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

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Overview of Invited Talks and Sessions

(Lecture hall H3; Poster P)

Young Scientist Award for Socio- and Econophysics (YSA) - Award Session and Prize Talks

SOE 1.1	Wed	15:00–15:45	YSA	**Quantifying science and art** — •Roberta Sinatra
SOE 1.2	Wed	15:45–16:30	YSA	**Multilayer modeling and analysis of complex socio-economic systems** — •Manlio De Domenico

Plenary talks related to SOE

PV III	Mon	16:30–17:15	Audimax 1	**Complex networks with complex nodes** — •Raissa D'Souza

Topical Talks

SOE 4.1	Thu	10:00–10:30	H3	**Felix Auerbach and Zipf's Law for Cities** — •Diego Rybski, Antonio Ciccone
SOE 4.2	Thu	10:30–11:00	H3	**Envy-induced class separation in societies of competing agents** — •Claudius Gros
SOE 7.1	Fri	10:00–10:30	H6	**Why Ergodicity Breaking from Climate Change matters in Ecosystems?** — •Jan Nagler

Invited talks of the joint symposium SKM Dissertation Prize 2021 (SYSD)

See SYSD for the full program of the symposium.

SYSD 1.1	Mon	10:00–10:25	Audimax 2	**Avoided quasiparticle decay from strong quantum interactions** — •Ruben Verresen, Roderich Moessner, Frank Pollmann
SYSD 1.2	Mon	10:25–10:50	Audimax 2	**Co-evaporated Hybrid Metal-Halide Perovskite Thin-Films for Optoelectronic Applications** — •Juliane Borchert
SYSD 1.3	Mon	10:55–11:20	Audimax 2	**Attosecond-fast electron dynamics in graphene and graphene-based interfaces** — •Christian Heide
SYSD 1.4	Mon	11:20–11:45	Audimax 2	**The thermodynamics of stochastic systems with time delay** — •Sarah A.M. Loos
SYSD 1.5	Mon	11:50–12:15	Audimax 2	**First Results on Atomically Resolved Spin-Wave Spectroscopy by TEM** — •Benjamin Zingsem

Invited talks of the joint symposium The Physics of CoViD Infections (SYCO)

See SYCO for the full program of the symposium.

SYCO 1.1	Mon	13:30–14:00	Audimax 1	**A Tethered Ligand Assay to Probe SARS-CoV-2:ACE2 Interactions** — Magnus Bauer, Sophia Gruber, Adina Hausch, Lukas Milles, Thomas Nicolaus, Leonard Schendel, Pilar Lopez Navajas, Erik Procko, Daniel Lietha, Rafael Bernadi, Hermann Gaub, •Jan Lipfert
SYCO 1.2	Mon	14:00–14:30	Audimax 1	**From molecular simulations towards antiviral therapeutics against COVID-19** — •Rebecca Wade
SYCO 1.3	Mon	14:45–15:15	Audimax 1	**The physical phenotype of blood cells is altered in COVID-19** — Markéta Kubánková, Martin Kräter, Bettina Hohberger, •Jochen Guck
SYCO 1.4	Mon	15:15–15:45	Audimax 1	**Extended lifetime of respiratory droplets in a turbulent vapor puff and its implications on airborne disease transmission** — •Detlef Lohse, Kai Leong Chong, Chong Shen Ng, Naoki Hori, Morgan Li, Rui Yang, Roberto Verzicco
SYCO 1.5	Mon	15:45–16:15	Audimax 1	**Beyond the demographic vaccine distribution: Where, when and to whom should vaccines be provided first?** — •Benno Liebchen, Jens Grauer, Fabian Schwarzendahl, Hartmut Löwen

Invited talks of the joint symposium Advanced neuromorphic computing hardware: Towards efficient machine learning (SYNC)

See SYNC for the full program of the symposium.

