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Overview of Invited Talks and Sessions

(Lecture Room H37; Poster C)

Plenary Talks related to SOE

PV III Mon 14:00–14:45 H15 **The Dynamics of Wealth, Persuasion, and Popularity** — •Sidney Redner

Award Session: Young Scientist Award for Socio- and Econophysics

SOE 7.1 Mon 16:00–16:45 H37 **Mind the gap: What can economics, social insects and statistical physics learn from each other?** — •Alan Kirman

SOE 7.2 Mon 17:00–17:45 H37 **Fighting infectious diseases in a complex world** — •Vittoria Colizza

Invited Talks

SOE 13.1 Tue 12:00–12:45 H37 **The Complexity, Simplicity, and Unity of Living Systems from Cells to Cities; A Physicist's Search for Unifying Theories of Biological and Social Structure and Dynamics** — •Geoffrey West

SOE 8.1 Tue 9:30–10:15 H37 **Distributed sensing and decision-making in animal and human collectives** — •Iain Couzin

SOE 16.1 Wed 15:00–15:45 H37 **Information spreading and multi-stability in social systems** — •Kim Sneppen

SOE 23.1 Thu 15:00–15:45 H37 **Modelling innovation as expansion into the adjacent possible** — Francesca Tria, •Vittorio Loreto, Vito D.P. Servedio, Steven H. Strogatz

Focus Session: Dynamics of Adaptive Networks (joint with DY and BP)

SOE 15.1 Wed 9:30–10:00 H37 **Adaptive Networks: Of social interactions and mathematical tools** — •Anne-Ly Do

SOE 15.8 Wed 11:30–12:00 H37 **Bio-molecular Networks: Structure, Function, Evolution** — •Michael Lässig

SOE 15.9 Wed 12:00–12:30 H37 **Adaptive networks and critical dynamics** — •Stefan Bornholdt

Focus Session: Big Data (joint with jDPG)

SOE 22.2 Thu 10:00–10:30 H37 **Network analysis literacy** — •Katharina Anna Zweig

SOE 22.3 Thu 10:30–11:00 H37 **From Noise to Signal. Stories about big data.** — •Sune Lehmann, Yong-Yeol Ahn, Alan Mislove, Jukka-Pekka Onnela, Niels James Rosenquist

SOE 22.7	Thu	12:00–12:30	H37	**Web-Based Cognitive Science: Harnessing the Power of the Internet to Study Human Cognition** — •Christopher Y. Olivola
SOE 22.1	Thu	9:30–10:00	H37	**Physics and the Information Society: Turning Big Data into Big Insight** — •René Pfitzner
SOE 22.6	Thu	11:30–12:00	H37	**Information Retrieval, Applied Statistics and Mathematics on BigData** — •Romeo Kienzler

Sessions

SOE 1.1–1.1	Mon	9:30–10:00	H37	**Risks and Large Deviations in Economic Networks I**
SOE 2.1–2.3	Mon	10:00–10:45	H37	**Financial Markets and Risk Management I**
SOE 3.1–3.3	Mon	10:45–11:30	H37	**Financial Markets and Risk Management II**
SOE 4.1–4.6	Mon	11:30–13:00	H37	**Economic Growth and Longevity I**
SOE 5.1–5.1	Mon	14:00–14:45	H15	**Plenary Talk Sidney Redner**
SOE 6.1–6.3	Mon	15:00–15:45	H37	**Economic Models**
SOE 7.1–7.2	Mon	16:00–19:00	H37	**YSA Award Ceremony: Young Scientist Award for Socio- and Econophysics**
SOE 8.1–8.1	Tue	9:30–10:15	H37	**Decision-making in societies (Invited Talk Iain Couzin)**
SOE 9.1–9.8	Tue	9:30–11:45	H47	**Statistics and Dynamics of/on Networks (joint session BP/DY/SOE)**
SOE 10.1–10.4	Tue	10:15–11:15	H37	**Opinion Formation I**
SOE 11.1–11.2	Tue	11:15–11:45	H37	**Opinion Formation II**
SOE 12.1–12.1	Tue	11:45–12:00	H37	**Risks and Large Deviations in Economic Networks II**
SOE 13.1–13.1	Tue	12:00–12:45	H37	**Economic Growth and Longevity II (Invited Talk Geoffrey West)**
SOE 14.1–14.4	Tue	15:00–16:00	H37	**Evolutionary Game Theory (joint with BP and DY)**
SOE 15.1–15.9	Wed	9:30–12:30	H37	**Focus Session: Dynamics of Adaptive Networks (joint with DY and BP)**
SOE 16.1–16.1	Wed	15:00–15:45	H37	**Networks (Invited Talk Kim Sneppen)**
SOE 17.1–17.5	Wed	15:45–17:00	H37	**Networks, From Topology to Dynamics (joint with DY and BP)**
SOE 18.1–18.6	Wed	15:00–17:30	H44	**Focus Session: Modern Power Grid, Nonlinear Dynamics and Self-Organization (joint with DY)**
SOE 19.1–19.4	Wed	17:00–18:00	H37	**Social Systems and Group Dynamics**
SOE 20.1–20.1	Wed	18:00–18:15	H37	**Traffic Dynamics, Urban and Regional Systems**
SOE 21	Wed	18:20–19:20	H37	**Annual Member's Assembly of SOE**
SOE 22.1–22.7	Thu	9:30–12:30	H37	**Focus Session: Big Data (joint with jDPG)**
SOE 23.1–23.1	Thu	15:00–15:45	H37	**Innovation Dynamics (Invited Talk Vittorio Loreto)**
SOE 24.1–24.6	Thu	15:45–17:15	H37	**Group Dynamics**
SOE 25.1–25.19	Thu	17:15–19:00	Poster C	**Poster session**

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

Wed 18:20–19:20 H37

SOE 1: Risks and Large Deviations in Economic Networks I

Time: Monday 9:30–10:00 Location: H37

SOE 1.1 Mon 9:30 H37

Global Hyper-Risks, and How to Respond — •Dirk Helbing — ETH Zurich, Clausiusstrasse 50, 8092 Zurich

Financial crises, large-scale conflicts, pandemics, global warming, failures of information and communication systems and their interdependencies can be considered global hyperrisks posing serious threats to our society. They may be triggered by small perturbations or coincidences, or may not need a trigger at all. They are hard to understand, predict, and control. Identical causes may have different effects, while the same effects may have different causes. Global hyper-risks can materialise even if decision-makers are well skilled and do their best. The resulting damage may have any scale. Yet, a "global systems science" could create the understanding needed to manage and avoid them. The talk will discuss, how the above 21st century challenges may be scientifically approached.

SOE 2: Financial Markets and Risk Management I

Time: Monday 10:00–10:45 Location: H37

SOE 2.1 Mon 10:00 H37

A stochastic nethod for risk quantification of technical systems — •Magda Schiegl — University of Applied Sciences, Landshut, Germany

We introduce a new method for the risk quantification of complex technical systems (for instance technical devices, processes) and apply it to an example of medical technology. The Fault Tree Analysis (FTA), a method of the classical engineering risk analysis, is combined with methods of stochastic risk management to calculate the total claim distribution of complex technical systems.

The result of a FTA is a structured tree showing all possible problems of the technical system producing claims (costs). The probabilities of the claim events on every node of the FTA tree are also included. At the end of every single tree branch we are left with quite a specific kind of technical problem. Therefore its cost (claim) distribution can be specified quite easily by an expert. As a next step we use stochastic simulation (Monte Carlo) to aggregate all these specific single claim distributions to the system*s total claim distribution. The aggregation is according to the tree*s structure and probabilistic character. In this way all risk measures being used in modern risk management * as for instance VaR or expected shortfall * are accessible. We demonstrate the new method in applying it to a practical example: The dentist*s chair.

SOE 2.2 Mon 10:15 H37

Systematic analysis of system-caused systemic risk — •Lasse Loepfe[1], Antonio Cabrales[2], and Angel Sanchez[1] — [1]Grupo Interdisciplinar de Sistemas Complejos (GISC), Departamento de Matemáticas, Universidad Carlos III de Madrid, 28911 Leganés, Spain — [2]Department of Economics, Universidad Carlos III de Madrid, Madrid 126, 28903 Getafe, Spain

In response to the 2007-2008 financial crisis the consensus among policymakers increased that a macroprudential approach to regulation and supervision should be adopted. The currently preferred policy option is the regulation of capital requirements, with the main focus on combating procyclicality and on identifying the banks that have a high systemic importance, those that are too 'big to fail'. Here we argue that the concept of systemic risk should not be limited to assessing the relative contribution of individual firms to the total risk, but include the analysis of the system as a whole. In a thorough study going from analytical models to empirical data, we systematically explore the effects of network topology on the overall resistance to external shocks. We show that more connected networks are more robust to small tailed shock distributions but more vulnerable to fat tailed shock distributions. The amount of Tier 1 capital required to reduce risk to a given level therefore greatly depends on the topology of the whole system. Other network properties, such as assortativity or clustering had only a minor influence on shock resistance. Vulnerability decreased with firm size heterogeneity when shocks were random, but increased when they were directed at the largest firms.

SOE 2.3 Mon 10:30 H37

Indications of an upcoming financial breakdown — •Jan Jurczyk[1], Johannes Schneider[2], and Ingo Morgenstern[1] — [1]Faculty of Physics, University of Regensburg, 93040 Regensburg, Germany — [2]Department of Physics, Mathematics, and Computer Science, Johannes Gutenberg University of Mainz, 55099 Mainz, Germany

The financial crisis in 2008 showed the weakness of traditional risk evaluation for private investors. In the beginning of 2008 well known financial newspapers and rating firms underestimated the growing risks within the stock market. Therefore the private investor was made to believe that there is no risk within such a system. But the similarities between the spin glass behaviour of the portfolio selection problem, already shown by Markowitz, reveal that the risk is an important observable for recognizing a financial breakdown.

The physical formulation of the portfolio selection problem makes it easier to unveil the risk for a private investor by introducing a simple indicator, which is derived from the idea that ground states of the optimization problem are very sensitive to changes in the solution space and suggests a phase transition.

SOE 3: Financial Markets and Risk Management II

Time: Monday 10:45–11:30 Location: H37

SOE 3.1 Mon 10:45 H37

Alternate entropy measure for assessing volatility in financial markets — •Kay Hamacher[1] and Ranjan Bose[2] — [1]Department of Computer Science, Department of Physics & Department of Biology, Technische Universitaet Darmstadt, Germany — [2]Department of Electrical Engineering, IIT Delhi, Hauz Khas, New Delhi, India

(Stock) market dynamics has become the ultimate challenge for our understanding of complex system dynamics. Thus, new ways to probe properties of the dynamics is an important step towards a better understanding - in particular, since simple pdfs were disregarded as the typical dynamics is governed by non-Gaussian fluctuations.

Here [1], we propose superinformation [2], which is a measure of the disorder of the entropy of general data sets. Besides obvious signals - such as the 2008 financial crisis - we were able to extract relations to volatility measures; an important quantity on which derivates are traded. In particular, we observe correlations to the VIX index.

Going on step further, we introduce the super mutual information. Signatures were observed whose exploitation might be used to mitigate idiosyncratic risk.

[1] K. Hamacher, R. Bose. "Alternate entropy measure for assessing volatility in financial markets" Phys. Rev. E, 86(5):056112, 2012.

[2] R. Bose, S. Chouhan. Phys. Rev. E 83, 051918 (2011).

SOE 3.2 Mon 11:00 H37

From linearity to nonlinearity in commodity price analysis — •Benedikt Gleich and Andreas Rathgeber — Institute of Materials Resource Management (MRM), University of Augsburg, Germany

In the field of minerals economics, the analysis of commodity prices

using classical econometric approaches mostly incorporates linear models, in particular linear OLS (ordinary least squares) regressions. However, research on complex systems highly suggests nonlinear approaches and pure linearity could be a serious bias.

To compare linear and nonlinear methods, as a benchmark, we present a classical linear OLS regression analysis on price time series of 42 commodities (mostly industrial metals) and 11 common price factors like mining production or economic growth. While this linear approach frequently detects significant correlations, the effect of an independent variable in many cases is both positive as well as negative depending on the respective commodity. We argue that this variation is no result of fundamental (market) laws, but in fact comes from limitations of linearity. In contrast, we therefore evaluate and present a selection of alternative non-linear models and simulations, in particular using non-linear multi factor models and differential equation systems, which show an improved performance in explaining the real world relationship between commoditiy prices and common price factors.

Our results constitute an extension of current de facto standards in minerals economics and financial commodity price modeling, in particular by the utilization of non-linear models instead of linear OLS models. They enable a more realistic analysis of commodity price building.

SOE 3.3 Mon 11:15 H37

Triangular arbitrages in foreign exchange markets — •Kenta Yamada[1], Takatoshi Ito[2], Hideki Takayasu[3], and Misako Takayasu[4] — [1]Waseda University, Tokyo, Japan — [2]University of Tokyo, Tokyo, Japan — [3]Sony CSL, Tokyo, Japan — [4]Tokyo Institute of Technology, Tokyo, Japan

We confirm triangular arbitrages exist in foreign exchange markets by using high frequency data for 12 years from 1999 to 2010. When we make a triangular exchange such as yen to dollar, dollar to euro and then euro back to yen, usually we lose money because of the spread which is the difference between the bid price and the offer price. However sometimes we have a chance to make a profit. This arbitrage opportunity is against non-arbitrage principles in economics. These triangular arbitrage opportunities were originally identified by Aiba et. al. in 2002 [1]. They realized the triangular arbitrage opportunity existed by analyzing the foreign exchange market data for two months in 1999, and they found these triangular opportunities exist about 6.4 percent of the time. In our study we observed a consistent value in the same period, while the probability of arbitrage on January 2010 was only 0.1 percent. We calculated the number of triangular arbitrage opportunities and the disappearance probability of triangular arbitrages within one second each month for 12 years, and modeled the occurrence of the triangular arbitrage with volatility, the number of deals and the number of AI traders [2].

[1] Yukihiro Aiba, et. al., Physica A 310 (2002) 467-479.

[2] Takatoshi Ito, et. al. , NBER Working Paper No. 18541 (2012).

