lognormal distribution except for the housing bubble periods. By considering the location of a house as an additional attribute, the distribution of size-adjusted price is close to a lognormal distribution even in bubble periods.

Pareto law in house price distribution can be considered to be generated by the exponential distribution of house size and the linear relationship between the log price and the size.

[1] T. Ohnishi, T. Mizuno, C. Shimizu and T. Watanabe, "On the Evolution of the House Price Distribution", preprint (2010).

SOE 18.8 Thu 12:15 GÖR 226

Statistical Mechanics of a spin stock market model — •Sebastian Krause and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen, Otto-Hahn-Allee, 28359 Bremen

The prices of stocks and other financial assets show a typical behavior, known as stylized facts. One example is the power law distribution of the logarithmic absolute returns, wich means that big changes are more common than in a Gaussian random walk, hence there is more risk.

For a better understanding of the emergence of stylized facts from local behavior, the study of agent based models with specific statistical properties is reasonable. We here investigate a magnetic spin model, which is known to reproduce several stylized facts [1]. We identify the mechanism, which leads to power law distributed returns, especially considering finite size effects, and find a crossover in the model dynamics. Our findings also shed some light on the fact that power laws can be found for different time scales with increasing volatility (hence risk) for larger times, reflecting the same property in real markets.

[1] 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; T. Kaizoji, S. Bornholdt, Y. Fujiwara, Dynamics of price and trading volume in a spin model of stock markets with heterogeneous agents, Physica A 316 (2002) 441-452

SOE 18.9 Thu 12:30 GÖR 226

Dependence of defaults and recoveries in credit risk models — •Rudi Schäfer[1] and Alexander Koivusalo[2] — [1]Fakultät für Physik, Universität Duisburg-Essen, Germany — [2]Danske Capital, Copenhagen, Denmark

In view of the recent financial crises the modelling of credit risk is of great importance. There are two fundamentally different modelling approaches: the structural approach which derives both default events and recovery rates from the value of an underlying process at maturity time. And the reduced form approach where defaults and recovery rates are modelled independently. First, we discuss the structural model with correlated diffusion analytically. We find a functional relation between default probabilities and recovery rates with only a single parameter. Although derived for the diffusion case, we demonstrate in Monte-Carlo simulations that the same relation also holds for other processes in very good approximation. We discuss how to incorporate this relation into reduced form models, in order to restore essential structural information which is usually neglected in the reduced form approach.

SOE 18.10 Thu 12:45 GÖR 226

LPM method for portfolio optimization: theory and praxis — •Uli Spreitzer[1] and Vladimir Reznik[2] — [1]Bonus Pensionskassen AG, Traungasse 14-16, 1030 Vienna, Austria — [2]Towers Watson Deutschland GmbH, Abraham-Lincoln-Str. 22, 65189 Wiesbaden, Germany

The well known discussion on what is the most reasonable measure of risk (e.g. not VaR, Artzner [1]) many fund companies (or Pensionskasse in Austria) still use the variance based optimisation strategies. As we suggested, other measures as e.g. lower partial moments LPM may be much more suitable. Most because this measure covers the economic risk much better. Some time ago a fund suitable for pension funds uses this LPM method with excellent results during the financial crisis 2008 - 2010. We will explain, why this method is so successful

[1] P. Artzner, F. Delbaen, J.M. Eber, and D. Heath, Coherent measures of risk. Mathematical Finance, 9: 203ff,1999.

[2] MAARK funds of West LB Mellon

[3] U.W. Spreitzer and V. Reznik, On the optimization of a CAPM portfolio using lower partial moments as measure of risk and using the possibility of safeguarding its loss, Physica A: 378, 2, 423ff, 2007

SOE 18.11 Thu 13:00 GÖR 226

Some considerations on scaling of measures of risk with time — Uli Spreitzer[1] and •Thomas Riepl[2] — [1]Adertshausen 5, 92277 Hohenburg, Germany — [2]Thomas-Mann-Str. 22, 93077 Bad Abbach, Germany

Beside the well known discussion on what is the most reasonable measure of risk (e.g. not VaR, Artzner [1]) investment funds must face the problem that they have cash flow with a certain granularity, and they must optimize using risk measures, which used as input data with a certain granularity. Risk measures are according to Brown movement is used. Using data from several stock indices we show, that this scaling is insufficient and underestimates the increase of these risk measures with time. This in accordance with other results [2]

[1] P. Artzner, F. Delbaen, J.M. Eber, and D. Heath. Coherent measures of risk. Mathematical Finance, 9: 203ff,1999.