SYNC 1.1	Wed	10:00–10:30	Audimax 1	**Equilibrium Propagation: a Road for Physics-Based Learning** — •Damien Querlioz
SYNC 1.2	Wed	10:30–11:00	Audimax 1	**Machine Learning and Neuromorphic Computing: Why Physics and Complex Systems are Indispensable** — •Ingo Fischer
SYNC 1.3	Wed	11:00–11:30	Audimax 1	**Photonic Tensor Core Processor and Photonic Memristor for Machine Intelligence** — •Volker Sorger
SYNC 1.4	Wed	11:45–12:15	Audimax 1	**Material learning with disordered dopant networks** — •Wilfred van der Wiel
SYNC 1.5	Wed	12:15–12:45	Audimax 1	**In-memory computing with non-volatile analog devices for machine learning applications** — •John Paul Strachan

Prize talks of the joint Awards Symposium (SYAW)

See SYAW for the full program of the symposium.

SYAW 1.1	Wed	13:30–14:00	Audimax 1	**Organic semiconductors - materials for today and tomorrow** — •Anna Köhler
SYAW 1.2	Wed	14:00–14:30	Audimax 1	**PbTe/CdTe nanocomposite as an attractive candidate for room-temperature infrared detectors** — •Grzegorz Karczewski
SYAW 1.3	Wed	14:40–15:10	Audimax 1	**Fingerprints of correlation in electronic spectra of materials** — •Lucia Reining
SYAW 1.4	Wed	15:10–15:40	Audimax 1	**Artificial Spin Ice: From Correlations to Computation** — •Naëmi Leo
SYAW 1.5	Wed	15:40–16:10	Audimax 1	**From microwave optomechanics to quantum transport – carbon nanotubes as highly versatile hybrid devices** — •Andreas K. Hüttel
SYAW 1.6	Wed	16:20–16:50	Audimax 1	**Quantum spin dynamics of a spin-1/2 antiferromagnetic Heisenberg-Ising chain** — •Zhe Wang
SYAW 1.7	Wed	16:50–17:20	Audimax 1	**Imaging the effect of electron transfer at the atomic scale** — •Laerte Patera

Invited talks of the joint symposium Spain as Guest of Honor (SYES)

See SYES for the full program of the symposium.

SYES 1.1	Wed	13:30–13:40	Audimax 2	**DFMC-GEFES** — •Julia Herrero-Albillos
SYES 1.2	Wed	13:40–14:10	Audimax 2	**Towards Phononic Circuits based on Optomechanics** — •Clivia M. Sotomayor Torres

SYES 1.3	Wed	14:10–14:40	Audimax 2	**Adding magnetic functionalities to epitaxial graphene** — •Rodolfo Miranda
SYES 1.4	Wed	14:45–15:15	Audimax 2	**Bringing nanophotonics to the atomic scale** — •Javier Aizpurua
SYES 1.5	Wed	15:15–15:45	Audimax 2	**Hydrodynamics of collective cell migration in epithelial tissues** — •Jaume Casademunt
SYES 1.6	Wed	15:45–16:15	Audimax 2	**Understanding the physical variables driving mechanosensing** — •Pere Roca-Cusachs

Invited talks of the joint symposium Climate and energy: Challenges and options from a physics perspectiv (SYCE)

See SYCE for the full program of the symposium.

SYCE 1.1	Thu	13:30–14:00	Audimax 1	**The challenge of anthropogenic climate change - Earth system analysis can guide climate mitigation policy** — •Matthias Hofmann
SYCE 1.2	Thu	14:00–14:30	Audimax 1	**Towards a carbon-free energy system: Expectations from R&D in renewable energy technologies** — •Bernd Rech, Rutger Schlatmann
SYCE 1.3	Thu	14:30–15:00	Audimax 1	**Decarbonizing the Heating Sector - Challenges and Solutions** — •Florian Weiser
SYCE 1.4	Thu	15:15–15:45	Audimax 1	**A carbon-free Energy System in 2050: Modelling the Energy Transition** — •Christoph Kost, Philip Sterchele, Hans-Martin Henning
SYCE 1.5	Thu	15:45–16:15	Audimax 1	**The transition of the electricity system to 100% renewable energy: agent-based modeling of investment decisions under climate policies** — •Kristian Lindgren