SOE 4: Economic Growth and Longevity I

Time: Monday 11:30–13:00 Location: H37

SOE 4.1 Mon 11:30 H37

Adaptability and growth of socioeconomic systems — •Flavioaugusto Pinto Piabatto, Anselmo García Cantu Ros, Camila Flórez Bossio, Linda Krummenauer, Katja Voigt, and Jürgen P. Kropp — Potsdam Institute for Climate Impact Research, Potsfach 601203, 14412 Potsdam

The article offers a perspective on socioeconomic systems, worth for analyzing their adaptive dynamics and evolution. We represent socioeconomic systems from two functions -perspectives and productivity functions, to formalize the relations among the main descriptors of adaptability (sensitivity, susceptibility, vulnerability, resilience, coping and adaptive capacity). Adaptation occurs locally, from loops of transformations of insights and potentials into capacity. The creation of capacity to cope with vicissitudes of any type and size-including shocks-is carried out by a structure in charge of the qualification of socioeconomic systems. We show that the transformation of the productive structure of socioeconomic systems over the last two or three centuries has been the construction of the structure of qualification, the structure of adaptive capacity. We explore implications of Ksi for adaptation and growth.

SOE 4.2 Mon 11:45 H37

Condensation of wealth and control in a network of firms — •Sebastian M. Krause, Tiago P. Peixoto, and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen, Hochschulring 18, D-28359 Bremen

A recent analysis of the global network of corporate control found a strongly-connected core of about 1300 large firms controlling up to 80% of the world economy [1]. An interesting question concerning this effect of control concentration is whether it arises due to purposeful strategies, or it is simply a byproduct of simple organization rules.

Here we show that a non-growth rich-get-richer phenomenon in a toy model of wealth flows suffices to forecast a strongly-connected core of rich firms controlling the rest of the system. We find that the distribution of wealth resulting from this dynamics is very broad, even if the substrate graph is random. The wealth distribution, together with the core-periphery structure arises out of a symmetry-breaking process, and is not unique for the same graph. The model has a single parameter controlling the overall relative profit due to dividends which, if increased, results in a broader wealth distribution and smaller controlling core of firms.

[1] S. Vitali, J. B. Glattfelder, and S. Battiston, The Network of Global Corporate Control, PLoS ONE 6 (2011) e25995.

SOE 4.3 Mon 12:00 H37

Statistical mechanics of organizational growth processes — •Hernan Mondani[1], Petter Holme[2], and Fredrik Liljeros[1] — [1]Department of Sociology, Stockholm University, 106 91 Stockholm, Sweden — [2]Department of Physics, Umeå University, 901 87 Umeå, Sweden

In this study we address the question of the origin of non-Gaussian, fat-tailed growth-rate distributions in organizational growth processes.

In particular, the remarkable feature that the probability distribution for the growth rate –i.e. how quickly the size changes – follows a non-Gaussian pattern, something unexpected in traditional approaches. In practice, this means that organizational size changes very little most of the time, but dramatically every once in a while.

This pattern shows up in growth processes of various unrelated systems, from bird migration dynamics to investments in mutual funds.

We verify the emergence of this pattern on real data from voluntary organizations in Sweden.

We implement a stochastic model on a contact network with influence-based time evolution. We simulate the model for different network configurations, and are able to reproduce the key features with this model.

We then construct a physical analogy to the model, motivated by the sociological concept of preference falsification. This allows us to find two distinct phases emerging in extreme cases of the control parameter.

Keywords: sociophysics, organizational growth process, tent-shaped distribution, complex networks, preference falsification.

SOE 4.4 Mon 12:15 H37

Growth compulsion in the monetary system — Christian Kimmich[1,3] and •Oliver Richters[2,3] — [1]Humboldt-Universität zu Berlin — [2]Universität Oldenburg — [3]Wissenschaftliche Arbeitsgruppe nachhaltiges Geld

The need for economic growth is underlined regularly in politics and most branches of economics, though in the 1970ies, fundamental thermodynamic arguments and system dynamics models gave first evidence of "the Limits to Growth". These economic constraints are today confirmed, e.g. by the strong correlation of rising energy consumption and greenhouse gas emissions with Gross domestic product (GDP). To solve this contrast, it is necessary to ask the question if and how our economy is reliant on positive growth rates. In our work, we specifically focus on the monetary order.

We investigate a simplified version of our current monetary system using a stock-flow-consistent system dynamics model of credit money creation, use and redemption. We distinguish between different behaviours of debtors and creditors and examine in each case the trend evolution of debts, deposits and the GDP. Integrating empirical data

from economics, we derive the dominant scenarios and conclude that positive growth rates are crucial for the stability of the investigated monetary system. Finally, we motivate why this result can be extrapolated to existing monetary systems and present possible model extensions.

SOE 4.5 Mon 12:30 H37

Can economic growth last? — •Oliver Richters — Universität Oldenburg, Institut für Physik — Vereinigung für Ökologische Ökonomie

Many economist have no doubt about ongoing economic growth, as long as we shift to a "green economy" getting his energy supply from renewables. But if we assume – nowadays conservative – a world energy consumption growth rate of 2.3% per year, the power limits of solar radiation to earth are reached within less than 200 years, and even the harvesting of total galaxy throughput would just delay the run-out of energy supply by just one millennium. So let us focus on alternative technologies such as nuclear fission or fusion? Keeping in mind the principles of thermodynamics, every human activity finally ends up as heat. Using Stefan-Boltzmann law calculating earth temperature, the analysis shows why boiling oceans are not even 500 years away under the assumption of exponential growth – even neglecting "peanuts" such as the greenhouse effect. Discontent with this absurdity, more realistic growth schemes has to be taken into account. But all mathematically mandatory show growth rates dropping to zero in the long run, and it can be shown that this is then also valid for growth rates of GDP, that can not be completely decoupled from energy supply. A short insight is given into the significance this trend has for finance, economics, social security and the people on earth.

SOE 4.6 Mon 12:45 H37

Can economics succeed with an inflationary scale (money) for predicting real progress in human life? — •Hans Danielmeyer and Thomas Martinetz — Institut für Neuro- und Bioinformatik, Uni Lübeck

During the last 12 years we developed two independent sets of analytically closed solutions: One predicts real medium and long-term economic growth per capita with six relevant variables calibrated with biologically stabilized constants of the human species; the other quantifies short-term business cycles with six different variables calibrated within the inflationary monetary system.

Both sets are used here for separating the investment required for real structural growth from the zero sum game of speculative investment. This is impossible with the mathematical approximations of economic theory, but relatively easy with analytically closed solutions whose time derivatives and some integrals maintain constant parameters. We suggest an alternative to ever increasing but ineffective political controls of the global financial system. It compares the G7 life style with the natural order: the inherited human genome carries gigabytes of information, the destructible technical infrastructure carries kilobytes, money carries nothing.

SOE 5: Plenary Talk Sidney Redner

Time: Monday 14:00–14:45 Location: H15

Plenary Talk SOE 5.1 Mon 14:00 H15

The Dynamics of Wealth, Persuasion, and Popularity — •Sidney Redner — Boston University, Boston, USA

In this talk, I discuss how a number of simple models of statistical physics can be adapted to help elucidate some well-known social dynamics phenomena. I first present a way to describe the wealth distribution of a society through an idealized model in which random pairs of individuals repeatedly exchange some amount of their assets. I will then treat the connection between the kinetic Ising model and basic models of social persuasion, in which individuals are regarded as social atoms. Models of this genre can help understand how consensus may or may not be achieved in a socially-interacting population. Finally, I will review the preferential attachment model of popularity and show how this ostensibly global dynamical evolution of complex networks can be obtained by a purely local growth rule. Throughout, I will show how these three models can be treated within the unifying framework of non-equilibrium statistical physics.

SOE 6: Economic Models

Time: Monday 15:00–15:45 Location: H37

SOE 6.1 Mon 15:00 H37

Regulation of self-organized cartel dynamics via information dissemination — •Tiago P. Peixoto and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen, Hochschulring 18, D-28359 Bremen, Germany

In a simplified model of a market where buyers are forced to buy from a predetermined number of sellers which they can choose, there occurs the emergence of a "cartel phase" where sellers agree on a higher average price, despite the lack of communication between them, and thus any agreement on a specific strategy. The onset of this dynamical phase is controlled by a single parameter which specifies the relative speed with which the sellers update their strategies, compared to the buyers. If this value is below a critical value, the cartel phase is replaced by an optimum for the buyers, where the prices become the lowest possible.

Recent legislative measures were proposed which intended to thwart this effect in actual gasoline markets. They consist in forcing the sellers to report any price change immediately, so that a global price repository can be built. We incorporate this regulatory feature in the model, and investigate the conditions necessary for the existence of the cartel phase.

T.P.Peixoto, S.Bornholdt, "No Need for Conspiracy: Self-Organized Cartel Formation in a Modified Trust Game", Phys. Rev. Lett. 108, 218702 (2012)

SOE 6.2 Mon 15:15 H37

Sectoral Gross Domestic Product composition: a dynamical modelling approach — •Diego Rybski, Raphael Lutz, Michael Spies, Dominik E. Reusser, and Jürgen P. Kropp — Potsdam Institute for Climate Impact Research, 14469 Potsdam, Germany

Exploring a simple system of differential equations we characterise the transfer of GDP shares – i.e the partitioning into agrarian, industrial, and service sectors – between the sectors in the course of economic development. The model fits for the majority of countries providing 4 country-specific parameters. Relating the agrarian with the industrial sector, a data collapse over all countries and all years supports the applicability of our approach. Depending on the parameter ranges, country development exhibits different transfer properties. Most countries follow 3 of 8 characteristic paths. The types are not random but show distinct geographic and development patterns.

SOE 6.3 Mon 15:30 H37

How does money memorize social interactions? Understanding time-homogeneity in monetary systems. — •Andreas Schacker, Matthias Schmitt, and Dieter Braun — Systems Biophysics, LMU München

How does money shape and memorize our social interactions? There are many schools of thought on as to how monetary systems contribute to crises or boom/bust cycles. Statistical physics can provide a refreshing perspective to probe the stability of monetary systems [1,2,3]. We analyze how credit mechanisms introduce non-locality and time-heterogeneity to the monetary memory. Motivated by an analogy to particle physics, locality and time-homogeneity can be imposed to monetary systems. As a result, a full reserve banking system [4] is implemented by a two-currency system of non-bank assets (*money*) and

bank assets (*antimoney*). Payment can either be made by passing on money or by receiving antimoney. As a result, a free floating exchange rate between non-bank assets and bank assets is established. Interestingly, credit creation is replaced in this monetary memory by a liquidity transfer that simultaneously transfers money and antimoney at a negotiated exchange rate. We analyze this novel monetary mechanism under random social interactions. Analytical results for all relevant distributions cen be provided, including an analysis of a fully transparent liquidity market. [1] European Physical Journal B 17, 723-729 (2000). [2] Reviews of Modern Physics 81, 1703 (2009). [3] Physica A 321, 605-618 (2003). [4] Ryan-Collins, Greenham, Werner, Jackson: Where Does Money Come From? positivemoney.org.uk.

SOE 7: YSA Award Ceremony: Young Scientist Award for Socio- and Econophysics

Time: Monday 16:00–19:00 Location: H37

Invited Talk SOE 7.1 Mon 16:00 H37

Mind the gap: What can economics, social insects and statistical physics learn from each other? — •Alan Kirman — GREQAM, EHESS, 2 Rue de la Charite, 13002 Marseille,France

Macroeconomists have been preoccupied by the analysis of equilibrium states and their properties. They assume that the economy will automatically find an equilibrium, from which it is perturbed only by exogenous shocks. Out of equilibrium behaviour is disregarded. The current crisis has shown again however, that what is needed, are models of the economy as a complex evolving system which may undergo sudden and radical endogenous changes. Interaction among the individuals, groups and institutions in the economy produces aggregate phenomena which are intrinsically different from the behavior of the individuals themselves. Collective results may be more or less *rational* than individual behavior. The gap between individual and collective rationality is real and important. "Swarm intelligence" reveals the potential increase in the cognitive capacity of a collectivity. Herd behaviour on markets shows how imitation can generate bubbles and crashes.Simple models based on approaches from other disciplines, statistical physics in particular, will allow us to achieve the important task of analysing the erratic evolution of the economy and the emergence of crises.

Presentation of the Young Scientist Award for Socio- and Econophysics to Vittoria Colizza.

Prize Talk SOE 7.2 Mon 17:00 H37

Fighting infectious diseases in a complex world — •Vittoria Colizza — INSERM & Universite Pierre et Marie Curie (Paris, France) — ISI Foundation (Turin, Italy)

New advances in science and medicine help us gain ground against certain infectious diseases, yet new infections continue to emerge that spread rapidly into the population and may reach pandemic proportions. We face a perpetual challenge against the capacity of new pathogens to lead to emerging epidemics. And our global, mobile and interconnected world contributes with dangerous mechanisms that may potentially greatly magnify the global burden of diseases, causing significant human and economic costs - namely, the increasing complexity of our social relations, trade systems, and mobility patterns. The ICT and 'Big Data' revolution enabled us to start quantifying this complexity and to envision modeling frameworks able to confront this epidemic reality. Models integrating mathematical epidemiology with complex systems and statistical physics approaches, computational sciences and Geographic Information Systems offer new tools as important as medical, clinical, genetic or molecular diagnosis tools in the fight against infectious diseases. In the talk I will report on our efforts in the development of data-driven modeling applications to infectious disease spread, from the global scale to the individual host level, addressing the effect of complexity inherent in the multiple facets of reality on the properties of epidemic propagation and on the efficacy of the intervention strategies that can be envisioned.

After the awardees talk, there will be a social gathering with beer and pretzels in the close-by Chemistry cafeteria (opposite building, close to lecture hall H34)

SOE 8: Decision-making in societies (Invited Talk Iain Couzin)

Time: Tuesday 9:30–10:15 Location: H37

Invited Talk SOE 8.1 Tue 9:30 H37

Distributed sensing and decision-making in animal and human collectives — •Iain Couzin — Department of Ecology and Evolutionary Biology, Princeton University, Princeton, NJ, USA

The capacity for groups to exhibit collective intelligence is an often cited advantage of group living. Previous studies have shown that social organisms often benefit from pooling imperfect individual estimates. However, collective properties can also emerge from the structure and dynamics of social interactions among individuals, rather than from enhancement of personal estimates. Using an integrated theoretical and experimental approach (employing computer vision to explicitly reconstruct sensory networks among organisms), we reveal that emergent problem solving is the predominant mechanism by which mobile animal groups sense, and respond to, complex environmental gradients. This distributed sensing requires rudimentary cognition and is shown to be highly robust to noise. Furthermore we demonstrate the crucial role that uninformed individuals play during consensus decision-making in collectives, notably in promoting democratic consensus (despite the inability for individuals in many animal groups, such as schooling fish, to explicitly *vote*) and also enhancing the speed and accuracy of decision-making. Our results emphasize how distributed cognition can emerge from dynamical networks of social interactions among organisms, including humans, and suggest general principles by which sensing networks may be organized in biological collectives.