[2] Jón Daníelsson, Jean-Pierre Zigrand, On time-scaling of risk and the square-root-of-time rule, Journal of Banking and Finance, 30, 10, 2701ff (2006)

SOE 19: Economic Models and Evolutionary Game Theory II (with BP, DY)

Time: Thursday 14:00–15:00 Location: GÖR 226

SOE 19.1 Thu 14:00 GÖR 226

learning, evolution and population dynamics — juergen jost and •wei li — Max-Planck-Institute for Mathematics in the Sciences

We study a complementarity game as a systematic tool for the investigation of the interplay between individual optimization and population effects and for the comparison of different strategy and learning schemes. The game randomly pairs players from opposite populations. It is symmetric at the individual level, but has many equilibria that are more or less favorable to the members of the two populations. Which of these equilibria is then attained is decided by the dynamics at the population level. Players play repeatedly, but in each round with a new opponent. They can learn from their previous encounters and translate this into their actions in the present round on the basis of strategic schemes. The schemes can be quite simple, or very elaborate. We can then break the symmetry in the game and give the members of the two populations access to different strategy spaces. Typically, simpler strategy types have an advantage because they tend to go more quickly toward a favorable equilibrium which, once reached, the other population is forced to accept. Also, populations with bolder individuals that may not fare so well at the level of individual performance may obtain an advantage toward ones with more timid players. By checking the effects of parameters such as the generation length or the mutation rate, we are able to compare the relative contributions of individual learning and evolutionary adaptations.

SOE 19.2 Thu 14:15 GÖR 226

When does stochastic learning in game theory fixate ? — John Realpe-Gomez[1], Bartosz Szczesny[2], Luca Dall'Asta[3], and •Tobias Galla[4] — [1]Politecnico di Torino, Corso Duca degli Abbruzzi 24, 10129 Torino, Italy — [2]University of Leeds, Department of Applied Mathematics, School of Mathematics, Leeds LS2 9JT, UK — [3]The Abdus Salam International Centre for Theoretical Physics, Strada Costiera 11, 34014 Trieste, Italy — [4]University of Manchester, School of Physics and Astronomy, Manchester M13 9PL, UK

Evolutionary dynamics in finite populations is known to fixate eventually in the absence of mutation. We here show that a similar phenomenon can occur in stochastic learning of a fixed set of players interacting repeatedly in a given game. We study in detail the mechanisms behind these absorption phenomena, in particular we present analytical predictions for the resulting fixation times and provide a detailed comparison with fixation in evolutionary dynamics. Specific examples are discussed, including simple two-player games, but also multi-player games defined on networks, resulting in more complicated interaction structures. In the final part of the talk I will discuss an imitation dynamics leading to absorption at fixed points in the interior of strategy space, a phenomenon not usually observed in standard models of evolutionary dynamics.

SOE 19.3 Thu 14:30 GÖR 226

How small are small mutation rates ? — Bin Wu[1,2], •Chaitanya Gokhale[1], and Arne Traulsen[1] — [1]Research Group for Evolutionary Theory, Max-Planck-Institute for Evolutionary Biology, August-Thienemann-Str. 2, 24306 Plön, Germany — [2]Center for Systems and Control, State Key Laboratory for Turbulence and Complex Systems, College of Engineering, Peking University, Beijing, China

In recent years numerous analytical advances have been made in the field of evolutionary game theory. Some of them consider processes in which strategies can mutate between each other. Often the assumption of small mutation rates is made to keep the analysis tractable [1,2,3]. For small mutation rates the population is monomorphic most of the time. Occasionally a mutation arises. It can either reach fixation or go extinct. The evolutionary dynamics of the process under small mutation rates can be approximated by an embedded Markov chain on the pure states. Previously it was shown that in the limit of mutation rates going to zero the embedded Markov chain is a good approximation [4]. Here we derive an upper limit until where the approximation holds good. For a coexistence game it is *necessary* that the mutation rate μ is less than $N^{-1/2}\exp[-N]$ and for *all other* games, it is *sufficient* if the mutation rate is smaller than $(N \ln N)^{-1}$. Our results hold for a wide class of imitation processes under arbitrary selection intensity.