Sessions

SOE 1.1–1.2	Wed	15:00–16:30	YSA	**Young Scientist Award for Socio-and Econophysics**
SOE 2.1–2.4	Wed	17:00–18:00	P	**Poster**
SOE 3	Wed	18:00–19:00	MVSOE	**Member's Assembly**
SOE 4.1–4.2	Thu	10:00–11:00	H3	**Dynamics and Scaling of Cities and Societies**
SOE 5.1–5.1	Thu	11:15–11:45	H3	**Financial Systems**
SOE 6.1–6.2	Thu	11:45–12:45	H3	**Dynamics of Social and Adaptive Networks I**
SOE 7.1–7.2	Fri	10:00–11:00	H6	**Socio-economic models of climate change impact**
SOE 8.1–8.3	Fri	11:15–12:45	H6	**Dynamics of Social and Adaptive Networks II**
SOE 9.1–9.4	Fri	13:30–16:00	ESS	**Symposium: Synchronization Patterns in Complex Dynamical Networks (organized by Jakub Sawicki, Sabine Klapp, Markus Bär and Jens Christian Claussen) (joint session DY/SOE)**

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

Wednesday 18:00–19:00 MVSOE

1. Report of the Chairpersons
2. Announcements and Discussion of future Activities
3. Elections
4. Miscellaneous

SOE 1: Young Scientist Award for Socio-and Econophysics

Time: Wednesday 15:00–16:30 Location: YSA

Prize Talk SOE 1.1 Wed 15:00 YSA

Quantifying science and art — •Roberta Sinatra — NERDS, IT University of Copenhagen, Copenhagen, Denmark — SODAS, University of Copenhagen, Copenhagen, Denmark — Complexity Science Hub, Vienna, Austria

Performance, representing the objectively measurable achievements in a certain domain of activity, like the publication record of a scientist or the winning record of an athlete, captures the actions of an individual entity. In contrast, success, captured by impact or visibility, is a collective phenomenon, representing a community's reaction and acceptance of an individual entity's performance. We are often driven by the belief that the detection of extraordinary performance is sufficient to predict exceptional success. However, the link between these two measures, while often taken for granted, is actually far from being understood. Nevertheless, differently from performance, success is quantifiable and predictable: given its collective nature, its signatures can be uncovered from the many pieces of data around us using the tools of statistical physics, complex systems, network science, and data science. In this talk, I will focus on success in science and art as a way to test our ability to model and predict the collective phenomenon of success. I will discuss the role of luck in achieving success, and will address the relation between performance and success in a variety of settings, highlighting the challenges of gauging performance through success.

Prize Talk SOE 1.2 Wed 15:45 YSA

Multilayer modeling and analysis of complex socio-economic systems — •Manlio De Domenico — Complex Multilayer Networks Lab, Fondazione Bruno Kessler, Trento (Italy)

Complex systems are characterized by constituents – from neurons in the brain to individuals in a social network – which exhibit special structural organization and nonlinear dynamics. As a consequence, a complex system can not be understood by studying its units separately because their interactions lead to unexpected emerging phenomena, from collective behavior to phase transitions. Recently, we have discovered that a new level of complexity characterizes a variety of natural and artificial systems, where units interact, simultaneously, in distinct ways. For instance, this is the case of multimodal transportation systems (e.g., metro, bus and train networks) or of social networks, whose interactions might be of different type (e.g. trust, trade, virtual, etc.). The unprecedented newfound wealth of socio-economic data allows to categorize system's interdependency by defining distinct "layers", each one encoding a different network representation of the system. The result is a multilayer network model. In this talk we will discuss the most salient features of multilayer systems, with special attention to socio-ecological and socio-technical ones.

SOE 2: Poster

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

SOE 2.1 Wed 17:00 P

Scaling properties of bimodal on-demand public transportation — •Puneet Sharma[1,2], Stephan Herminghaus[1,2], Helge Heuer[1,2], Steffen Muehle[1], and Knut Heidemann[1,2] — [1]Max Planck Institute for Dynamics and Self-Organization, Goettingen — [2]Georg-August-Universität Göttingen

While modern cities offer various modes of motorized transportation, considered separately, none of them is both efficient, i.e., sustainable, and convenient. A taxi service is convenient, in a sense, due to door-to-door service, but is inefficient since it usually serves one customer only. Demand responsive ride pooling (DRRP) with minibuses is more efficient, but leads to undue competition with line services (LS), which provide even better pooling (average number of passengers per vehicle) but are less convenient due to fixed routes and stops. A combination of both modes, DRRP and LS, may provide an ideal solution but is challenging to organize due to a trade-off between convenience and efficiency. Here we derive conditions for efficient and convenient transportation for a bi-modal service based on a simple square-grid geometry. We relate the optimal mesh size, i.e., distance between stations, to external parameters like passenger density and traveling behavior.