SOE 9: Statistics and Dynamics of/on Networks (joint session BP/DY/SOE)

Time: Tuesday 9:30–11:45 Location: H47

SOE 9.1 Tue 9:30 H47

Chimera states in neural systems — •Iryna Omelchenko[1,2], Oleh Omel'chenko[3], Philipp Hövel[1,2,4], and Eckehard Schöll[1] — [1]Institut für Theoretische Physik, Technische Universität Berlin — [2]Bernstein Center for Computational Neuroscience, Humboldt-Universität zu Berlin — [3]Weierstrass Institute, Berlin — [4]Center for Complex Network Research, Northeastern University, Boston, USA

Chimera states are spatio-temporal patterns of synchrony and disorder observed in systems of nonlocally coupled identical elements. They are characterized by coexistence of spatial regions with regular synchronized and irregular incoherent motion. Initially discovered for phase oscillators, chimera states have been also found in systems of nonlocally coupled discrete maps [1], time-continuous chaotic systems [2], and have been recently realized in experiments [3].

We investigate the cooperative dynamics of nonlocally coupled neural populations modeled by FitzHugh-Nagumo systems, where each in-

dividual system displays oscillatory local dynamics, and demonstrate the existence of chimera states there. We analyse the stability of chimera states in the parameter space of the system and discuss mechanisms of transitions between different chimera types.

[1] I. Omelchenko, Yu. Maistrenko, P. Hövel, and E. Schöll, Phys. Rev. Lett. 106, 234102 (2011).

[2] I. Omelchenko, B. Riemenschneider, P. Hövel, Yu. Maistrenko, and E. Schöll. Phys. Rev. E 85, 026212 (2012).

[3] A.M. Hagerstrom, T.E. Murphy, R. Roy, P. Hövel, I. Omelchenko, and E. Schöll. Nature Physics 8, 658 (2012).

SOE 9.2 Tue 9:45 H47

Scaling Laws in Critical Random Boolean Networks with General in- and out-Degree Distributions — •Marco Möller and Barbara Drossel — Institute for condensed matter physics, TU Darmstadt, Germany

We evaluate analytically and numerically the size of the frozen core and various scaling laws for critical Boolean networks that have a power-law in- and/or out-degree distribution. To this purpose, we generalize an efficient method that has previously been used for conventional random Boolean networks and for networks with power-law in-degree distributions. With this generalization, we can also deal with power-law out-degree distributions. When the power-law exponent is between 2 and 3, the second moment of a distribution changes, and the scaling exponent of the nonfrozen nodes depends on the degree distribution exponent.

Furthermore, the exponent depends also on the dependence of the cutoff of the degree distribution on the system size. Altogether, we obtain an impressive number of different scaling laws depending on the type of cutoff as well as on the exponents of the in- and out-degree distribution. We confirm our scaling arguments and analytical considerations by numerical investigations.

SOE 9.3 Tue 10:00 H47

Small-World Network Spectra in Mean-Field Theory — •Carsten Grabow[1], Stefan Grosskinsky[2], and Marc Timme[3] — [1]Potsdam Institute for Climate Impact Research, Potsdam, Germany — [2]Mathematics Institute and Centre for Complexity Science, Warwick, UK — [3]Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany

Collective dynamics on small-world networks emerge in a broad range of systems with their spectra characterizing fundamental asymptotic features. Here we derive analytic mean-field predictions for the spectra of small-world models that systematically interpolate between regular and random topologies by varying their randomness. These theoretical predictions agree well with the actual spectra (obtained by numerical diagonalization) for undirected and directed networks and from fully regular to strongly random topologies. These results may provide analytical insights to empirically found features of dynamics on small-world networks from various research fields, including biology, physics, engineering, and social science. (Based on Grabow, C., Grosskinsky, S. & Timme, M. Small-World Network Spectra in Mean-Field Theory. Phys. Rev. Lett 108, (2012).)

SOE 9.4 Tue 10:15 H47

Robust large-scale properties in networks — •Tiago Peixoto and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen, Hochschulring 18, D-28359 Bremen, Germany

Most network systems possess large- or mesoscale structures, which are not captured by local measures such as, e.g. degree and subgraph statistics. Many network models, as well as mean field analysis of dynamical processes on networks neglect such features. Here we include in a general fashion such large-scale properties in the the analysis of a paradigmatic percolation problem in networks with interdependence, as well as Boolean dynamics based on majority functions, meant to describe systems which are robust against noise, such as gene regulation.

A model for the evolution of such systems is proposed, where networks with more robust properties survive with greater probability. By mapping the evolutionary process into a statistical ensemble, the free energy of the system is minimized, and its equilibrium properties are obtained. The analysis reveals a topological phase transition at a specific value of selective pressure, where a core-periphery topology emerges, characterized by the existence of a smaller subset of nodes which regulate the entire system; a feature which is also found in many real systems.

T. P. Peixoto, S. Bornholdt, Phys. Rev. Lett. 109, 118703 (2012); T. P. Peixoto, Phys. Rev. E 85, 041908 (2012); T. P. Peixoto, Phys. Rev. E 85, 056122 (2012)

15 min. break.

SOE 9.5 Tue 10:45 H47

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

Dynamical processes on complex networks are a growing field of interest. Performing simulations on large system of this kind demand a high computational power. To handle dynamics on networks the NetEvo C++ library can assign dynamical systems to edges and nodes. Furthermore it solves these ODEs via the ODEint library and can perform heuristic optimization. We introduce an extension to NetEvo using OpenCL on GPUs. With this approach we achieve an increase of computational performance up to a factor of 100, compared to an optimized C++ code on a modern CPU. Additionally we developed a framework to visualize intermediate results and to perform instantaneous visual analytics. The software will be applied in epidemiology, simulating disease spread on trade networks by solving the SIR model*s ODEs. The modification of parameter in real-time and the immediate access to simulation results leads to intuitive insights into the behavior of epidemics on large complex networks.

SOE 9.6 Tue 11:00 H47

Diffusion processes and entropy prodcution in weakly coupled complex networks — Grzegorz Siudem and •Janusz Hołyst — Faculty of Physics, Center of Excellence of Complex Systems Research, Warsaw University of Technology, Poland

We consider diffusion phenomena on a pair of weakly coupled complex networks. Assuming that a density of internetwork connections is much lower than a density of intranetwork links we could make use of a time separation for processes taking place in and between the networks. As result we truncated the system dynamics to a simple Markov Chain and we received an equation corresponding to the Fick's First Law. We got an analytical form for internetwork diffusion coupling and estimated entropy production during the equilibration process.

SOE 9.7 Tue 11:15 H47

A Network Generation Process for Temporal Graphs — •Peter A. Kolski[1,2], Thomas Selhorst[1], Markus Abel[2], and Arkady Pikovsky[2] — [1]Friedrich-Loeffler-Institut, Wusterhausen, Germany — [2]University of Potsdam, Germany

In this work we show a mechanism for creating Temporal Graphs inspired by real world trade transportation. In the last years complex networks have been in the focus of theoretical and applied research. Although networks like the power grid or water assets have continuos flow on the edges, trade networks are intrinsically discrete. We present a generic model for the generation and evolution of these Temporal Graphs: A continuous state is assigned to each node, described by a dynamical process. In our case we use an integrate-and-fire model. Once a threshold is exceeded, a node becomes "active" and, according to a cost function, selects another active node. This way an edge is temporarily established. Through these edges, nodes interact by resetting their states to zero. In addition, the cost function is modified in a way that the probability to reuse the edge is increased. We present first results on the analysis of this model by i) the degree distribution of the graph formed of the aggregated edges and ii) the degree distribution at a single time. In addition, we study the differences between a two-dimensional and a full graph. In particular we discuss details in the temporal evolution of the degree distribution, as one of the most important characteristics.

SOE 9.8 Tue 11:30 H47

Transmission grid extensions during the build-up of a fully renewable European electricity supply — •Sarah Becker[1], Rolando A. Rodriguez[2], Gorm B. Andresen[2], Stefan Schramm[1], and Martin Greiner[2] — [1]Frankfurt Institute for Advanced Studies, Goethe-Universität Frankfurt — [2]Aarhus Department of Engineering and Department of Mathematics, Aarhus University, Denmark

Spatio-temporal generation patterns for wind and solar photovoltaic power in Europe are used to investigate the effect of an increasing

penetration of these variable renewable energy sources (VRES) on the European electricity system, in particular on the required link capacities of the transmission grid. VRES growth predictions according to the official National Renewable Energy Action Plans of the EU countries are used and extrapolated logistically up to a fully VRES-supplied power system. It is examined how the need for transmission rises in the future. We find that quadrupling today's international net transfer capacities over the next forty years reduces the final need for backup energy by more than one third. The remaining backup energy is due to correlations in the generation patterns, and can thus not be reduced by transmission. Additionally, our results show how the optimal mix between wind and solar energy shifts from about 70% to 80% wind share as the transmission grid is enhanced. Finally, we exemplify how reinforced transmission affects the import and export opportunities of single countries during the VRES ramp-up and the coupled transmission grid extension.

SOE 10: Opinion Formation I

Time: Tuesday 10:15–11:15 Location: H37

SOE 10.1 Tue 10:15 H37

Dynamics of competing words — •Fakhteh Ghanbarnejad, Martin Gerlach, Jose M. Miotto, and Eduardo G. Altmann — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

How does a community choose between different terms with similar meanings? How is consensus achieved? How is the evolution of the frequency of words borrowed from different languages when compared to their translated counterparts? Answering these questions would not only help us to improve our understanding of language change but would also bring insights on the dynamics of social interactions. Borrowing and social interactions are two key elements shaping language change and have accelerated during recent decades due to globalization. In this work, we apply data mining techniques to statistically analyze empirical data in different communities. We try to detect the general trends of emerging and competing words. We focus on scientific and technical terms for which consensus is usually stimulated, and we try to estimate the impact and significance of these regulatory efforts. We then compare different simple models and compare their predictions to the empirical data and we discuss if social network structure could play role on the dynamics of words spreading.

SOE 10.2 Tue 10:30 H37

A model of adaptive convergence in science — •Stefano Balietti and Dirk Helbing — Clausiusstrasse 50 8092 Zurich

How does scientific consensus of separate communities ("schools") emerge? This study brings together two areas of research, organizational learning and opinion formation models, and it is in line with the recommendations of Nicolas Payette (2011) "For an Integrated Approach to Agent- Based Modeling of Science".

A population of scientists exploring an epistemic landscape simultaneously takes into account the desire for individuality and the effects of social influence coming from related opinions. Noise is used as a driver for the formation of metastable clusters of opinions characterized by consensus within clusters, and diversity between them (Maes, Flache, and Helbing, 2010).

Our preliminary results show formation of interesting consensus patterns emerging from simple interactions of a large number of individuals in space. Clusters formed in local minima can be displaced by opinions with higher attractiveness, once discovered, and clusters that grow too large can spontaneously split into subclusters (Mulkay and Edge, 1972).

SOE 10.3 Tue 10:45 H37

Phase transitions in the q-voter model with two types of stochastic driving — •Piotr Nyczka, Katarzyna Sznajd-Weron, and Jerzy Cisło — Institute of Theoretical Physics, University of Wrocław, pl. Maxa Borna 9, 50-204 Wrocław, Poland

We study a nonlinear q-voter model with stochastic driving on a complete graph. We investigate two types of stochasticity that, using the language of social sciences, can be interpreted as different kinds of nonconformity. From a social point of view, it is very important to distinguish between two types nonconformity, so-called anticonformity and independence. A majority of work has suggested that these social differences may be completely irrelevant in terms of microscopic modeling that uses tools of statistical physics and that both types of nonconformity play the role of so-called social temperature. In this paper we clarify the concept of social temperature and show that different types of noise may lead to qualitatively different emergent properties. In particular, we show that in the model with anticonformity the critical value of noise increases with parameter q, whereas in the model with independence the critical value of noise decreases with q.Moreover, in the model with anticonformity the phase transition is continuous for any value of q, whereas in the model with independence the transition is continuous for q * 5 and discontinuous for $q > 5$.

[Phys. Rev. E 86, 011105 (2012)]

SOE 10.4 Tue 11:00 H37

Modeling spatial patterns in voting behavior — •Juan Fernandez-Gracia, Krystof Suchecki, Jose J. Ramasco, Victor M. Eguiluz, and Maxi San Miguel — IFISC, Palma de Mallorca, Spain

A very rich set of results has been derived from different opinion models. Nevertheless this theoretical efforts require at some point a confrontation with empirical data, which has been mostly elusive. The difficulty of designing social experiments is certainly one of the reasons. Nevertheless the present big data paradigm should help us in this direction. We claim that election data is a rich source of data for contrasting opinion models.

We try to fill the gap between theory and observations by testing the voter model as a model for voters. We develop a metapopulation framework for the voter model which incorporates the mobility patterns that are available from commuting data. Furthermore using real data on commuting behavior and population sizes incorporates to the model the non trivial heterogeneities found in real demographic data. We contrast the results of the model with features of election results and find that certainly the voter model is able to explain spatial features observed in real elections.

SOE 11: Opinion Formation II

Time: Tuesday 11:15–11:45 Location: H37

SOE 11.1 Tue 11:15 H37

Opinions, Conflicts and Consensus: Modeling Social Dynamics in a Collaborative Environment — •János Török[1], Gerardo Iñiguez[2], Taha Yasseri[1], Maxi San Miguel[3], Kimmo Kaski[2], and János Kertész[4,1,2] — [1]Institute of Physics, Budapest University of Technology and Economics, H-1111 Budapest, Hungary — [2]Department of Biomedical Engineering and Computational Science, FI-00076 Aalto, Finland — [3]FISC (CSIC-UIB), Campus Universitat Illes Balears, E-07071 Palma de Mallorca, Spain — [4]Center for Network Science, Central European University, H-1051 Budapest, Hungary

Information-communication technology promotes collaborative environments like Wikipedia where, however, controversiality and conflicts can appear. To describe the rise, persistence, and resolution of such conflicts we devise an extended opinion dynamics model where agents with different opinions perform a single task to make a consensual product. As a function of the convergence parameter describing the influence of the product on the agents, the model shows spontaneous symmetry breaking of the final consensus opinion represented by the medium. For the case when agents are replaced with new ones at a

certain rate, a transition from mainly consensus to a perpetual conflict occurs, which is in qualitative agreement with the scenarios observed in Wikipedia.