References: [1] Hauert C *et al.*, Science 316, 2007. [2] Van Segbroeck S *et al.*, Phys Rev Lett 102:058,105, 2009. [3] Sigmund K *et al.*, Nature 466, 2010. [4] Fudenberg D, Imhof LA, J Econ Theory 131, 2006.

SOE 19.4 Thu 14:45 GÖR 226

Universality of weak selection — Bin Wu[1,2], •Philipp M. Altrock[1], Long Wang[2], and Arne Traulsen[1] — [1]Max-Planck-Institute for Evolutionary Biology, Plön — [2]College of Engineering, Peking University, Beijing

Weak selection, which means a phenotype is slightly advantageous over another, is an important limiting case in evolutionary biology. Recently it has been introduced into evolutionary game theory. In evolutionary game dynamics, the probability to be imitated or to reproduce depends on the performance in a game. The influence of the game on the stochastic dynamics in finite populations is governed by the intensity of selection. In many models of both unstructured and structured populations, a key assumption allowing analytical calculations is weak selection, which means that all individuals perform approximately equally well. In the weak selection limit many different microscopic evolutionary models have the same or similar properties. How universal is weak selection for those microscopic evolutionary processes? We answer this question by investigating the fixation probability and the average fixation time not only up to linear, but also up to higher orders in selection intensity. We find universal higher order expansions, which allow a rescaling of the selection intensity. With this, we can identify specific models which violate (linear) weak selection results, such as the one–third rule of coordination games in finite but large populations.

[1] Wu, Altrock, Wang, and Traulsen, Physical Review E 82, 046106 (2010).

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

Time: Thursday 15:00–17:15 Location: GÖR 226

SOE 20.1 Thu 15:00 GÖR 226

Predicting nodes' influence in Boolean networks — •Fakhteh Ghanbarnejad and Konstantin Klemm — Bioinformatics Group, Institute for Computer Science, Leipzig University, Germany

Boolean networks serve as discrete models of regulatory dynamics in biological cells. In recent years, the Boolean modelling approach has been successfully applied to real systems. A key question in this context is the relevance of a single node for system behaviour. We quantify the dynamical influence of a node as the statistical dependence between the node's initial state and the attractor reached asymptotically. We find that the eigenvector centrality of the network is a good predictor of dynamical influence. It outperforms several other centrality measures, including out-degree, betweenness centrality and k-shell index. Quality of prediction is further improved when eigenvector centrality is based on the weighted matrix of activities rather than pure adjacencies.

SOE 20.2 Thu 15:15 GÖR 226

Activity dependent criticality and threshold networks closer to biology — •Matthias Rybarsch and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen, Otto-Hahn-Allee, 28359 Bremen

Spin models of neural networks and genetic networks are simple and elegant and benefit from the statistical mechanics toolkit developed for spin glasses and magnetic systems. However, the conventional choice of variables in spin systems may cause problems in some models of biological systems when parameter choices and normalizations are unrealistic. We here consider a prototypical network model, that is biologically plausible in the local mechanisms represented in the model with each node locally defined and no non-local fine tuning required. As a result this model yields biologically plausible ensemble statistics for randomly wired networks. We explore the critical properties of such random networks and find a more realistic behavior as compared to random Boolean networks or classical spin versions of threshold networks. Finally we observe that the present model allows a simpler implementation of recent models of budding yeast and fission yeast networks.