SOE 2.2 Wed 17:00 P

Income inequality from multiple behavioural strategies — •Anjlee Gopiani and Jens Christian Claussen — Mathematics EPS, Aston University Birmingham

Income inequality, and thereby wealth inequality, is a societal problem on national and global scale. Here we investigate a monetary exchange model with interactions motivated from game theory. We assume a diversity of strategies and investigate through agent-based simulations the resulting income distributions in this artificial society. If the majority of agents is acting towards rationality and selflessness to fulfill personal and societal success, inequality is less prevalent.

SOE 2.3 Wed 17:00 P

The Principle of Largest Squares — •Martin Erik Horn — IU Internatinal University of Applied Sciences, Campus Berlin, and ISM International School of Management, Campus Berlin

Regression analysis is an important statistical tool to understand interdependencies between different variables in empirical sciences. And it is astonishing that this tool obviously is used only in Euclidean spaces - as if variables always have to act in an Euclidean way in the scientific world of socio economics and of other domains.

To critically question this Euclidean dominance, orthogonal regression will be transferred into spacetime. The didactical consequences are interesting: We are then discussing relativistic ideas with students who do not study physics, but economics, computer science or other subjects relying on empirical analysis. And the conceptual consequences are surprising: We will no longer apply the principle of least squares but have to switch to the principle of largest squares.

SOE 2.4 Wed 17:00 P

Complexity measures of small-world networks — •Yipei Zhao and Jens Christian Claussen — Mathematics EPS, Aston University Birmingham

While the notion of complexity is established for strings or texts, it is less clear how complexity of a network shall be defined, and various complexity measures have been defined and compared (Claussen 2007, Physica A 375, 365; Kim and Wilhelm 2008, Physica A 387, 2637). Here we compare several of the complexity measures listed in Kim and Wilhelm on small-world networks in comparison to random graphs. We compare Watts-Strogatz graphs in comparison to random graphs that fulfill the small-world property based on the small-world indes. The results are in line with the intuition that small-world structure can add to complexity, but reminescents of a lattice structure lower the complexity values.

SOE 3: Member's Assembly

Member's assembly - a Zoom link will be distributed to the SOE members of the DPG and displayed in the conference system.

Time: Wednesday 18:00–19:00 Location: MVSOE

Online only.

SOE 4: Dynamics and Scaling of Cities and Societies

Time: Thursday 10:00–11:00 Location: H3

Topical Talk SOE 4.1 Thu 10:00 H3

Felix Auerbach and Zipf's Law for Cities — •Diego Rybski[1,2,3] und Antonio Ciccone[4] — [1]Potsdam Institute for Climate Impact Research - PIK, Member of Leibniz Association, P.O. Box 60 12 03, Potsdam 14412, Germany — [2]University of California Berkeley, Department of Environmental Science, Policy and Management, 130 Mulford Hall #3114, Berkeley, CA 94720, USA — [3]Complexity Science Hub Vienna, Josefstädterstrasse 39, A-1090 Vienna, Austria — [4]Department of Economics, University of Mannheim, Mannheim, Germany

Power-law city size distributions are a statistical regularity researched in many countries and urban systems. In this history of science treatise we reconsider the paper by F. Auerbach published in 1913. Therefore, we review his empirical analysis and find (i) that a constant absolute concentration (AK), as introduced by him, is equivalent to a power-law distribution with exponent ≈ 1, (ii) the value of his AK relates to the size of the largest city, and (iii) the specific concentration (SpK), as also introduced by Auerbach, relates to the number of cities. We further investigate his legacy as reflected in citations and find that important follow-up work does give proper reference to his discovery – but other does not. A bibliographic analysis shows that almost all city-related works that cite Auerbach 1913 also cite Zipf 1949. However, only approximately 20 % of works citing Zipf 1949 also cite Auerbach 1913. To our best knowledge A.J. Lotka 1925 was the first to describe the power-law rank-size rule. Consequently, we suggest to use "Auerbach-Lotka-Zipf law" (or "ALZ-law") instead of "Zipf's law for cities".