SOE 11.2 Tue 11:30 H37

Stochastic model for the vocabulary growth in natural languages — •Martin Gerlach and Eduardo G. Altmann — Max-Planck-Institute for the Physics of Complex Systems

We propose a stochastic model for the number of different words in a given database which incorporates the dependence of the database size and historical changes. The main feature of our model is the existence of two different classes of words: (i) a finite number of core-words which have higher frequency and do not affect the probability of a new word to be used; and (ii) the remaining virtually infinite number of noncore-words which have lower frequency and once used reduce the probability of a new word to be used in the future. Our model is motivated by a careful analysis of the google-ngram database of books published in the last centuries and its main consequence is the generalization of Zipf's and Heaps' law to two scaling regimes. We confirm that this approach yields the best simple description of the data among generic linguistic models and that the two free parameters depend only on the language but not on the database. From the point of view of our model the main change on historical time scales is the composition of the specific words included in the finite list of core-words, which we observe to decay exponentially in time with a rate of approximately 30 words per year.

SOE 12: Risks and Large Deviations in Economic Networks II

Time: Tuesday 11:45–12:00 Location: H37

SOE 12.1 Tue 11:45 H37

Large-deviation properties of simple energy-grid models — •Alexander K. Hartmann — Institute of Physics, University of Oldenburg

Here the large-deviation properties of a simple model of the stability of energy grids and other transport networks are studied numerically [1]. The model is based an the shortest-path edge centrality which is used to estimate the amount of additional reserve capacity which must be available to prevent cascading failures upon the failure of the most important connections. The large-deviation properties of the distribution of this reserve capacity are obtained using specifically biased [2] Monte Carlo simulations. This allows to obtain the distribution easily in regions where the probabilities are as small as 10^{-40}. In particular the most resilient (optimum) as well as the least resilient (worst) networks are obtained during the simulations. The results, in particular fits to assess the shape of the distributions are obtained for different graph ensembles like two-dimensional diluted grids, Small-World networks and Erdős-Rényi random graphs.

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

[2] A.K. Hartmann, Sampling rare events: statistics of local sequence alignments, Phys. Rev. E **65**, 056102 (2002)

SOE 13: Economic Growth and Longevity II (Invited Talk Geoffrey West)

Time: Tuesday 12:00–12:45 Location: H37

Invited Talk SOE 13.1 Tue 12:00 H37

The Complexity, Simplicity, and Unity of Living Systems from Cells to Cities; A Physicist's Search for Unifying Theories of Biological and Social Structure and Dynamics — •Geoffrey West — Santa Fe Institute, Santa Fe, NM, USA

Despite its extraordinary complexity, many of Life's most fundamental phenomena scale with size in a surprisingly simple and universal fashion. For example, metabolic rate scales approximately as the 3/4-power of mass over 27 orders of magnitude from complex molecules to multicellular organisms. Time-scales (such as lifespans and growth-rates) and sizes (such as genome lengths and RNA densities) scale with exponents which are typically simple multiples of 1/4. These "universal" scaling laws follow from dynamical and geometrical properties of space-filling, fractal-like, branching networks presumed optimised by natural selection. This leads to a quantitative framework that captures many essential features of diverse biological systems, including vasculature, growth, cancer, aging and death, sleep and DNA nucleotide substitution rates. Cities and companies also scale: wages, profits, patents, crime, disease, pollution, road lengths scale similarly across the globe, reflecting underlying social network dynamics and principles of organization that transcend their individuality. Are cities and companies "just" large organisms? Why then do almost all cities persist, yet all companies die? Why does the pace of life continue to accelerate and how is this related to innovation and wealth creation that fuel socio-economic systems? Answers to such questions have potentially dramatic implications for growth, development and global sustainability.

SOE 14: Evolutionary Game Theory (joint with BP and DY)

Time: Tuesday 15:00–16:00 Location: H37

SOE 14.1 Tue 15:00 H37

How selection pressure changes the nature of social dilemmas in structured populations — •Flavio Pinheiro[1,2], Francisco Santos[1,3], and Jorge Pacheco[1,4] — [1]ATP-Group CMAF at Universidade de Lisboa, Lisbon, Portugal — [2]Centro de Física at Universidade do Minho, Braga, Portugal — [3]Departamento de Engenharia Informática & INESC-ID, IST-UTL, Lisboa Portugal — [4]Departamento de Matemática e Aplicações at Universidade do Minho, Braga, Portugal

When members of a population engage in dyadic interactions reflecting a prisoner's dilemma game, the evolutionary dynamics depends crucially on the population structure, described by means of graphs and networks. Here, we investigate how selection pressure contributes to change the fate of the population. We find that homogeneous networks, in which individuals share a similar number of neighbors, are very sensitive to selection pressure, whereas strongly heterogeneous networks are more resilient to natural selection, dictating an overall robust evolutionary dynamics of coordination. Between these extremes, a whole plethora of behaviors is predicted, showing how selection pressure can change the nature of dilemmas populations effectively face. We further show how the present results for homogeneous networks bridge the existing gap between analytic predictions obtained in the framework of the pair-approximation from very weak selection and simulation results obtained from strong selection.

SOE 14.2 Tue 15:15 H37

How 'first carrot, then stick' incentives promote cooperation — •Tatsuya Sasaki[1,2], Xiaojie Chen[1], Åke Brännström[3,1], and Ulf Dieckmann[1] — [1]International Institute for Applied Systems Analysis, Laxenburg, Austria — [2]University of Vienna, Vienna, Austria — [3]University of Umeå, Umeå, Sweden

Social institutions often use rewards and penalties to promote cooperation. As providing such incentives tends to be costly, it is important to find efficient strategies for gauging positive and negative incentives

as a situation demands. Most game-theoretical studies of cooperation have, however, modeled rewarding and punishing in isolation and by focusing on peer sanctioning, through which each player separately decides whether or not to sanction a co-player.

Here, we study how a sanctioning policy we call 'first carrot, then stick' affects the evolution of cooperation in public good games. Assuming the existence of institutions that can provide incentives on a limited budget, we examine an adaptive sanctioning policy that switches the incentive from rewarding to punishing when defectors decrease below a certain frequency. We find that in well-mixed populations this policy is more efficient in promoting and maintaining full cooperation than either rewards or penalties alone. We also demonstrate that this finding extends to spatially structured populations. Such an institutional hybrid incentive with adaptive feedback is a simple yet unifying solution for encouraging cooperative behaviors.

SOE 14.3 Tue 15:30 H37

Learning, Evolution and Population Dynamics — Juergen Jost and •Wei Li — MPI for Math. in the Sci.

We study an iterated game, in which players from opposite populations are randomly paired, for the investigation of the interplay between individual optimization and population effects and for the comparison of different strategies and learning schemes. Players can rely on the information from previous encounters. A population adapts by selection, and/or the members of the population could learn individually, e.g., by reinforcement learning, or socially, via imitation.

The situation each player faces is changing, as coevolution exerts a high pressure on any learning strategy. Thus, the game between the populations is about quickly finding and converging to a favorable equilibrium. Within the population, the contest is about getting higher pay-offs.

The first aspect favors simple evolutionary schemes or learning strategies over more complex ones. The second aspect relates to the most effective use of the information from previous rounds or available within some social network inside the population.

We find an improved reinforcement learning that outperforms most evolutionary strategies, as well as the standard reinforcement learning with optimal parameters. The best imitating strategy here is payoff-biased. Imitating behavior can spread within a mixed population who can defeat a pure population with solely individual learners, independently of the precise learning scheme employed.

SOE 14.4 Tue 15:45 H37

Banish or vanish? The evolution of cooperation by social exclusion — •Tatsuya Sasaki[1,2] and Satoshi Uchida[3] — [1]International Institute for Applied Systems Analysis, Laxenburg, Austria — [2]University of Vienna, Vienna, Austria — [3]Rinri Institute, Tokyo, Japan

Fines and exclusion are ubiquitous, yet very different ways of punishing freeriders. In the former, punishers are allowed to fine freeriders at a cost to themselves. It is clearly difficult for only fines to promote cooperation due to this punisher's cost. Less clear is the latter, in which punishers are allowed to exclude freeriders from the common good at a cost to themselves. When does exclusion solve the commons dilemma?

We investigate the replicator dynamics in standard public good games with costly exclusion. Costly exclusion reduces the group size, but not necessarily the group benefit, and thus, the punisher's net payoff may increase through excluding freeriders. We demonstrate how exclusion of freeriders can establish a coercion-based regime. Our results do not require a genetic relationship, repeated interaction, reputation, or group selection. Instead, only a limited number of freeriders are required to prevent the second-order freeriders from eroding the social immune system.

SOE 15: Focus Session: Dynamics of Adaptive Networks (joint with DY and BP)

Adaptive Networks attracted recent interest through their dynamical properties that emerge from the interaction of two classes of processes (which may include stochasticity): (i) Growth and restructuring of the network topology itself, and (ii) Coupled dynamical systems defined on the network nodes. In this session, an introduction and overview into adaptive networks and their analytical and numerical investigation is complemented by their recent application to socio-economic, biological and epidemologic systems. (Session compiled by Eckehard Schöll, TU Berlin and Jens Christian Claussen, U Lübeck.)

Time: Wednesday 9:30–12:30 Location: H37

Topical Talk SOE 15.1 Wed 9:30 H37

Adaptive Networks: Of social interactions and mathematical tools — •Anne-Ly Do — Max-Planck-Institut für Physik komplexer Systeme, Dresden

Adaptive networks are characterized by the co-evolution of local and topological degrees of freedom. Prime examples are networks of social interactions: Individuals are altered and shaped through interaction with others. On the other hand, they can often decide with whom to interact. Adaptive network models of social systems have attracted keen interest as they promise to provide the key to a number of prominently discussed phenomena such as fragmentation of groups into like-minded subgroups, evolution or break-down of social structures promoting cooperation, and emergence of fairness and leadership. In this talk, I review recent studies that link emergent phenomena in social systems to adaptive feedback in the respective interaction nets. Moreover, I discuss the analytical techniques used, thus aiming to outline both, findings and tools.

SOE 15.2 Wed 10:00 H37

Controlling cluster synchronization by adaptive network topology — •Judith Lehnert[1], Anton Selivanov[2], Alexander Fradkov[2,3], and Eckehard Schöll[1] — [1]Institut für Theoretische Physik,TU-Berlin, Hardenbergstr 36, 10623 Berlin, Germany, — [2]SPb State University, Universitetskii pr.28, St.Petersburg, 198504 Russia — [3]Institute for Problems of Mechanical Engineering, Russian Academy of Sciences, Bolshoy Ave, 61, V. O., St. Petersburg, 199178 Russia

Adaptive networks are characterized by a complicated interplay between the dynamics on the nodes and a changing topology: The topology evolves according to the state of the system, while at the same time the dynamics on the network and thus its state is influenced by that topology. Here, we present an algorithm for a changing topology that allows us to control the dynamics on the network. In particular, we control zero-lag and cluster synchronization in delay-coupled networks of Stuart-Landau oscillators. Our method is robust towards different initial conditions. Furthermore, it is not necessary to adapt the network as a whole but it is sufficient to apply the method to a subset of the links to control the dynamics of all nodes. Finally, we discuss the topological characteristics of the network after successful control.

SOE 15.3 Wed 10:15 H37

Resilience of collective dynamics in fluctuating network environments — •Alexander Grimm — ETH Zürich, Chair of Systems Design, Switzerland

Do totalitarian networks perform better than democratic networks? What is the most appropriate hierarchy level for networks embedded in volatile environments? We use agent-based models to discover the effect of hierarchy on performance in networks located in highly fluctuating environments. We investigate the emergence of collective dynamics of many units embedded in complex network environments which change boundary conditions constantly. The agents have to adopt their behavior due to these constantly changing conditions. Although the individual node properties do not change, the network shows permanently changing structure with enormously differing properties. The fluctuating environments come into force via three different dynamics which happen on different time scales in adiabatic approximations. We show that a synchronization process is a good approach to model information transfer. The information transfer in the model interlinks the three dynamics. First, the link formation process is the most

fundamental process. It is driven by centrality. Second, the a synchronization process describes the information transfer among the nodes. And third, an endogenized node churn removes those nodes which deviate from the networks' common culture. In differing hierarchy values we find a phase transition in centrality. Hysteresis effects and trade-off properties make it possible to determine the most appropriate topology of the network, given its operation area.

SOE 15.4 Wed 10:30 H37

Absence of epidemic thresholds in a growing adaptive network — •Güven Demirel[1] and Thilo Gross[2] — [1]Max-Planck-Institute for the Physics of Complex Systems, Dresden, Germany — [2]University of Bristol, Bristol, United Kingdom

In epidemics on network, a central role is played by the degree distribution, i.e. the distribution of the number of neighbors of nodes. In particular in scale-free networks, where the variance of the degree distribution diverges, no epidemic thresholds exist, such that even diseases with arbitrary low infectiousness can percolate. By contrast, in networks where the variance of the degree distribution is finite, diseases generally need to surpass a threshold infectiousness to persist. In the real world the degree distribution is not independent of epidemics, but is shaped through disease induced behavioral changes and mortality in a complex interplay. Here, we consider the growth of a network from which nodes are simultaneously removed due to disease-induced mortality. We show analytically and numerically that in this system no epidemic thresholds exists, although the interplay between network growth and epidemic spreading leads to networks in which the degree distribution has a finite variance.

SOE 15.5 Wed 10:45 H37

Hierarchical transport structures in the network of *Physarum polycephalum* — •Werner Baumgarten and Marcus J. B. Hauser — Abteilung Biophysik, Otto-von-Guericke-Universität Magdeburg, Magdeburg, Germany

The plasmodium of the slime mould *Physarum polycephalum* consists of a single multinucleate giant amoeboid cell that forms a characteristic two-dimensional vein network. Through the entire tubular network protoplasm is transported periodically back and fro. During evolution this transportation network is optimized for efficiency [1].