15 min. break

SOE 20.3 Thu 15:45 GÖR 226

Topological traps and coordination failures on real networks — •Carlos P. Roca[1,2], Sergi Lozano[1], Alex Arenas[3,4], and Angel Sánchez[2,4,5] — [1]Chair of Sociology, in particular of Modeling and Simulation, ETH Zurich, Switzerland — [2]Grupo Interdisciplinar de Sistemas Complejos (GISC), Departamento de Matemáticas, Universidad Carlos III de Madrid, Leganés, Spain — [3]Departament d'Enginyeria Informàtica i Matemàtiques, Universitat Rovira i Virgili, Tarragona, Spain — [4]Instituto de Biocomputación y Física de Sistemas Complejos (BIFI), Universidad de Zaragoza, Spain — [5]Instituto de Ciencias Matemáticas CSIC-UAM-UC3M-UCM, Madrid, Spain

Coordination is a crucial phenomenon in many social and economic systems. We study evolutionary games in real social networks, with a focus on coordination games [1]. We find that populations fail to coordinate in an important number of cases, a feature not observed in most artificial model networks. We show that this result arises from the relevance of correlations beyond the first neighborhood, in particular from topological traps formed by links between nodes of different degrees, in regions with few or no redundant paths. This specificity of real networks has not been modeled so far with synthetic networks, hence we show the need to include these mesoscopic structures to address issues such as the emergence of cooperation in real societies. We claim that topological traps are a very generic phenomenon. which may arise in very many different networks and fields, such as opinion models, spread of diseases or ecological networks.

[1] Roca, Lozano, Arenas and Sánchez, PLoS ONE, in press.

SOE 20.4 Thu 16:00 GÖR 226

Synchronization and stability of power grids with renewable energy sources — •Martin Rohden[1], Andreas Sorge[1], Dirk Witthaut[1], and Marc Timme[1,2] — [1]MPI fuer Dynamik und Selbstorganisation, Göttingen, Deutschland — [2]Bernstein Center for Computational Neuroscience, Göttingen, Deutschland

The integration of renewable energy sources poses severe challenges for power grids of the future because these sources are substantially smaller, more fluctuating and more distributed than fossil-based power plants. We present a detailed numerical study of synchronization speed and stability of complex power grids, based on a recent model [1] derived from basic equations for electric circuits which describes the real dynamics of a power grid. This approach bridges the gap between very detailed but practically intractable power grid models and too abstract ones on the other hand. A stable working alternating-current power grid has to have a fixed frequency and needs to be robust against power fluctuations. We present simulations for different topologies of power grid networks regarding stability against power failures and overall synchronization speed. Furthermore we analyze the integration of renewable power sources into the grid and show the consequences for its stability and synchronization speed.

[1]: G. Filatrella et. al., Eur. Phys. J. B **61**, 485 (2008)

SOE 20.5 Thu 16:15 GÖR 226

Adaptive time-delayed feedback control of unstable fixed points and cluster states in networks — •Judith Lehnert[1], Anton Selivanov[2], Peter Guzenko[3], Philipp Hövel[1], Thomas Dahms[1], Alexander Fradkov[2,3], and Eckehard Schöll[1] — [1]Institut f. Theo. Physik, Technische Universität Berlin — [2]Saint Petersburg State University, Russia — [3]Institute for Problems of Mechanical Engineering, Russian Academy of Sciences

Time-delayed feedback as originally proposed by Pyragas is a simple and efficient scheme for the control of unstable periodic orbits and unstable fixed points. It is non-invasive since it employs the difference of an output signal $s(t)$ and its delayed counterpart $s(t-\tau)$, multiplied by the feedback gain K. In the (K,τ)-plane this gives rise to domains of successful control where the largest Lyapunov exponent becomes negative. Here, we show that it is possible to obtain an optimal value of the feedback gain by applying adaptive control, namely the speed gradient method. Furthermore, we study the role of different initial conditions and show the robustness of our method with respect to noise. We apply our method to stabilize unstable fixed points as well as to reach different M-cluster states in networks. By the latter we refer to a state where the nodes of a network are zero-lag synchronized within M clusters with a constant phase difference between these clusters.