Topical Talk SOE 4.2 Thu 10:30 H3

Envy-induced class separation in societies of competing agents — •Claudius Gros — Institute for Theoretical Physics, Goethe University Frankfurt

Everything is relative. This holds for Darwinian selection, which is based on relative fitness advantages, and today's social success and fairness criteria. The desire to compare own's own incomes and resources with that of others is the basis of envy. In game theoretical settings, envy is described by a psychological component, in addition to the monetary payoff function. We find that envy leads to a phase transition in societies of competing agents. Below the transition, most agents play pure strategies which follow from occupying the most yielding options. When approaching the transition, an increasing number of agents play mixed strategies, which eventually merge to a single encompassing mixed strategy played by a large number of agents, the lower class. All the while, upper-class agents continue to play high-rewarding pure strategies. Considering the Ultimatum game with envy, we estimate the strength of human envy from the respective laboratory results. One finds that envy is strongly relevant for humans societies.

C. Gros, "Collective strategy condensation: When envy splits societies", Entropy 23, 157 (2021).

C. Gros, "Self induced class stratification in competitive societies of agents: Nash stability in the presence of envy", Royal Society Open Science 7, 200411 (2020).

SOE 5: Financial Systems

Time: Thursday 11:15–11:45 Location: H3

SOE 5.1 Thu 11:15 H3

A New Attempt to Identify Long-term Precursors for Financial Crises in the Market Correlation Structures — •Anton J. Heckens and Thomas Guhr — Universität Duisburg-Essen, Lotharstr. 1, 47048 Duisburg

Prediction of events in financial markets is every investor's dream and, usually, wishful thinking. From a more general, economic and societal viewpoint, the identification of indicators for large events is highly desirable to assess systemic risks. Unfortunately, the non-stationarity nature of financial markets make this challenge a formidable one, leaving little hope for fully fledged answers. Nevertheless, it is called for to collect pieces of evidence in a variety of observables to be assembled like the pieces of a puzzle that eventually might help to catch a glimpse of precursors for large events - if at all in a statistical sense. Here, we present a new piece for this puzzle. We use the quasi-stationary market states which exist in the time evolution of the correlation structure in financial markets. Recently, we identified such market states relative to the collective motion of the market as a whole [1]. We study their precursor properties in the US stock markets over 16 years, including the pre-phase of the Lehman Brothers crash [2].

[1] A. J. Heckens, S. M. Krause, T. Guhr, Uncovering the Dynamics of Correlation Structures Relative to the Collective Market Motion J. Stat. Mech. 2020, 103402 (2020), preprint: arXiv:2004.12336

[2] A. J. Heckens, T. Guhr, A New Attempt to Identify Long-term Precursors for Financial Crises in the Market Correlation Structures (2021), preprint: arXiv:2107.09048

SOE 6: Dynamics of Social and Adaptive Networks I

Time: Thursday 11:45–12:45 Location: H3

SOE 6.1 Thu 11:45 H3

Understanding force directed layouts through latent space models — •Felix Gaisbauer, Armin Pournaki, Sven Banisch, and Eckehard Olbrich — Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany

This contribution brings together two strands of research: Latent space approaches to network analysis and force-directed layout algorithms. The former can be considered as extensions of spatial random graph models for social networks, which have the goal of embedding a graph/network in an underlying social space [1] and have been employed successfully in the estimation of ideological positions from follower networks on Twitter [2]. The latter are used ubiquitously for data exploration, illustration, and analysis. Nevertheless, an interpretation of the outcomes of graph drawings with force-directed algorithms is not straightforward. We show that interpretability can be provided by random graph models in which the nodes are positioned in a latent space. The closer the positions of the nodes, the more probable it is that they are connected. We show that force-directed layout algorithms can be considered as maximum likelihood estimators of such models. We also present ready-to-use implementation of the layout algorithm and show its application to Twitter retweet networks.

[1] P. D. Hoff, A. E. Raftery, and M. S. Handcock (2002). Latent space approaches to social network analysis. Journal of the American Statistical association, 97(460), 1090-1098. [2] P. Barberá (2015). Birds of the same feather tweet together: Bayesian ideal point estimation using Twitter data. Political analysis, 23(1), 76-91.