The vein network of *P. polycephalum* is considered a weighted undirected graph, with veins as edges and branching points as nodes, the weight is given by the local drag of each vein [2]. A graph analysis is performed on the network of *P. polycephalum* based on the conjecture of laminar flow in the veins. Experiments to quantify the structure were carried out on multiple scales. We demonstrate that the network posses a self-similar hierarchic structure which consists of nested loops of veins of decreasing transport efficiency. These results are used to describe the network evolution.

[1] A. Tero, S. Takagi, T. Saigusa, K. Ito, D. P. Bebber, M. Fricker, K. Yumiki, R. Kobayashi, T. Nakagaki, 2010, Science, 327, 439

[2] W.Baumgarten, T. Ueda, M.J.B. Hauser, Phys. Rev. E 2010, 82, 046113

SOE 15.6 Wed 11:00 H37

Natural emergence of clusters and bursts in network evolution — •James Bagrow and Dirk Brockmann — Northwestern University

Network models with preferential attachment, where new nodes are injected into the network and form links with existing nodes proportional to their current connectivity, have been well studied for some time. Extensions have been introduced where nodes attach proportional to arbitrary fitness functions. However, in these models attaching to a node increases the ability of that node to gain more links in the future. We study network growth where nodes attach proportional to the clustering coefficients, or local densities of triangles, of existing nodes. Attaching to a node typically lowers its clustering coefficient, in contrast to preferential attachment or rich-get-richer models. This simple modification naturally leads to a variety of rich phenomena, including aging, non-poissonian bursty dynamics, and community formation. This shows that complex network structure can be modeled without artificially imposing multiple dynamical mechanisms.

SOE 15.7 Wed 11:15 H37

Evolution of Cooperation on Stochastic Dynamical Networks — •Bin Wu and Arne Traulsen — Research Group for Evolutionary Theory, Max-Planck-Institute for Evolutionary Biology, Plön, Germany

Cooperative behavior that increases the fitness of others at a cost to oneself can be promoted by natural selection only in the presence of an additional mechanism. One such mechanism is based on population structure, which can lead to clustering of cooperating agents. Recently, the focus has turned to complex dynamical population structures such as social networks, where the nodes represent individuals and links represent social relationships. We investigate how the dynamics of a social network can change the level of cooperation in the network. Individuals either update their strategies by imitating their partners or adjust their social ties. For the dynamics of the network structure, a random link is selected and breaks with a probability determined by the adjacent individuals. Once it is broken, a new one is established. This linking dynamics can be conveniently characterized by a Markov chain in the configuration space of an ever-changing network of interacting agents. Our model can be analytically solved provided the dynamics of links proceeds much faster than the dynamics of strategies. This leads to a simple rule for the evolution of cooperation: The more fragile links between cooperating players and non-cooperating players are (or the more robust links between cooperators are), the more likely cooperation prevails. Our approach may pave the way for analytically investigating coevolution of strategy and structure.

Topical Talk SOE 15.8 Wed 11:30 H37

Bio-molecular Networks: Structure, Function, Evolution — •Michael Lässig — Institut für theoretische Physik, Universität zu Köln

In biological systems, networks exist at multiple levels. One is structure: components of a system are linked because they are close in space. An example is the adjacency of amino acids in a protein. Another level is function: components are linked because they do something together, such as the genes in a regulatory or metabolic network. In this talk, I discuss how structure and function networks shape the evolutionary dynamics of organisms and species - and conversely, how evolutionary observations can uncover underlying functional networks. I use two examples: the evolutionary properties of gene regulatory networks and the evolution of the human influenza virus.

Topical Talk SOE 15.9 Wed 12:00 H37

Adaptive networks and critical dynamics — •Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen

Dynamical networks have been studied from the perspective of statistical physics, motivated by questions of information processing in neural networks and genetic networks. In both applications, hypotheses have been discussed that relate optimality of information processing to dynamical criticality in the networks. Consequently, toy models for adaptive networks have been constructed that robustly establish criticality in the network. Here I review a particularly simple model class based on models from physics and discuss its application to the phenomenon of criticality in biological neural networks.

[1] M. Rybarsch and S. Bornholdt, Self-organized criticality in neural network models, in: "Criticality in Neural Systems", Niebur E, Plenz D, Schuster HG (eds.) 2013 (in press); arXiv:1212.3106.

[2] M. Rybarsch and S. Bornholdt, Binary threshold networks as a natural null model for biological networks, Phys. Rev. E 86 (2012) 026114.

[3] M. Rybarsch and S. Bornholdt, Self-organization to criticality in neural networks: A minimal model with binary threshold nodes, arXiv:1206.0166.

SOE 16: Networks (Invited Talk Kim Sneppen)

Time: Wednesday 15:00–15:45 Location: H37

Invited Talk SOE 16.1 Wed 15:00 H37

Information spreading and multi-stability in social systems — •Kim Sneppen — Niels Bohr Institute, Copenhagen, Denmark

Information spreading and "winner takes all" competition are ingredients in social system formation. Using word spreading and language competition as model systems, I will discuss [1] a simple model for word spreading, that emphasize information age as a selection principle, [2] a simple model for idea spreading, that emphasize the effect of social thresholds and [3] a model for preservation of diversity when multiple languages/opinions compete for dominance. Finally, I will briefly discuss implications for scale free versus modular structures of social networks [4].

[1] L. Lizana, N. Mitarai, H. Nakanishi, and K. Sneppen, PRE 83 (2011)
[2] S. Bornholdt, M. H. Jensen and K. Sneppen, PRL 106 (2011)
[3] K, Sneppen and N. Mitarai, PRL. 109 (2012)
[4] M. Rosvall and K. Sneppen, PRE 79 (2009)

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

Time: Wednesday 15:45–17:00 Location: H37

SOE 17.1 Wed 15:45 H37

Eigenvector centrality as a measure of influence in dynamics on networks — •Konstantin Klemm[1], M. Angeles Serrano[2], Victor M. Eguiluz[3], Maxi San Miguel[3], and Fakhteh Ghanbarnejad[4] — [1]Bioinformatics, Institute for Computer Science, Leipzig University, Germany — [2]Fisica Fonamental, University of Barcelona, Spain — [3]Institute for Cross-Disciplinary Physics and Complex Systems, Palma de Mallorca, Spain — [4]MPI for Physics of Complex Systems, Dresden, Germany

Definitions of centrality aim at quantifying the importance of a node in a given graph. Among many others, the degree, the betweenness and the closeness are examples of frequently used measures of centrality. Here we ask which notion of centrality is best suited for predicting the influence a node has on dynamics. The concept of dynamical influence is made rigorous for a class of dynamical rules that asymptotically lead the system to a stationary state $y(\infty)$ from any initial condition $y(0)$. Then the influence of node v is the dependence of the asymptotic state on the initial condition $y_v(0)$ at node v. We find that the principal eigenvector of the coupling matrix is an accurate predictor of influence for various kinds of dynamics [1,2], including critical epidemic and Ising models, Boolean networks, the voter model as well as Kuramoto and Rössler oscillators.

[1] Klemm et al., Scientific Reports 2, 292 (2012).
[2] Ghanbarnejad and Klemm, EPL 99:58006 (2012).

SOE 17.2 Wed 16:00 H37

A macroscopic view on temporal networks — •Hartmut Lentz[1,2], Thomas Selhorst[1], and Igor M Sokolov[2] — [1]Friedrich-Loeffler-Institute, Federal Research Institute for Animal Health, 16868 Wusterhausen, Germany — [2]Humboldt-University of Berlin, 12489 Berlin, Germany

The concept of accessibility graphs can be extended to temporal networks. An accessibility graph (transitive closure) of a network contains a link, wherever there is a path of arbitrary length between node pairs. Building an accessibility graph by consecutively adding paths of growing length ("unfolding") yields information about the distribution of shortest path durations and reveals characteristic time-scales in temporal networks. Accessibility contributes a key element for a theoretical framework for the macroscopic analysis of temporal networks, because it maps the whole causal path structure of the system onto a single mathematical object. In addition, we define a causal fidelity, measuring the goodness of the static representation of a temporal network. The methods provided here can be implemented efficiently and their capability is demonstrated in applications, as shown by our discussion of three temporal network data sets, namely social contacts, livestock trade and sexual contacts.

Reference: Unfolding accessibility provides a macroscopic approach to temporal networks, arXiv:1210.2283.

SOE 17.3 Wed 16:15 H37

Clustering coefficient of temporal networks — •Vitaly Belik[1,2], Igor M Sokolov[3], and Hartmut Lentz[3,4] — [1]Max Planck Institute for Dynamics and Self-Organization, Göttingen — [2]Massachusetts Institute of Technology, Cambridge, USA — [3]Humboldt-University of Berlin — [4]Friedrich-Loeffler-Institute, Wusterhausen

The science of complex networks has experienced a tremendous development in recent years. Most of the research was devoted to static networks where interactions between nodes are aggregated over time. However with increasing availability of empirical data of high temporal resolution, the dynamics of networks becomes the focus of research. In the present study we generalize the concept of clustering coefficient to temporal networks allowing for arbitrary durations of triangles fulfilling the requirement of causality. In contrast to many algorithmic approaches, we build up on the current advances in the mesoscopic description of temporal networks [1]. We apply our approach to various empirical datasets, in particular a conference contact network and a mobile phone dataset, as well as to their randomized counterparts.

[1] Unfolding accessibility provides a macroscopic approach to temporal networks, H Lentz, T Selhorst, I M Sokolov, arXiv:1210.2283

SOE 17.4 Wed 16:30 H37

Devil's Staircases, Crackling Noise and Phase Transitions in Percolation — •Jan Nagler — Max Planck Inst. f. Dyn. & Self-Organization

We identify and study certain phenomena in percolation that can subvert predictability and controllability in networked systems. We establish devil's staircase phase transitions, non-self-averaging, and power-law fluctuations in percolation. We provide exact conditions for percolation that exhibits multiple discontinuous jumps in the order parameter where the position and magnitude of the jumps are randomly distributed - characteristic of crackling noise. The framework is linked to fragmentation processes, where groups or particles repeatedly split up, to susceptible-infected type dynamics, and also to effects in ferromagnetic materials.

SOE 17.5 Wed 16:45 H37

Resilience to Leaking - Dynamic Systems Modeling of Information Security — •Kay Hamacher — Department of Computer Science, Department of Physics & Department of Biology, Technische Universitaet Darmstadt, Germany

Leaking of confidential material is a major threat to information security. This insight become popular wisdom since Wikileaks, which hopes to attack 'unjust' systems or 'conspiracies'.

Eventually, such threats to information security rely on a biologistic argument on the benefits and drawbacks that uncontrolled leaking might pose for 'just' and 'unjust' entities. Such biological metaphors are almost exclusively based on the economic advantage of participants.

Here, I introduce a mathematical model of the complex systems dynamics implied by leaking. The complex interactions of adversaries are modeled by coupled logistic equations including network effects of econo-communication networks.

Situations might arise where leaking can strengthen the 'conspiracy'. The only impact leaking can have on an organization originates in the exploitation of leaks by a competing entity. We conclude that leaks can be used as a 'tactical mean' in direct adversary relations, but do not necessarily increase public benefit.

Within the model exploiting the competition between entities seems to be a more promising approach to control malicious organizations: divide-et-impera policies triumph here.

[1] K. Hamacher, "Resilience to Leaking - Dynamic Systems Modeling of Information Security", PLoS One, 2012, accepted

SOE 18: Focus Session: Modern Power Grid, Nonlinear Dynamics and Self-Organization (joint with DY)

The drastic change from our traditional energy system based on fossil fuels to one based dominantly on renewable sources provides an extraordinary challenge for the robust operation of future power grids. Complementing standard approaches of electric engineering with principles of self-organization and methods from nonlinear dynamics may help us to understand collective dynamical grid features, emerging due to increasing decentralization, line upgrades, and correlated fluctuations. The Focus Session provides a snapshot of current research in this emerging cross-disciplinary field and points to pressing problems to be addressed in the near future. (Organizers Dirk Witthaut and Marc Timme)

Time: Wednesday 15:00–17:30 Location: H44

Invited Talk SOE 18.1 Wed 15:00 H44

Energiewende 2.0 * the transformation of energy systems in uncertain times — •Jürgen-Fr. Hake and Wolfgang Fischer — FZ Jülich

The German Energiewende represents a very ambitious national political program. The specific targets range from GHG emissions reduction motivated by the mitigation of climate change to technology specific goals emphasizing renewable energy in contrast to nuclear energy. The scope of the Energiewende covers a period of time of about 40 years. Scenario-based analyses point out the feasibility of this politically enforced transformation. A closer look at these scenarios also shows their limitations with respect to the socio-economic foundation and the technological differentiation. Moreover, in many cases linear models are used to describe the system under investigation which might be regarded as another weak point. These deficiencies require an integrated assessment covering **in- depth description of the anticipated major socio-political trends, **the economic embedding of the energy sector, and **an detailed well-balanced technology portfolio. A major criterion for all national initiatives is the compatibility with the transformation of the EU system.

Invited Talk SOE 18.2 Wed 15:30 H44

Basin Stability and its Consequences for Power Grids — •Jürgen Kurths, Peter Menck, and Peng Ji — Potsdam Institute for Climate Impact Research, P.O. Box 601203, 14412 Potsdam,

The human brain, power grids, arrays of coupled lasers, and the Amazon rainforest contain the same seed of trouble: multistability. With undesired states looming in state space, it matters strongly how stable the desired state is against major perturbations. Surprisingly, this basic question has so far received little attention. Here we claim that the traditional linearization-based approach to stability is too local to answer it. As a complement, we suggest to quantify stability in terms of basin stability, a new measure related to the volume of the basin of attraction. Basin stability is non-local, non-linear, and easily applicable even to high-dimensional systems. Its consequences for evaluating stability of power grids and their will be discussed.

Invited Talk SOE 18.3 Wed 16:00 H44

Requirements and Concepts for Self-Organized Agent-Based Control in Smart Distribution Grids — •Astrid Niesse — OFFIS - Institute for Information Technology

Transforming the existing power generation to renewable, distributed generation implicates an increase in complexity for the control of the overall system. We propose a distributed control method to launch products of self-organized coalitions of small active units in a power grid at markets for trading active power as well as ancillary services. Our concept combines the integration of grid restrictions into proactive scheduling of active power with provision of ancillary services, and additionally provides reactive scheduling of active power, e.g. in the case of ancillary service activation.

