SOE 3: Poster

Time: Monday 17:30–19:30 Location: P4

SOE 3.1 Mon 17:30 P4

Causal Hierarchy in the Financial Market Network - Uncovered by the Helmholtz-Hodge-Kodaira Decomposition — •Tobias Wand[1,2,3], Oliver Kamps[1], and Hiroshi Iyetomi[3,4] — [1]CeNoS Münster — [2]Institut für Theoretische Physik, Universität Münster — [3]Faculty for Data Science, Rissho University, Kumagaya, Japan — [4]Canon Institute for Global Studies, Tokyo, Japan

Granger causality can uncover the cause-and-effect relationships in financial networks. However, such networks can be convoluted and difficult to interpret, but the Helmholtz-Hodge-Kodaira decomposition can split them into rotational and gradient components which reveal the hierarchy of the Granger causality flow. Using Kenneth French's business sector return time series, it is revealed that during the COVID crisis, precious metals and pharmaceutical products were causal drivers of the financial network. Moreover, the estimated Granger causality network shows a high connectivity during the crisis, which means that the research presented here can be especially useful for understanding crises in the market better by revealing the dominant drivers of crisis dynamics.

This contribution is based on the publication Wand et al., Entropy 2024, 26(10), 858 and was supported by the JSPS Summer Program.

SOE 3.2 Mon 17:30 P4

A Game-Theoretic Approach to Misinformation on Social Media — •Grace Galanthay and Eckehard Olbrich — Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany

Misinformation and disinformation are considered a significant problem with the rise of social media. While much research concentrates on the spread of information, our work focuses on the strategic actions of individual actors. Using a game-theoretic signaling framework, we study interactions where a sender communicates a noisy signal about the state of the world to a receiver, whose response determines payoffs for both actors. Existing "cheap talk" models explore strategic communication between two actors with misaligned preferences. We extend this framework to multiple senders and adapt the theoretical model to social media, where the traditional roles of sender and receiver merge. Our extension to a multi-actor signaling game in social media contexts represents a distinct approach to modeling the spread and strategic use of mis- and disinformation on digital platforms.

SOE 3.3 Mon 17:30 P4

Unraveling 20th-century political regime dynamics using the physics of diffusion — •Paula Pirker-Díaz[1], Sönke Beier[1], Matthew Wilson[2], and Karoline Wiesner[1] — [1]Institute of Physics and Astronomy, University of Potsdam, Potsdam, Germany — [2]Department of Political Science, University of South Carolina, Columbia, USA

Uncertainty remains regarding why some countries democratize while others do not, and why some remain democratic while others backslide into autocracy. Also the nature and changes of intermediate regimes is particularly unclear. By applying the Diffusion Map, a spectral dimensionality-reduction technique, on V-Dem political data (1900-2021), we identify a low-dimensional manifold describing electoral regimes. Using the diffusion equation from statistical physics, we measure the time scale on which countries change their degree of electoral quality, freedom of association, and freedom of expression depending on their position on the manifold. Democracies show subdiffusive dynamics, while collapsing autocracies exhibit super-diffusive dynamics. Intermediate regimes display distinct and more unstable diffusion behaviors, linked to a higher risk of civil conflict. This research bridges statistical physics and political science, offering a quantitative framework for understanding regime transformation and risk-of-conflict assessment. [arXiv:2411.11484]

SOE 3.4 Mon 17:30 P4

Analysis of (Mis)information Spread across Telegram Communities — Roman Ventzke[1,2], Anastasia Golovin[1,2], Sebastian Mohr[1,2], Andreas Schneider[1,2], and •Viola Priesemann[1,2] — [1]Max-Planck-Institut für Dynamik und Selbstorganisation, Göttingen — [2]Georg-August-Universität Göttingen

Statistically, do lies spread better than the truth? To effectively combat the proliferation of misinformation in online social media, it is important to understand how content spreads in social networks. We investigate the dynamics of (mis)information diffusion on the Telegram messaging platform to understand if (and how) the spread of both true information and misinformation differs.

As a basis for this study, we employ a novel large dataset of messages from Telegram group chats and channels. This dataset comprises more than 2.3 billion messages from more than 150,000 different chats and focuses on COVID-19-related content since the start of the pandemic.

Tracking information propagation, we show that information spread can be modeled by a Random Field Ising Model. Our results show that on Telegram misinformation spreads further than reliable information and is linked to "super spreaders". We also investigate whether factors like emotional engagement can drive misinformation spread.