SOE 6.2 Thu 12:15 H3

Balanced Triad Formation explained by Dyadic Interactions — •Tuan Pham[1,2], Jan Korbel[1,2], Rudolf Hanel[1,2], and Stefan Thurner[1,2,3] — [1]Medical University of Vienna — [2]Complexity Science Hub Vienna — [3]Santa Fe Institute

The evolution of social (signed) triads towards so-called balanced states with either one or three positive links often results in the formation of clusters of positively-linked agents. We argue that –surprisingly– such cluster formation can emerge from *dyadic* interactions if homophily between agents is present. We show this in a Hamiltonian model, where every agent is linked to K others and holds binary opinions

on G issues, in an opinion vector $\mathbf{s}_i$. If two agents i and j are connected by a link J_{ij} then $J_{ij} = \text{sign}(\mathbf{s}_i \cdot \mathbf{s}_j)$. Without knowledge of the triads in their neighbourhoods, agents modify their opinions so as to minimize a social tension, $H^{(i)}$, defined via the weighted sum of opinion overlaps with friends and opinion discordance with enemies: $H^{(i)} = -\frac{\alpha}{G} \cdot \sum_{j:J_{ij}>0} \mathbf{s}_i\mathbf{s}_j + \frac{1-\alpha}{G} \cdot \sum_{j:J_{ij}<0} \mathbf{s}_i\mathbf{s}_j$, where α is the relative strength of positive interactions to that of negative ones. The model exhibits a transition from unbalanced- to balanced society at a critical temperature which depends on (G, K, α). As α exceeds $1/2$, another transition between steady states with different fractions of balanced triads occurs. We show that the model explains actual data of triad statistics in social networks. The model produces z-scores for triads that is compatible with empirical values in real social networks, such as the *Pardus* computer game and the United Nations General Assembly.

SOE 7: Socio-economic models of climate change impact

Time: Friday 10:00–11:00 Location: H6

Topical Talk SOE 7.1 Fri 10:00 H6

Why Ergodicity Breaking from Climate Change matters in Ecosystems? — •Jan Nagler — Centre for Human and Machine Intelligence, Frankfurt

We show that and how ergodicity breaking due to temperature fluctuations adds up to the effects from rising temperatures and increasing fluctuations. Ergodicity breaking fluctuation-induced phenomena are well known in finance, where volatility can turn winning trading strategies into losing ones, or losing strategies into winning strategies. In physics, ergodicity breaking can result in an array of anomalous behaviours in stochastic systems. We show how ecosystems and evolutionary dynamics are affected. Ergodicity breaking in ecosystems may even dominate other effects from climate change. We report on a field study in nematodes on La Reunion Island that have adapted to temperature fluctuations. Ergodicity breaking leads to a shift of the adapted mean temperature, which we predict from first principles.

SOE 7.2 Fri 10:30 H6

Carbin dioxide emission quota attributions in a power system comprised of highly self-sufficient European actors — •Leon Joachim Schwenk-Nebbe[1,2], Marta Victoria[1,2], Gorm Bruun Andresen[1,2], and Martin Greiner[1,2] — [1]Department of Engineering, Aarhus University, Aarhus, Denmark — [2]iCLIMATE Interdisciplinary Centre for Climate Change, Aarhus University

The European countries all agree that carbon dioxide (CO2) emissions need to be decreased in the power sector. The ever dividing question is who must contribute by how much. We investigate possible near-future electricity system configurations where three aspects of collaboration between the individual countries are parametrized. First, the individual countries are attributed a CO2 emission quota in different ways. We show that a global carbon dioxide emission constraint with a global price leads to a particularly uneven emission distribution in a cost-optimal European electricity system. Different emission attributions are shown to strongly influence the required local emission prices. Second, they can collaborate by relaxing their need for autonomy and becoming less self-sufficient by placing generation capacity in countries with better prerequisites. Third, collaboration can also be strengthened by extending the cross-border transmission grid. We conclude that it is significantly easier for certain countries to decarbonize their electricity production than for others. We find that a deep collaboration between the European countries leads to not only a lowered total system cost but to CO2 emissions, and required CO2 prices that are much more equal between the European partners.

SOE 8: Dynamics of Social and Adaptive Networks II

Time: Friday 11:15–12:45 Location: H6

SOE 8.1 Fri 11:15 H6

Spinning faster and faster: acceleration of collective attention — •Philipp Hövel — University College Cork, Irlenad

Due to the advent of smart phones and other tools of modern communication, news are available in real time and social media reactions spread across the globe in seconds. As a consequence, the public discussion seems to be accelerated and its pace ever increasing. In longitudinal datasets across various domains (online and offline), covering multiple decades, we find significantly increasing gradients and shortened periods in the trajectories of how cultural items receive collective attention. Is this the inevitable conclusion of the way information is disseminated and consumed?