SOE 20.6 Thu 16:30 GÖR 226

The symmetry of group and cluster synchronization — •Thomas Dahms, Judith Lehnert, and Eckehard Schöll — Institut f. Theor. Physik, Sekr. EW 7-1, Technische Universität Berlin,

Hardenbergstr. 36, 10623 Berlin, Germany

We investigate stability of synchronized states in networks where synchronization takes place in cluster states. Using a master stability approach, we find that the master stability function shows a rotational symmetry depending on the number of groups. Topologies that allow for solutions on group or cluster synchronization manifolds show a very similar symmetry in their eigenvalue spectrum, allowing to reduce the extent of the parameter on which the master stability function has to be evaluated. We illustrate our results by calculating stability in the example of delay-coupled semiconductor lasers.

SOE 20.7 Thu 16:45 GÖR 226

Stability and Resonance in Networks of Delay-Coupled Delay Oscillators — •Johannes Höfener[1], Gautam Sethia[1,2], and Thilo Gross[1] — [1]Biological Physics Section, Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Straße 38, Dresden 01187, Germany — [2]Institute for Plasma Research, Bhat, Gandhinagar 382 428, India

Dynamical networks with time-delays (delay networks) have many applications in diverse range of fields from physics and biology. Their analysis is challenging, because even a single delay differential equation constitutes an infinite-dimensional dynamical system. In this talk we describe a method to efficiently analyse the stability of delay networks and investigate the stability of large networks of delay-coupled delay oscillators. When the local dynamical stability of these networks is plotted as a function of the two delays a pattern of tongues is revealed. Exploiting a link between structure and dynamics, we show that in ensembles of large networks this pattern can be well approximated analytically.

SOE 20.8 Thu 17:00 GÖR 226

Coherence-incoherence transition in nonlocally coupled — •Iryna Omelchenko[1], Yuri Maistrenko[1], Philipp Hoevel[2], and Eckehard Schoell[2] — [1]Institute of Mathematics, National Academy of Sciences of Ukraine, Tereshchenkivska str. 3, 01601 Kyiv, Ukraine — [2]Institut fuer Theoretische Physik, Technische Universitaet Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

In networks of coupled oscillators we investigate the effects of nonlocal interactions on the dynamics and pattern formation. Novel types of bifurcations at the transition from coherence to incoherence are analyzed. They represent a critical pattern transformation which gives rise to breakdown of the spatially coherent state and transition to spatial chaos. The transition starts with the appearance of narrow layers of incoherence which then grow and occupy, eventually, the whole system. We follow the bifurcation scenarios for non-locally coupled logistic maps (both chaotic and periodic), and non-locally coupled Roessler systems, and conclude that the transition from spatial coherence to incoherence is typically accompanied by the appearance of hybrid, partially coherent states where coherent phase-locked regions coexist with incoherent spatially chaotic regions. In non-locally coupled Roessler systems chimera states appear at the coherence-incoherence transition.

SOE 21: Traffic Dynamics, Urban and Regional Systems

Time: Friday 10:15–11:00 Location: GÖR 226

SOE 21.1 Fri 10:15 GÖR 226

On vehicular traffic data analysis — •Martins Brics and Reinhard Mahnke — Institute of Physics, Rostock University, Germany

This contribution consists of analysis of empirical vehicular traffic flow data. The main focus lies on the Next Generation Simulation (NGSIM) data. The first findings show that there are artificial structures within the data due to errors of monitoring as well as smoothing position measurement data. As a result speed data show discretisation in 5 feet per second.

The aim of this investigation is to construct microscopic traffic flow models which are in agreement to the analysed empirical data.

The ongoing work follows the subject of research summarized by Christof Liebe in his PhD thesis entitled "Physics of traffic flow: Empirical data and dynamical models" (Rostock, 2010), see `http://rosdok.uni-rostock.de`.

SOE 21.2 Fri 10:30 GÖR 226

Game theoretic modelling of evacuation dynamics — •Michalis Smyrnakis and Tobias Galla — Complex Systems Group, School of Physics & Astronomy, The University of Manchester, Manchester M13 9PL, UK

We model and simulate the dynamics of crowd evacuation in a game theoretic setting, based on extensions of the Helbing-Farkas-Vicsek model. In particular we consider situations in which agents evacuate rooms, bridges or corridors with several exits. Each agent then needs to make a decision on which exit route to choose, trying to optimise their own 'payoff', i.e. their chances of safe escape. Overall crowding and limitations in the geometry lead to potentially competitive strategic interaction between individual evacuees. Agents make their decisions based on information available to them (e.g. local degree of crowding, distance from the different potential exits, local direction of flow) and within the physical constraints imposed on them by other agents. The available information may change over time, and agents may revise their decisions as the evacuation progresses, using a myopic adaptation rule. We will also examine the impact of communication between pedestrians and how the number of agents with access to communication devices (e.g. mobile phones) can influence the total evacuation time.