In this talk, an overview on requirements for distributed control on smart distribution grid is given, along with results on how this ICT-based approach can be realized using software agents.

Invited Talk SOE 18.4 Wed 16:30 H44

A 100% renewable power system in Europe — •Martin Greiner[1], Sarah Becker[2], Rolando Rodriguez[1], Tue Jensen[1], Timo Zeyer[1], Anders Soendergaard[1], and Gorm Andresen[1] — [1]Aarhus University, Aarhus, Denmark — [2]FIAS, Frankfurt, Germany

Todays overall macro energy system based on fossil and nuclear resources will transform into a future system dominantly relying on fluctuating renewable resources. At the moment it is not really clear what will be the best transitional pathway between the current and the future energy system. In this respect it makes sense to think backwards, which means in a first step to get a good functional understanding of fully renewable energy systems and then in a second step bridge from there to todays energy system. Based on state-of-the-art high-resolution meteorological and electrical load data, simple spatio-temporal modelling, solid time-series analysis and the physics of complex networks, fundamental properties of a fully renewable pan-European power system are determined. Amongst such characteristics are the optimal mix of wind and solar power generation, the optimal combination of storage and balancing, the optimal extension of the transmission network, as well as the optimal ramp down of fossil and nuclear power generation during the transitional phase. These results indicate that the pathways into future energy systems will be driven by an optimal systemic combination of technologies, and that economy and markets have to follow technology.

SOE 18.5 Wed 17:00 H44

Synchronization and Voltage Stability in a Network of Synchronous Machines — •Katrin Schmietendorf and Rudolf Friedrich — Institute for Theoretical Physics, University of Münster, Germany

Since the progressive integration of renewable energy sources involves substantial changes in grid topology and feed-in characteristics, the questions of power system stability and design have to be reconsidered. Power system stability, or more precisely rotor angle stability, is related to synchronization phenomena as the classical synchronous machine representation can be shown to correspond to a modified version of the prominent Kuramoto model. The Kuramoto model describes the dynamics of a population of coupled oscillators displaying a phase transition from incoherence to partial synchronized states. In this talk we extend the classical Kuramoto-like model which assumes constant voltages by adding dynamical voltage equations. This yields a model which allows to treat both rotor angle and voltage stability and involves the feature of rotor angle and voltage stability interplay. We compare the behaviour of small networks of synchronous machines governed by the classical and the extended model during and after being subjected to different types of disturbances and discuss the implications for the simulation of complex power grids.

SOE 18.6 Wed 17:15 H44

How trading impacts distribution in complex power grids — •Sebastian Klipp[1], Dirk Witthaut[1], and Marc Timme[1,2] — [1]Network Dynamics, Max Planck Institute for Dynamics and Self-Organization, 37077 Göttingen — [2]Faculty of Physics, University of Göttingen

Instabilities in the collective dynamics of power grids may induce transmission line overloads or even large-scale power outages. One possible source of instability is the energy trading market that modifies locations, times, and volumes of electric power generation and demand. Here we investigate how economic factors can influence the distribution of energy-flow in a power-grid. We reveal that and how the interdependence of the economic and the physical network can induce dynamic instabilities and explain the mechanisms underlying them. These results offer a complementary perspective on the development of smart power grids and the integration of renewable energies.

SOE 19: Social Systems and Group Dynamics

Time: Wednesday 17:00–18:00 Location: H37

SOE 19.1 Wed 17:00 H37

Complex Communication between Social Whales — •Sarah Hallerberg[1], Heike Vester[2], Kurt Hammerschmidt[4], and Marc Timme[1,3] — [1]Network Dynamics, Max Planck Institute for Dynamics and Self-Organization, Göttingen — [2]Ocean Sounds, Henningsvaer, Norway — [3]Faculty of Physics, University of Göttingen — [4]Research Group Cognitive Ethology Lab, German Primate Center, Göttingen

Complex vocal communication simultaneously requires high cognitive abilities, a large flexibility in sound production, and advanced social interactions. Among non-humans, social whales are closest to fulfill these requirements. The fundamentals about how acoustic signals are used and how acoustic patterns are organized, however, are largely unknown. Up to date, mostly human observers classify acoustic patterns through hearing and visual comparison of spectrograms, making any such classification partly unreliable and highly subjective. Thus, objectively relating specific acoustic patterns to an observed context seems impossible so far. Here, we propose a novel perspecitve and study distributions of acoustic features (in particular, cepstrum coefficients) generated from *ensembles* of killer whale vocalizations conditioned on contexts. Comparing these distributions by computing Kullback-Leibler-divergences we find substantially different distributions for specific behavioural contexts, such as Salmon-feeding, Herring-feeding or non-feeding.

SOE 19.2 Wed 17:15 H37

Transition due to preferential cluster growth of collective emotions in online communities — •Anna Chmiel and Janusz Hołyst — Faculty of Physics, Center of Excellence for Systems Research, Warsaw University of Technology, Poland

We consider a preferential cluster growth in a stochastic model describing the dynamics of a binary Markov chain with a long-range memory. The model is driven by data corresponding to emotional patterns observed during online communities' discussions with binary states corresponding to emotional valencies. The system undergoes a transition where a preference exponent describing the memory strength is changed. For low values of this exponent both emotional states are observed during the string evolution in the majority of simulated discussion threads. When the exponent crosses a characteristic value, in the majority of threads an ordered phase emerges, i.e. from a certain time moment only one emotion is represented. The transition becomes discontinuous in the thermodynamical limit when the discussions are infinitely long and even an infinitely small preference exponent leads to the ordering behavior in every discussion thread. Numerical simulations are in a good agreement with approximated analytical formula. The ordered phase is visible in Blog06 dataset although its volume is limited by fluctuations and sentiment classification errors.

SOE 19.3 Wed 17:30 H37

Entropy-growth-based model of emotionally charged online dialogues — Julian Sienkiewicz[1], Marcin Skowron[2], Georgios Paltoglou[3], and •Janusz Hołyst[1] — [1]Faculty of Physics, Center of Excellence for Complex Systems Research, Warsaw University of Technology, Poland — [2]Interaction Technologies Group, Austrian Research Institute for Artificial Intelligence, Austria — [3]School of Technology, University of Wolverhampton, United Kingdom

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

SOE 19.4 Wed 17:45 H37

Resilience of social-ecological systems — •Steven Lade[1,2] and Maja Schlüter[1] — [1]Stockholm Resilience Centre, Stockholm University, Sweden — [2]Nordita, KTH Royal Institute of Technology and Stockholm University, Sweden

'Resilience' is emerging as a key concept that researchers and organisations (including the United Nations) use to understand and deal with many of the problems facing contemporary environment and society. In this talk I provide a brief overview of research on the resilience of social-ecological systems and how physicists could contribute to its future development. First, local stability concepts of nonlinear dynamics are closely linked to the original, resistance to shock conception of resilience. I summarise one recent work in which a recently developed tool of nonlinear dynamics, generalised modelling, has been used to better understand the behaviour of a social-ecological system. Second, and especially recently, the understanding of resilience has expanded to include the ability of a system to adapt and transform in response to threats and challenges, as well as an increased emphasis on the interactions and feedbacks between the social and ecological parts of the system. So far modelling studies have generally not kept pace with these conceptual developments, but as I will outline network perspectives show potential to do so. Brainstorming on other modelling approaches that may meet modern challenges of resilience research will also be most welcome.

SOE 20: Traffic Dynamics, Urban and Regional Systems

Time: Wednesday 18:00–18:15 Location: H37

SOE 20.1 Wed 18:00 H37

About CO2 emissions from cities: scaling with city-size — •Diego Rybski, Till Sterzel, Dominik E. Reusser, Christina Fichtner, and Jürgen P. Kropp — Potsdam Institute for Climate Impact Research, 14469 Potsdam, Germany

Analyzing CO2 emission inventories of almost 200 cities from various countries we find power-law relations between the emissions and city size, measured in population. The results suggest that in developing countries large cities emit more CO2 per capita compared to small cities, i.e. they tend to comprise super-linear correlations. For developed countries the results suggest the opposite, i.e. linear or sub-linear correlations, implying better efficiency of large cities. We derive how the total emissions of an entire country relate with the power-law correlations and find that the size of the most populated city is dominating in the case of linear and super-linear correlations, while a transition occurs to sub-linear correlations, where the size of the largest city has no influence. We conclude that from the climate change mitigation point of view, urbanization is desirable in developed countries and should be avoided in developing countries, if efficiency increasing mechanisms can not be established.

SOE 21: Annual Member's Assembly of SOE

Time: Wednesday 18:20–19:20 Location: H37

The annual member's assembly of SOE (chairman's report, announcements of conferences, workshops or summerschools, followed by a general discussion on future activities of SOE). After the Member's Assembly, there will be a social gathering at one of the many restaurants in Regensburg (details will be announced during the assembly).

SOE 22: Focus Session: Big Data (joint with jDPG)

The availability of large-scale data invades all areas of econophysics, sociodynamics, as well as bioinformatics and poses methodical challenges for data analysis, visualization and modeling. This session provides an overview how methods adapted from statistical physics and network analysis deepen the understanding of the interaction of humans through language and social media, their emergent collective behaviour the assessment of risks and the detection of crises. (Session compiled by Kerstin Kämpf, TU Darmstadt and Jens Christian Claussen, U Lübeck.)

Time: Thursday 9:30–12:30 Location: H37

Topical Talk SOE 22.1 Thu 9:30 H37

Physics and the Information Society: Turning Big Data into Big Insight — •René Pfitzner — ETH Zurich, Chair of Systems Design, Switzerland

As of today 2.3 Billion people are online, spend 1 Billion hours on the web, write 400 Mio. tweets and produce a total of 65 terabytes of Facebook content – every day.
Inspired by these impressive numbers, in this talk I will illustrate two main points about "Big Data" research. First, based on examples I will show how the availability of large amounts of "online" data facilitates research to gain insights into "offline" phenomena like disease spreading. Second, I will show that in complex information systems, composed of interacting social and technical components, non-trivial questions about information propagation, the emergence of memes or measuring the relevance of content occur.
I will point to methodologies that have been developed, and continue to be developed, to cope with these research challenges and opportunities - often inspired by theories well known from the Physics literature.

Invited Talk SOE 22.2 Thu 10:00 H37

Network analysis literacy — •Katharina Anna Zweig — TU Kaiserslautern, Computer Science Department, Graph theory and complex network analysis, Gottlieb-Daimler-Str. 48, 67663 Kaiserslautern, Germany

Big data often comes in a form that relates objects or subjects to each other. Examples for this kind of data describe interactions between proteins or people, plane connections between cities, or references from articles to other articles. Relational data is best analyzed by network analytic measures which have been proven useful in very different disciplines; high hopes have been put in them to finally understand the complex systems surrounding us. While network analysis is often very successful, in this talk I will show that not all relational data should actually be represented as a network and that not all measures are likely to give reasonable results in all contexts. I will discuss the "trilemma of social network analysis" which puts an emphasis on matching the data and its network representation, the method to use, and the question to be answered.

Invited Talk SOE 22.3 Thu 10:30 H37

From Noise to Signal. Stories about big data. — •Sune Lehmann[1], Yong-Yeol Ahn[2], Alan Mislove[3], Jukka-Pekka Onnela[4], and Niels James Rosenquist[5] — [1]Technical University of Denmark, Kgs Lyngby, Denmark — [2]Indiana University, Bloomington Indiana — [3]Northeastern University, Boston, MA, USA — [4]Harvard School of Public Health, Boston, MA, USA — [5]Mass General Hospital, Boston, MA

This talk tells the story of how we used over 300 million tweets (Sep 2006 - Aug 2009) to map the collective mood of the United States. The mood of each tweet was inferred using a simple word-list (ANEW), and the results are represented as density-preserving cartograms. A cartogram is a map in which the mapping variable (in this case, the number of tweets) is substituted for the true land area. Thus, the geometry of the actual map is altered so that the shape of each region is maintained as much as possible, but the area is scaled in order to be proportional to the number of tweets that originate in that region. For the final part of the talk, we will discuss the importance of visualization in analysis of Big Data as well as new developments in the area of Big Data.

SOE 22.4 Thu 11:00 H37

Geopolitical risk-index derived from 60 million news articles predicts war — •Thomas Chadefaux — Chair of sociology, modeling and simulation, ETH Zurich, Clausiusstrasse 50, 8092 Zurich, Switzerland

There have been more than 200 wars since the start of the 20th century, leading to about 35 million battle deaths. However, efforts at forecasting conflicts have so far performed poorly for lack of fine-grained and comprehensive measures of geopolitical tensions. Here, we developed a weekly risk-index by analyzing a comprehensive dataset of historical newspaper articles for 166 countries over the past century, which we then tested on a data of all conflicts within and between countries recorded since 1900. Using only information available at the time, we could predict the onset of a war within the next year with up to 85% confidence; we also forecasted over 70% of large-scale wars, while issuing false alarms in only 16% of observations. Predictions were improved up to one year prior to interstate wars, and six months prior to civil wars, giving policy-makers significant additional warning time.

SOE 22.5 Thu 11:15 H37

Big data; fame and money, box office prediction based on Wikipedia activity data — Márton Mestyán[1], •Taha Yasseri[1,2,3], and János Kertész[1,3,4] — [1]Institute of Physics, Budapest University of Technology and Economics, Budapest, Hungary — [2]Oxford Internet Institute, University of Oxford — [3]Department of Biomedical Engineering and Computational Science, Aalto University, Aalto, Finland — [4]Center for Network Science, Central European University, Budapest, Hungary

Use of socially generated Big Data to predict the collective reaction of individuals in societies to a certain event or product has become of great interest in recent years. In this work [1], we investigate the possibility of making precise predictions for the financial success of movies, by monitoring activity and the traffic on Wikipedia articles on the movies. We consider a sample of 312 movies released in the USA market in 2010, and show that, by using a minimalistic linear regression model, one could easily outperform the existing prediction methods. Our model, free of any content analysis, reaches a coefficient of determination of 0.92, one month prior to the movie release.