We present a simple mathematical model that is based on Lotka-Volterra dynamics with a memory kernel. The three main mechanisms are imitation/production, saturation/aging and competition. The common resource, for which different topics compete, is the collective attention of the userbase. The numerical time series are able to explain the empirical data remarkably well. Our modeling suggests that the accelerating ups and downs of popular content are driven by increasing production and consumption of content, resulting in a more rapid exhaustion of limited attention resources. In the interplay with competition for novelty, this causes growing turnover rates and individual topics receiving shorter intervals of collective attention.

SOE 8.2 Fri 11:45 H6

Evolutionary Reinforcement Learning Dynamics with Irreducible Environmental Uncertainty — •Wolfram Barfuss[1,2] and Richard P. Mann[2] — [1]University of Tübingen, Germany — [2]University of Leeds, United Kingdom

In this work we derive and present evolutionary reinforcement learning dynamics in which the agents are irreducibly uncertain about the current state of the environment. We evaluate the dynamics across different classes of partially observable agent-environment systems and find that irreducible environmental uncertainty can lead to better learning outcomes faster, stabilize the learning process and overcome social dilemmas. However, as expected, we do also find that partial observability may cause worse learning outcomes, for example, in the form of a catastrophic limit cycle. Compared to fully observant agents, learning with irreducible environmental uncertainty often requires more exploration and less weight on future rewards to obtain the best learning outcomes. Furthermore, we find a range of dynamical effects induced by partial observability, e.g., a critical slowing down of the learning processes between reward regimes and the separation of the learning dynamics into fast and slow directions. The presented dynamics are a practical tool for researchers in biology, social science and machine learning to systematically investigate the evolutionary effects of environmental uncertainty.

SOE 8.3 Fri 12:15 H6

Desynchronization Transitions in Adaptive Networks — •Rico Berner[1,2], Simon Vock[3], Serhiy Yanchuk[2], and Eckehard Schöll[1,4,5] — [1]Institut für Theoretische Physik, Technische Universität Berlin, Germany — [2]Institut für Mathematik, Technische Universität Berlin, Germany — [3]Charité-Universitätsmedizin Berlin, Germany — [4]Bernstein Center for Computational Neuroscience Berlin, Humboldt-Universität Berlin, Germany — [5]Potsdam Institute for Climate Impact Research, Potsdam, Germany

Adaptive networks change their connectivity with time, depending on their dynamical state [R. Berner, E. Schöll and S. Yanchuk, SIAM J. Appl. Dyn. Syst. 18, 2227 (2019)]. While synchronization in structurally static networks has been studied extensively, this problem is much more challenging for adaptive networks. In this work, we develop the master stability approach for a large class of adaptive networks [R. Berner, S. Vock, E. Schöll and S. Yanchuk, PRL 126, 028301 (2021)]. This approach allows for reducing the synchroniza-

tion problem for adaptive networks to a low-dimensional system, by decoupling topological and dynamical properties. We show how the interplay between adaptivity and network structure gives rise to the formation of stability islands. Moreover, we report a desynchronization transition and the emergence of complex partial synchronization patterns induced by an increasing overall coupling strength. We illustrate our findings using adaptive networks of coupled phase oscillators and FitzHugh-Nagumo neurons with synaptic plasticity.

SOE 9: Symposium: Synchronization Patterns in Complex Dynamical Networks (organized by Jakub Sawicki, Sabine Klapp, Markus Bär and Jens Christian Claussen) (joint session DY/SOE)

The program of this session is embedded in a symposium supported by DPG section DY and SOE as well as TU Berlin, SFB 910 and the BCSCCS e.V in Honor of Professor Eckehard Schöll's 70th Birthday. Eckehard Schöll has been the local organizer of the DPG-SKM conferences in Berlin for many years and was awarded the DPG badge of honour (Ehrennadel) for his service to the community.