SOE 21.3 Fri 10:45 GÖR 226

Optimization of occupation numbers of trains by financial measures of risk — Uli Spreitzer[1], Vladimir Reznik[2], and •Robert Löw[3] — [1]Bonus Pensionskassen AG, Traungasse 14-16, 1030 Vienna, Austria — [2]Towers Watson Deutschland GmbH, Abraham-Lincoln-Str. 22, 65189 Wiesbaden, Germany — [3]Continental, Siemensstrasse 12, 93055 Regensburg, Germany

Occupation numbers of trains or busses are calculated with a model of finite amount of train stations. We apply a random amount of persons entering or leaving a train at each station. Assuming distributions and volatility models used within financal mathematics we show a dependency between train occupation number, number of train stations and distribution of transfer passengers at train stations. We apply an process for optimization of the occupation number, as used in financal mathematics. The optimization is achieved by variation of a few parameters: the number of train stations, the homogenity of passenger transfers at train stations and the relation of train capacity to amount of transfer passengers.

SOE 22: Social Systems, Opinion and Group Dynamics II

Time: Friday 11:15–12:45 Location: GÖR 226

SOE 22.1 Fri 11:15 GÖR 226

Chemistry of Social Bonds: Cooperation, Integration, Segregation, Aggression — •Juergen Mimkes — Physics Department, U. Paderborn, Germany

Relatives mix like water and wine, enemies separate like water and oil. This chemical model of integration and segregation by Empedocles (490 to 430 BC) is discussed for regular binary solutions like sugar in tea or foreigners in Germany: The amount of sugar that can be dissolved, depends on the temperature of the tea and the cohesive forces of sugar. The amount of foreigners that can be integrated in Germany, depends on the German standard of living and on the cohesive forces of the foreign group due to differences in religion, language, ethnicity, etc. In alloys the model parameters lead to cooperation (NaCl), integration (CuNi), segregation (FePb) or aggression (H2,O2). In societies sympathy leads to cooperation and order, tolerance or indifference to

integration and disorder, preference to segregation and ghettos, antipathy to aggression and social conflict. The degree of integration is a thermometer of tolerance of a society. The model has been tested by intermarriage data in different binary societies: Germans and foreigners, Catholics and non-Catholics in Germany and Northern Ireland, Blacks and Whites in USA, Muslims and non-Muslims in Germany and Bosnia.

SOE 22.2 Fri 11:30 GÖR 226

Disease Dynamics on the Road and Sea Network of the Roman Empire — •Daniel Löb and Michael Ditter — Institut für Festkörperphysik, TU Darmstadt

In the latter half of the second century A.D., a pandemic known as the Antonine Plague ravaged the Roman Empire. Although it is known that it claimed on the order of millions of lives and killed at least one emperor, its severeness and therefore its contribution to the decline of the Empire are still a subject of controversy among historians.

We propose a stochastic model of disease dynamics on the travel network of the Roman Empire to solve some of the open questions surrounding the plague that historiography alone cannot answer.

Our travel network was composed using data from Roman road maps (mostly Itinerarium Antonini) and the historiographic literature, so as to get an adequate representation of the most important land and sea routes. All results are benchmarked using the surviving literary and archaeological evidence.