[1] Márton Mestyán, Taha Yasseri, and János Kertész, Early Prediction of Movie Box Office Success based on Wikipedia Activity Big Data, preprint available at: arXiv:1211.0970.

Topical Talk SOE 22.6 Thu 11:30 H37

Information Retrieval, Applied Statistics and Mathematics on BigData — •Romeo Kienzler — IBM Innovation Center Zurich, Switzerland

Although the majority of algorithms used for BigData Analytics have been developed decades ago, their application on BigData currently experiences a renaissance. In this talk a selection of algorithms and their application will be discussed in the context of BigData. A set of selected Use Cases in the field of Social Network Analysis, Bioinformatics, Financial Fraud Detection and Information Retrival will be discussed. Besides theoretical viewpoints this talk covers also runtime environments for BigData application and explains concepts of data parallelism, partition skew, aggregated storage to CPU bandwidth and fault tolerance on commodity hardware. Besides the omnipresent MapReduce/Hadoop example, which seems to be the de facto standard, we will also discuss massive parallel data warehousing and stream computing. Finally, a technical outlook tries to separate theory from reality, future from presence and hype from vision.

Invited Talk SOE 22.7 Thu 12:00 H37

Web-Based Cognitive Science: Harnessing the Power of the Internet to Study Human Cognition — •Christopher Y. Olivola — University of Warwick, UK

The Internet provides a unique and powerful tool for the social sciences, allowing researchers to collect data and carry out experiments at scales that were previously unfeasible. So far, web-based social science has mainly focused on aggregate behaviors and large-scale phenomena. In

contrast, the enormous potential of the Internet has been much less utilized by behavioral scientists studying individual behaviors and their underlying cognitive processes. In this presentation, I will discuss several examples of how web-based research methods can both aid the study of cognition and directly clarify its contents. In particular, I will highlight 4 distinct ways in which cognitive scientists can utilize the Internet: (1) running web-based experiments with large samples of human participants (at low cost); (2) using online games to collect data from intrinsically motivated participants (for free); (3) studying *naturally* occurring online individual behaviors; (4) measuring the contents of memory and the dynamics of attention over time. I will conclude by discussing how students and researchers with a quantitative background (e.g., physicists) can utilize the web to advance our understanding of human cognition.

SOE 23: Innovation Dynamics (Invited Talk Vittorio Loreto)

Time: Thursday 15:00–15:45 Location: H37

Invited Talk SOE 23.1 Thu 15:00 H37

Modelling innovation as expansion into the adjacent possible — Francesca Tria[1], •Vittorio Loreto[2,1], Vito D.P. Servedio[2], and Steven H. Strogatz[3,2] — [1]Institute for Scientific Interchange (ISI), Via Alassio 11C, 10126 Torino, Italy — [2]Physics Dept., Sapienza University of Rome, Piazzale Aldo Moro 5, 00185 Roma, Italy — [3]Cornell University, Dept. of Mathematics, 310 Malott Hall, Ithaca, NY 14853, USA

Innovation is a fundamental factor in the evolution of biological systems, human society and technology. By opening new possibilities, innovations pave the way for further innovations in an evolutionary process that Kauffman has called "expansion into the adjacent possible". In this talk we propose a simple mathematical model where the implications of this expansion are studied quantitatively and tested on four data sets capturing various facets of innovation in social and technological systems: the early adoption of new words in texts, the edit events of Wikipedia pages, the emergence of tags in annotation systems, and listening to new songs in online music catalogues. By quantifying the distinctive features of innovation via the adjacent possible, our results provide a starting point for a deeper understanding of this potentially important mechanism of biological, linguistic, cultural, and technological evolution.

SOE 24: Group Dynamics

Time: Thursday 15:45–17:15 Location: H37

SOE 24.1 Thu 15:45 H37

A statistical view on team handball results: home advantage, team fitness and prediction of match outcomes — •Jens Smiatek[1] and Andreas Heuer[2] — [1]Institut für Computerphysik, Universität Stuttgart, Germany — [2]Institut für Physikalische Chemie, WWU Münster, Germany

We analyze the results of the German Team Handball Bundesliga for ten seasons in a model-free statistical time series approach. We will show that the home advantage is nearly negligible compared to the total sum of goals. Specific interest has been spent on the time evolution of the team fitness expressed in terms of the goal difference. In contrast to soccer, our results indicate a decay of the team fitness values over a season while the long time correlation behavior over years is nearly comparable. We are able to explain the dominance of a few teams by large values for the total number of goals in a match. A method for the prediction of match winners is presented in good accuracy with the real results. We further analyze the properties of promoted teams and indicate drastic level changes between the Bundesliga and the second league. Our findings reflect in good agreement recent discussions on modern successful attack strategies.

SOE 24.2 Thu 16:00 H37

Human Interact in Evolving Online Affiliation Networks — •Diego Rybski[2,1], Lazaros K. Gallos[1], Fredrik Liljeros[3], Shlomo Havlin[4], and Hernan A. Makse[1] — [1]Levich Institute and Physics Department, City College of New York, New York, New York 10031, USA — [2]Potsdam Institute for Climate Impact Research, 14469 Potsdam, Germany — [3]Department of Sociology, Stockholm University, S-10691, Stockholm, Sweden and Institute for Futures Studies - Box 591, SE-101 31 Stockholm, Sweden — [4]Department of Physics, Bar-Ilan University, Ramat Gan 52900, Israel

We characterize online affiliation networks by observing their formation and evolution which allows us to analyze quantitatively the tendencies used to create ties. Therefore, we start by characterizing every single link when the tie was established in the network. This information allows us to identify significant differences in behavioral traits in the social tendencies among individuals according to their degree of activity, gender, age, popularity, and other attributes. For instance, in the particular data sets analyzed here, we find that women reciprocate connections 3 times as much as men and that this difference increases with age. Men tend to connect with the most popular people more often than women do, across all ages. On the other hand, triangular tie tendencies are similar, independent of gender, and show an increase with age. Our findings can be useful to build models of realistic social network structures and to discover the underlying laws that govern establishment of ties in evolving social networks.

SOE 24.3 Thu 16:15 H37

Mixture models of human mobility — •Peter Reisenauer and Jörg Reichardt — University of Würzburg, Würzburg, Germany

Understanding human mobility patterns is key to many applications, ranging from e-commerce to traffic forecasting and containment of epidemics. We present a mixture model of Markov processes for human mobility, that allows for efficient estimation from data via maximum likelihood or Bayesian techniques. We discuss the possible benefits of this model for the prediction of movement of individuals, as well as theoretical limitations of the approach, using both real world and simulated data.

SOE 24.4 Thu 16:30 H37

Prediction and predictability in systems with fat-tail distribution — •Jose M. Miotto and Eduardo G. Altmann — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

Availability of big databases of social media has triggered a wave of studies in such systems. Many different systems have shown to follow similar statistical behaviour (fat-tailed distributions) and to be modelled through similar models. Here we investigate the implications of these observations to prediction and predictability, into what extent it is possible to make a good prediction, and what are the factors that limit its quality. We focus our study in social systems in which many items are competing for a share of public attention; usually in these systems the distribution of activity among its items is fat-tailed, a feature that poses a big challenge to predictability. A paradigmatic case of study is the YouTube website: we collected a huge unbiased database of videos' activity time series, in which we tested some simple prediction schemes, and we report rigorous statistical measures of their performance and reliability. We analysed the possibilities of having a prediction with or without information about the previous popularity of a video, and we studied the role that fluctuations have in the performance measures.

SOE 24.5 Thu 16:45 H37

Quantitative indicators for roles in online discussion groups — Eleni Hitchinson and •Christian von Ferber — Applied Mathematics Research Centre, Coventry University, UK

A number of usenet groups have a long history where individual users are found to participate over long time ranges. These groups therefore

offer the possibility to test hypotheses like e.g. preferential attachment scenarios on such time scales.

Our focus is in particular on developing quantitative indicators for the type of discussion (e.g., technical or philosophical) and the self-defined roles of the participants. Analysing technical discussions we identify time evolving network motives that describe expert members who answer many questions while in philosophical discussions some members may occur who initiate a multitude of discussions. Developing indicators for such roles we may observe their evolution quantitatively.

SOE 24.6 Thu 17:00 H37

Ups and downs: how does the team strength of a soccer team vary with time? — •Andreas Heuer and Oliver Rubner — Institut für Physikalische Chemie, Corrensstr. 28/39, D-49149 Münster

The team strength of a soccer team can be defined in a straightforward manner [1,2]. Via some appropriate time series analysis of the German Bundesliga we characterize the temporal variations of the team strength. It is determined for very different time scales (match-to-match basis, intra-seasonal, inter-seasonal, 50 years of Bundesliga). Interestingly, during the course of a season the team strength just fluctuates around a team-specific but constant value. A sustainable variation of the team strength can only be detected during the summer break. However, even after many seasons dramatic long-time correlations remain present, in particular during more recent years. Good teams remain good and vice versa.

Based on this information it is checked whether knowledge of the current strength of a team as compared to its average strength during the season improves the prediction quality. Surprisingly, it turns out that due to the uncertainty of its estimation its consideration is irrelevant. In summary, the statistical description of the soccer Bundesliga is quite simple since the assumption of a constant season-specific team strength is already an excellent approximation.

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

[2] A. Heuer, "Der perfekte Tipp", Wiley-VCH (2012).

SOE 25: Poster session

Time: Thursday 17:15–19:00 Location: Poster C

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

SOE 25.1 Thu 17:15 Poster C

Quantum Monetary Science — •Stephen I. Ternyik — POB.201, D82043Munich

The physics of monetary systems is badly understood in the economics profession and the discipline lacks a scientific basis. In an advanced monetary production economy, all human needs are reduced into the need for money and the monetary quantum drives the dynamic efficiency of economic productivity.In this economic state, the typical working of the monetary body is the interplay of fiat credit from private banks via minimized fractional reserves and the emission of fiat money without the growth of economic productivity via public monetary police. This banking system is a violation of the physical or natural laws of economic production as the monetary sytem is a physical process of higher order, i.e. the global financial crisis is the result methodical monetary mischief; some economic alternatives to this systemic error shall be presented.

SOE 25.2 Thu 17:15 Poster C

The Calibration of the Extreme Value Equity Risk in the Solvency II Standard Model: An empirical Analysis — •Magda Schiegl — University of Applied Sciences, Landshut, Germany

The EU - project "Solvency II" aims to rule the regulatory capital requirements of all European insurance companies. A so called "Standard Model" has been developed that should calculate the individual, risk adequate capital every company should hold in order to survive a one in two hundred year event. In addition to the model the EU published the calibration methods as well as the calibrated values for the Standard Model's parameters. We focus in our work on the extreme value calibration of the equity risk. This part of the risk model aims to quantify the risk of equity-portfolio losses for insurance companies in the case of extreme market events. We compare the results of the EU calibration paper with empirical market data analysis and discuss the consequences.

SOE 25.3 Thu 17:15 Poster C

Dynamical Models of Dyadic Interactions with Delay — •Tadeusz Płatkowski, Natalia Bielczyk, and Urszula Foryś — Department of Mathematics, Informatics and Mechanics, Warsaw, Banacha 2

When interpersonal interactions between individuals are described by dynamical systems, the interactions are usually assumed to be instantaneous. In reality, a time delay should be included in the corresponding models. We investigate linear models of dyadic interactions with a discrete time delay. We prove that in such models the changes of stability of the stationary states from instability to stability or vice versa occur for various intervals of the parameters that determine the strengths of interactions. The analytical results indicate importance of deliberation in maintaining the stability of the relationship. The results also suggest that the joint strength of the reactions of the actors to the partner's state, described by the product of the strength of reactions of both partners, has greater impact on the dynamics of relationships than the joint strength of the reactions to their own states. The conditions guaranteeing arbitrary number of the changes of stability of the stationary state of the relationship are formulated and the relevant theorems are proved. The dynamics of interactions depend both on the strength of reactions of partners on their own emotional states as well as on the partner's state. Moreover, we have found that multiple stability switches are possible only when one of the partners reacts with delay to their own state. We also propose a generalization to triadic interactions.

SOE 25.4 Thu 17:15 Poster C

On the robustness of in- and out-components in a temporal network of animal trade — •Philipp Hövel[1,2,3], Mario Konschake[1,4], Hartmut Lentz[4,5], and Thomas Selhorst[5] — [1]Institut für Theoretische Physik, Technische Universität Berlin — [2]Bernstein Center for Computational Neuroscience Berlin — [3]Center for Complex Network Research, Northeastern University, Boston — [4]Friedrich-Loeffler-Institut, Wusterhausen — [5]Institut für Physik, Humboldt-Universität zu Berlin

Many networks exhibit time-dependent topologies, where an edge only exists during a certain period of time. In this work, we focus on the propagation properties of infectious diseases in time-dependent networks. In particular, we analyze a dataset containing livestock trade movements. The corresponding networks are known to be a major route for the spread of animal diseases and the chronology of contacts is crucial.

We find that a time-aggregated approach might fail to identify epidemiologically relevant nodes. Hence, we explore the adaptability of the concept of centrality of nodes to temporal networks using a data-driven approach on the example of animal trade. We utilize the size of the in- and out-component of nodes as centrality measures. We show that a ranking of nodes according to their component sizes is reasonably stable for a wide range of infectious periods. Samples based on this ranking are robust enough against varying disease parameters and hence are promising tools for disease control.

SOE 25.5 Thu 17:15 Poster C

City size distributions of urban clusters near the percolation transition: a global perspective — •Anselmo García Cantú Ros, Till Fluschnik, Steffen Kriewald, and Diego Rybski — Potsdam Institute for Climate Impact Research

Building on high resolution global land cover data we study the area and population size distribution of all cities above 100,000 worldwide. This task is accomplished by applying a percolation based city clustering algorithm. The latter also allows one to first identify a distance to the percolation threshold for clusters of cities and second to study how the proximity to percolation influences the characteristic exponent of city size distributions. Last, but not least, we study the allometric aspects of the area/population relation for the whole set of cities under

scope.