Time: Friday 13:30–16:00 Location: ESS

Invited Talk SOE 9.1 Fri 13:30 ESS

Network-Induced Multistability Through Lossy Coupling — •Jürgen Kurths — PIK, Potsdam, Germany — HU Berlin, Germany

The stability of synchronized networked systems is a multi-faceted challenge for many natural and technological fields, from cardiac and neuronal tissue pacemakers to power grids. For these, the ongoing transition to distributed renewable energy sources leads to a proliferation of dynamical actors. The de-synchronization of a few or even one of those would likely result in a substantial blackout. Thus, the dynamical stability of the synchronous state has become a leading topic in power grid research. Here we uncover that, when taking into account physical losses in the network, the back-reaction of the network induces new exotic solitary states in the individual actors and the stability characteristics of the synchronous state are dramatically altered. These effects will have to be explicitly taken into account in the design of future power grids. We expect the results presented here to transfer to other systems of coupled heterogeneous Newtonian oscillators.

Invited Talk SOE 9.2 Fri 14:00 ESS

Control of synchronization in two-layer power grids — •Simona Olmi[1], Carl Totz[2], and Eckehard Schöll[2] — [1]Istituto dei Sistemi Complessi - CNR - Firenze, Italy — [2]Technische Universität Berlin - Germany

In this talk we suggest to model the dynamics of power grids in terms of a two-layer network, and use the Italian high voltage power grid as a proof-of-principle example. The first layer in our model represents the power grid consisting of generators and consumers, while the second layer represents a dynamic communication network that serves as a controller of the first layer. In particular, the dynamics of the power grid is modelled by the Kuramoto model with inertia, while the communication layer provides a control signal P_i^c for each generator to improve frequency synchronization within the power grid. We propose different realizations of the communication layer topology and different ways to calculate the control signal. Then we conduct a systematic survey of the two-layer system against a multitude of different realistic perturbation scenarios, such as disconnecting generators, increasing demand of consumers, or generators with stochastic power output. When using a control topology that allows all generators to exchange information, we find that a control scheme aimed to minimize the frequency difference between adjacent nodes operates very efficiently even against the worst scenarios with the strongest perturbations.

30 min. break.

Invited Talk SOE 9.3 Fri 15:00 ESS

Relay and complete synchronization of chimeras and solitary states in heterogeneous networks of chaotic maps — Elena Rybalova[1], Eckehard Schöll[2], and •Galina Strelkova[1] — [1]Institute of Physics, Saratov State University, Astrakhanskaya str. 83, Saratov 410012, Russia — [2]Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

In this talk we discuss the phenomena of relay and complete synchronization in a heterogeneous three-layer network of chaotic maps. In the considered network two remote layers are not directly coupled but interact via a relay layer with which they are pairwise and symmetrically coupled. All the three layers represent rings of nonlocally coupled discrete-time oscillators but the relay layer is completely different in its spatiotemporal dynamics from that of the outer layers. We consider the cases when the individual elements of the relay layer and of the outer layers are described by Lozi maps and Henon maps, respectively, and vice versa. We establish and explore relay and complete synchronization of chimera structures and solitary state modes in a heterogeneous multiplex network and analyze the role of the relay layer structure in the resulted synchronous patterns. The results are illustrated by diagrams of desynchronized and synchronous regimes in the "inter-layer coupling - intra-layer coupling of the relay layer" parameter planes.

Invited Talk SOE 9.4 Fri 15:30 ESS

A bridge between the fractal geometry of the Mandelbrot set and partially synchronized dynamics of chimera states. — •Ralph G Andrejzak — Universitat Pompeu Fabra, Barcelona, Catalonia, Spain

A simple quadratic map with a complex-valued parameter c allows one to generate enormously rich dynamics and patterns. Fractal Julia sets and the Mandelbrot set divide the complex plane into stable and divergent regions of the map's initial conditions and parameters c. What happens if one couples several quadratic maps? We address this question using a minimal two-population network of two pairs of two quadratic maps. In dependence on c, the network enters into qualitatively different dynamical states. The network iterates can diverge to infinity or remain bounded. Bounded solutions can get fully synchronized, fully desynchronized, or enter into different partially synchronized states, including a symmetry-broken chimera state. We will at first inspect examples for these different dynamical states in the domain of the complex-valued iterates of the network. We then illustrate that the boundaries between different dynamical states form intriguing fractal patterns in the domain of the complex-valued c.