SOE 22.3 Fri 11:45 GÖR 226

Opinion formation and cyclic dominance in adaptive networks — •Güven Demirel[1], Roshan Prizak[2], Nitish Reddy[2], and Thilo Gross[1] — [1]Max-Planck-Institut für Physik komplexer Systeme, Dresden — [2]Department of Electrical Engineering, Indian Institute of Technology , Bombay, Powai, Mumbai, India

The Rock-Paper-Scissors(RPS) game is a paradigmatic model for cyclic dominance in biological systems. We consider this game in the social context of competition between opinions in a networked society. In our model, every agent has an opinion which is drawn from the three choices: rock, paper or scissors. In every timestep a link is selected randomly and the game is played between the nodes connected by the link. The loser either adopts the opinion of the winner or rewires the link. These rules define an adaptive network on which the agent's opinions coevolve with the network topology of social contacts. We show analytically and numerically that nonequilibrium phase transitions occur as a function of the rewiring strength. The transitions separate four distinct phases which differ in the observed dynamics of opinions and topology. In particular, there is one phase where the population settles to an arbitrary consensus opinion. We present a detailed analysis of the corresponding transitions revealing an apparently paradoxial behavior. The system approaches consensus states where they are unstable, whereas other dynamics prevail when the consensus states are stable.

SOE 22.4 Fri 12:00 GÖR 226

Unifying physical approaches to Schelling's model of segregation — •Tim Rogers and Alan McKane — School of Physics & Astronomy, The University of Manchester, Schuster Building, Manchester, M13 9PL, UK

Schelling's model of segregation is one of the first and most influential models in the field of social simulation. Over the last 40 years the model has been studied extensively, first in the fields of sociology and economics, and more recently from the perspective of statistical physics. Thus far, the interest of the physics community in Schelling's model has largely been limited to drawing tentative parallels with certain physical systems, and the proposal and simulation of variants of the model. This approach has led to a somewhat fragmented physics literature on the subject.

In this talk, I will present a unified framework for the study of Schelling model and its many variants in the context of statistical physics. A simple metamodel is introduced and its range of behaviours is studied from analytical and numerical perspectives. This methodology is useful two regards: firstly, it provides a provides a tool to differentiate between phenomena which are unique to a particular variant of the Schelling model and those which are universal; secondly, these universal phenomena may be understood in more depth through analytic studies of simpler forms of the model.

SOE 22.5 Fri 12:15 GÖR 226

Analytical calculation of fragmentation transitions in adaptive networks — •Gesa Boehme and Thilo Gross — Max-Planck-Institute for the Physics of Complex Systems, Dresden, Germany

In many adaptive networks fragmentation transitions have been observed, where the network breaks into disconnected state-homogeneous components. In network models which are based on contact processes and therefore contingent on the presence of links connecting different states (active links) this is an absorbing state. Especially models for opinion formation in social communities frequently display a phase transitions from a global homogeneous consensus state to a fragmented state. The critical parameter set, where the fragmentation transition occurs, is well known from numerical simulations, but hard to compute analytically. Moment closure approximations capture the phase transition qualitatively reasonable, but fail with respect to a precise prediction for the critical parameter values. In this talk we present an approach for determining the critical point of the fragmentation transition, which is based on ideas from percolation theory. We demonstrate the proposed approach for the example of an adaptive voter model and find a very good agreement between analytical calculations and numerical results.

SOE 22.6 Fri 12:30 GÖR 226

Bibliometric observation of a melting-like transition in the cooperation behaviour of scientists within former Yugoslavia — •Marcus John, Frank Fritsche, and Stefan Rescke — Fraunhofer-Institut für Naturwissenschaftlich-Technische Trendanalysen, Appelsgarten 2, 53879 Euskirchen, Germany

It is generally accepted that scientific work and scientific cooperation are sensitive to the societal and economic environment. But how exactly are they affected by the outbreak of social, economic or ethnic crises? To elucidate this question we have analysed the publication and cooperation behaviour of scientists in former Yugoslavia by means of a bibliometric approach treating the last 30 years. In most cases a simple gravity model describes the strength of cooperation between two republics reasonably well. We observe that this strength decreases significantly with the outbreak of ethnic conflicts at the beginning of the 1990s. Surprisingly, the state before the crisis is not restored after the conflicts have come to an end. Instead, the observerd cooperation system remains in a less strongly bound state. We conjecture that this is not due to continuing animosity between the republics, but that partners who have broken up their cooperation in the course of the crisis orientated themselves towards new cooperation partners. Thus there seems to be no need to restore the historic cooperation network after the end of the civil wars. We want to clarify this point by using techniques derived from network analysis.