SOE 25.6 Thu 17:15 Poster C

Vulnerability of proximity graphs to failure and attacks — •Christoph Norrenbrock, Oliver Melchert, and Alexander K. Hartmann — Carl-von-Ossietzky Universität Oldenburg

We study numerically [1] different proximity graphs (Delaunay-Triangulation, Gabriel graph, relative neighborhood graph, minimum-radius graph) that are discussed as "backbones" of ad-hoc communication networks. Ad-hoc networks represent, e.g., collections of radio-devices without fixed infrastructure. Typically, remote devices are seldom linked directly to each other, but connected indirectly via several paths composed of multiple nodes and edges. This motivates the question how structure and information-transmission efficiency of these graphs are affected by a failure of a given fraction of nodes. Therefore, we study and compare the influence of different node–removal strategies by considering systems up to $N = 4 \cdot 10^4$ and determine, using finite-size scaling techniques, the fraction of nodes (for each strategy) that yields a breakup of the respective graph in the thermodynamic limit.

[1] Hartmann, A. K., Practical guide to computer simulations (World Scientific, 2009)

SOE 25.7 Thu 17:15 Poster C

Correlations of optimized stocks portfolios in different market phases — •Alexander Eckrot[1], Jan Jurczyk[1], Johannes Schneider[2], and Ingo Morgenstern[1] — [1]Uni Regensburg, Regensburg, Germany — [2]Uni Mainz, Mainz, Germany

We investigate the correlations of optimized stocks portfolios in different market phases. These portfolios were created by means of Johannes Schneider's algorithm, maximizing the return and minimizing the risk. The correlations of the stocks portfolios are analyzed using methods of the Random Matrix Theory. We divide the data into three different market phases: A stable market around 2005, before the financial crisis. The climax of the crash at 2008. And this financial crisis' aftermath, we are facing in the very recent years.

SOE 25.8 Thu 17:15 Poster C

Indications of an upcoming financial breakdown — •Jan Jurczyk[1], Johannes Schneider[2], Ingo Morgenstern[1], and Manuel Miedl[1] — [1]Faculty of Physics, University of Regensburg, 93040 Regensburg, Germany — [2]Department of Physics, Mathematics, and Computer Science, Johannes Gutenberg University of Mainz, 55099 Mainz, Germany

The financial crisis in 2008 showed the weakness of traditional risk evaluation for private investors. In the beginning of 2008 well known financial newspapers and rating firms underestimated the growing risks within the stock market. Therefore the private investor was made to believe that there is no risk within such a system. But the similarities between the spin glass behaviour of the portfolio selection problem, already shown by Markowitz, reveal that the risk is an important observable for recognizing a financial breakdown.

The physical formulation of the portfolio selection problem makes it easier to unveil the risk for a private investor by introducing a simple indicator, which is derived from the idea that ground states of the optimization problem are very sensitive to changes in the solution space and suggests a phase transition.

SOE 25.9 Thu 17:15 Poster C

Modeling the spread of sexually transmitted diseases in Poland and Sweden — •Andrzej Jarynowski[1,2] and Ana Serafimovic[2] — [1]Smoluchowski Institute, Jagiellonian University, Cracow, Poland — [2]Stockholm University, Sweden

The aim of the project is to supplement the knowledge of the spread of sexually transmitted diseases in the first part of the project in Swidish and Polish society through computer simulations with the theoretical discussion about sexual, temporal network (who with whom, when and how often). The model has aggregated the most important paths of infection (the main heterosexual population, sex workers and men who have sex with men) for the most important pathogens. The main goal is the authoritative analysis of the costs and losses of potential epidemiological control strategies and identifies potential problems that health care will have to face in the future. In the second part, the purpose is to understand the structure of the network and the temporal aspects of sexual relationships of humans and the possibility of using this structure in the epidemiological control. Modeling the spread of sexually transmitted diseases in Poland contains: (1) Adjust various parameters of the epidemiology of pathogens based on medical reports from around the world; (2) Simulations of epidemiology of pathogens and associated diseases with control optimization problem in terms of medical and financial metrics. Constructed model describes the spread of pathogens and could indicate an effective tool in the fight against infectious diseases (vaccination, screaming of preventing programs). It would helped with verification of hypotheses on empirical analysis.

SOE 25.10 Thu 17:15 Poster C

Controllability of power fluctuations with variable pricing schemes — Stefan Börries, •Sebastian M. Krause, and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen, Hochschulring 18, D-28359 Bremen

Power markets including fluctuating energy sources as, e.g. windmills, face the challenge to satisfy the continuous demand for electricity. One possibility is to use time-varying pricing schemes that shift power consumption for activities as, e.g. washing and heating to times with excess supply.

We use an agent based model to investigate the behavior of power consumers faced with variable pricing schemes and analyze the statistical reaction of the market on an aggregate level. To answer the question, if the time-dependent power consumption can be controlled, we search for a reliable demand curve. By discussing the shape of the demand curve, as well as fluctuations and saturation effects, we hint at possible emergent effects.

SOE 25.11 Thu 17:15 Poster C

Social temperature and fear in an opinion formation model of markets — •Sebastian M. Krause and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen, Hochschulring 18, D-28359 Bremen

In the growing field of behavioral finance, market participants are characterized using psychological and sociological criteria. Two considerable effects among investors are herding behavior and a varying market temperature culminating in periods with panic-like behavior.

We incorporate both effects in an agent based model and study its statistical properties [1]. The herding behavior is captured with a model from the family of opinion formation models which are broadly discussed in the physics literature. Showing tunable social temperatures, these models show emergent behavior like phase transitions. With the introduction of a feedback acting on the temperature [2], the social temperature reacts to market imbalances and thus becomes time dependent. The system shows alternating metastable phases: (a) fluctuations around fixed points connected to a non-equilibrium phase transition, as well as: (b) ordered states of low temperature.

[1] S. M. Krause, S. Bornholdt, Opinion formation model for markets with a social temperature and fear, Phys. Rev. E 86 (2012) 056106.

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

SOE 25.12 Thu 17:15 Poster C

Inter-burst times of the empirical high-frequency financial market data and non-linear stochastic models — •Aleksejus Kononovicius and Vygintas Gontis — Institute of Theoretical Physics, Vilnius University, Vilnius, Lithuania

Recently we have proposed a non-linear stochastic model of return and trading activity in financial markets reproducing power law probability and spectral densities [1]. The reproduced statistical properties are in agreement with the high frequency empirical data. The proposed class of nonlinear stochastic differential equations is also known to exhibit power law bursting behavior [2,3], while similar behavior is also observed in the empirical data of financial markets [3]. In this contribution we will extend our previous approaches to the burst statistics by considerably more detailed analyses of the modelic and empirical inter-burst time durations.

[1] V. Gontis, J. Ruseckas and A. Kononovicius (2010): A Nonlinear Stochastic Model of Return in Financial Markets, in: Stochastic Control, ed. C. Myers, Intech.

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

[3] V. Gontis, A. Kononovicius and S. Reimann (2012): The class of nonlinear stochastic models as a background for the bursty behavior in financial markets, Advances in Complex Systems 15 (supp01).

SOE 25.13 Thu 17:15 Poster C

The generalized voter model as a kinetic Ising model — Sebastian M. Krause, •Philipp Böttcher, and Stefan Bornholdt — Institut für Theoretische Phsik, Universität Bremen, Hochschulring 18, D-28359 Bremen, Germany

Opinion formation models have sparked considerable interest in the physics community. A prominent model is the voter model which displays interesting features (i.e absorbing states), is analytically solvable and displays critical behaviour on a 2D-lattice. Variants introduce a social temperature, to tune between persuasiveness and non-conformity. These models display a non-equilibrium phase transition and define a new universality class, the generalized voter-model-class.
Here we investigate a kinetic Ising model on a two-dimensional torus without bulk noise and with a social temperature. The proposed model has a close relationship to the voter model, which is included at the critical social temperature, and the Sznajd model, in which persuasiveness also increases with growing number of proponents. It displays mean-field-like behaviour, absorbing states and an abrupt phase transition with critical convergences, and can be found in the generalized voter-model-class. Finally, we use a Fokker-Planck description and compare its results to mean-field calculations in order to investigate the phase transition, finite-size effects and effects of the absorbing states.

[1] S.Krause, P.Böttcher, and S.Bornholdt, Physical Review E 85, 031126 (2012)

SOE 25.14 Thu 17:15 Poster C

The impact of attractions on pedestrian flow — •Jaeyoung Kwak[1], Hang-Hyun Jo[2], Iisakki Kosonen[1], and Tapio Luttinen[1] — [1]Department of Civil and Environmental Engineering, Aalto University School of Engineering, Espoo, Finland — [2]Department of Biomedical Engineering and Computational Science, Aalto University School of Science, Espoo, Finland

Self-organized pattern formation of pedestrian crowds, such as lane formation, turbulent movement, and human trails, has been subject to interest of various disciplines. The microscopic pedestrian flow models have described the pedestrian motions in terms of driving, repulsive, and attractive forces. However, little attention has been paid to attractive interactions between pedestrians and objects including shopping displays and museum exhibits. In reality, such attractive interactions may lead to impulse stop behavior; pedestrian stop walking to destinations and join the attractions for certain amount of time. This study investigates the impact of attractive force on pedestrian flow by devising the social force model with attractive forces. Changing attractive force parameters yields radical transition between two distinct aggregate patterns. Relaxed pedestrian flow is observed when attractive interaction is weak. On the other hand, strong attractive interaction reveals clustering around the attractive objects, although pedestrians intended to walk to destinations with their desired speed. The proposed approach provides a useful framework to improve pedestrian facilities in shopping centers and museums.

SOE 25.15 Thu 17:15 Poster C

Fluctuation-dissipation relations in physiological data collected during emotional stimulation — •Jan Chołoniewski, Anna Chmiel, and Janusz Hołyst — Faculty of Physics, Center of Excellence for Complex Systems Research, Warsaw Univeristy of Technology, Poland

We present results of our search for fluctuation-dissipation relations in physiological data (i.e. phasic skin conductance, facial EMG). Data comes from experiments that were performed in the frame of Cyberemotions project [1] and concerned people's emotions observed during experiencing emotional stimuli (i.a. IAPS images). For the sake of this study, we also tried out several approaches for quantifying response function and fluctuations in physiological signals. Because of signals' nonlinearity and non-stationarity part of fluctuations analysis was based on time-frequency methods and signals decomposition (such as Empirical Mode Decomposition, Discrete Wavelet Transform).

[1] www.cyberemotions.eu

SOE 25.16 Thu 17:15 Poster C

Dynamic Nonlinearities in Financial Time Series — •Christoph Raeth — Max-Planck-Institut fuer extraterrestrische Physik

The investigation of financial times series by means of nonlinear data analysis is attracting more and more attention in statistical physics. The characteristic fat tails in the probability distribution of the returns are one example of the so-called stylized facts of the fluctuations of price indices. Many of those refer, however, only to the distribution of the returns, where temporal correlations are no longer taken into account.

Here, we present a new method to identify dynamic nonlinearities by analyzing the phase maps of Fourier phases. We find highly significant signatures for nonlinearities in the day-to day returns of the Dow Jones. We repeat the analysis for rank-ordered remapped Dow Jones data, for which by construction the stylized facts referring to fat tails are vanishing. Also in this case we can identify phase correlations. Comparing the data with respective surrogates, we estimate the significance of the detected new signatures of purely dynamic nonlinearities. We further demonstrate that the phase correlations propagate into the calculation of classical nonlinear statistics, e.g. the nonlinear prediction error [1]. We can thus establish qualitatively new signatures in time series of market indices. Realistic market models should be able to reproduce them in addition to the already well-known stylized fact.

[1] C. Raeth, M. Gliozzi, I. E. Papadakis and W. Brinkmann, PRL, 109, 144101 (2012)

SOE 25.17 Thu 17:15 Poster C

Network resilience for interdependent networks — •Marcell Stippinger and Éva Rácz — Department of Theor. Phys., Budapest Univ. of Technology and Economics, 8 Budafoki út, H-1111 Budapest, Hungary

The ongoing economic crisis has drawn special attention to the importance of network stability. Following the work of Buldyrev et al. (Nature 464, 1025*1028, 2010), we examine the behavior of interdependent networks under random failures. Motivated by real-life scenarios, we introduce the possibility of edge re-organization, as a means of enhancing network resilience, to the original model. The interdependence between two networks is known to lead to cascading failures, resulting in a first-order phase transition concerning the size of the mutually connected giant component. In our variant of the model, networks are able to *heal* to a degree that is easily tuned by a model parameter. We investigate the effect of healing on the order of the phase transition as a function of this parameter. We present simulation results for different kinds of network topologies and compare our results with previous findings.

SOE 25.18 Thu 17:15 Poster C

A Big Data approach to the governing rules of "No. 10 Downing Street" — Scott A. Hale, •Taha Yasseri, and Helen Z. Margetts — Oxford Internet Institute, University of Oxford, Oxford, UK

Analysing the collectively generated Big Data in cyberspace has significantly enriched our understanding of social phenomena in recent years. In this work, we focus on mobilization activities within the framework of the UK Government website, "No. 10 Downing Street". We consider a sample of 8,000 petitions and follow their dynamics in a period of two years. We extract the empirical laws governing the growth of the petitions in regard to the number of supporting individuals. We observe the importance of early time evolution of the petitions in determining the overall success of them over long time periods. Moreover, we measure the critical mass needed for a successful percolation of each petition in a giant piece of the society. Our results, not only deepen our knowledge on the mechanisms behind the growth and spread of socio-political ideas and opinions, but also could be considered to develop and enhance infrastructures to facilitate more effective government-society interactions.

SOE 25.19 Thu 17:15 Poster C

University collaboration networks — •Julian Sienkiewicz[1], Krzysztof Soja[1], Janusz Hołyst[1], and Peter Sloot[2,3,4] — [1]Faculty of Physics, Center of Excellence for Complex Systems Research, Warsaw University of Technology, Poland — [2]Computational Science, University of Amsterdam, The Netherlands — [3]National Research University of Information Technologies, Mechanics and Optics, Russia — [4]Nanyang Technological University, Singapore

We perform the analysis of scientific collaboration at the level of universities. The scope of this study tries two answer two fundamental questions: (i) can one indicate a category (i.e., a scientific discipline) that has the greatest impact on the rank of the university and (ii) do the best universities collaborate with the best ones only? Using two university ranking lists (ARWU and QS) as well as data from the Science Citation Index we show how the number of publications in certain categories correlates with the university rank. Moreover, using com-

plex networks analysis, we give hint that the scientific collaboration is highly embedded in the physical space. We also show that the strength of the ties between universities is proportional to product of their total number of publications.