SOE 3.5 Mon 17:30 P4

Interplay between algorithms, cognition and social interactions — •Beniamin Sereda and Janusz Hołyst — Faculty of Physics, Warsaw University of Technology, Koszykowa 75, PL-00-662 Warsaw, Poland

Modern societies are increasingly facing the issue of opinion polarisation, amplified by recommendation systems and their role in forming information cocoons. To understand how the evolution of user preferences and the topology of social networks influence opinion dynamics, the integrative agent-based model DAISY was developed. This model assumes three distinct levels of interactions: algorithmic, social, and cognitive. Algorithmic interactions are governed by recommendation algorithms, the social level reflects user preferences regarding whom to contact in the context of recommended items, and the cognitive level describes how individuals process information.The dynamics of preferences are driven by the algorithmic level, while opinion dynamics occur on the social and cognitive levels. Co-evolutional perspective on dynamics allows observation of how changes in network topology, triggered by recommendation systems, shape opinion evolution. Simulations show that increased personalisation accelerates the formation of informational cocoons, though in a non-linear and complex manner. Analysing social network evolution also revealed a deeper understanding of the irreversibility of processes within the system.

SOE 3.6 Mon 17:30 P4

Phase transition in maximally robust networks — •Thilo Gross[1,2,3] and Laura Barth[1,2,3] — [1]Helmholtz Institute for Functional Marine Biodiversity (HIFMB), Oldenburg — [2]Alfred-Wegener Institute (AWI), Helmholtz Center for Polar and Marine Research, Bremerhaven — [3]Carl-von-Ossietzky Universität Oldenburg

Here is a puzzle: You are building a network, but you know already that a certain proportion of nodes will fail, which will remove them and their links from your network. You don't know which nodes will fail, but you want your network to retain a connected component of functioning nodes that is as large as possible, after the failures have occured. Given a certain number of nodes and links, how do you connect the nodes? What kind of structure do you build?

Here we study a closely related though slightly simpler question: Instead of a fixed number of nodes and links, we consider an infinite network with a given mean degree. And, instead of allowing control over each individual link, we assume that the network is constructed as a configuration model. Hence the challenge becomes to pick the network's degree distribution such that after a certain proportion of nodes has failed the expectation value for the size of the giant component is still as large as possible.

We show this question can be solved using an analytical calculation, which reveals an infinite sequence of phase transitions between different configuration model structures.

SOE 3.7 Mon 17:30 P4

Game-theoretic model of group work contributions, neurodiverse versus neurotypical — •Lilliana Etheridge and Jens Christian Claussen — University of Birmingham, Edgbaston, UK

Evolution of cooperation and contribution to public goods have been long standing themes in game theory. Group work in the educational context, as well as teams in industry often have formalized workflows where individuals can decide to contribute different amounts. For this context, we formulate a game-theoretic model and analyze it via agent-

based simulations, both for neurotypical and neurodiverse contributors, modeled by differing decision behaviour.

SOE 3.8 Mon 17:30 P4

Weakly coupled FitzHugh-Nagumo oscillators and the influence of noise — •Max Contreras[1,2] and Philipp Hövel[2] — [1]Technische Universität Berlin, Germany — [2]Saarland University, Saarbrücken, Germany

We investigate neural oscillators modeled by FitzHugh-Nagumo systems that are weakly and diffusively coupled on a one-dimensional ring with finite coupling range. Operated in the oscillatory regime, we observe a simultaneous presence of robust collective oscillations and neuronal avalanches. The mechanism behind these avalanches is based on an inhibitory effect of interactions, which may quench the otherwise spiking of units due to an interplay with the maximal canard. The result are subthreshold oscillations close to an unstable fixed point. Furthermore, we explore the response of the networked system to noise, and find that for weak coupling, the network-mediated inhibition is weakened and that for intermediate coupling strength, noise can promote synchronized spiking.

SOE 3.9 Mon 17:30 P4

Characterizing similarities and differences in people's views based on open-ended expressions with LLMs and network science — •Ezequiel Lopez-Lopez and Stefan Herzog — Max Planck Institute for Human Development, Berlin

Citizens have diverse views on critical issues like pandemic management and climate change. Current methods to gather these views are limited: polls and surveys lack nuance, while qualitative approaches do not scale. We developed a computational framework that combines Large Language Models with network science to rapidly analyze citizens' evolving views without oversimplifying them. This novel approach extracts concepts from unstructured text and represents them in networks, offering deeper insights and faster analysis than traditional qualitative methods. We applied this framework to UK citizens' ideas on five UN Sustainable Development Goal-related policy problems. Our results demonstrate the framework's ability to capture nuanced differences across political, demographic, and cognitive variables. This approach has the potential to significantly enhance evidence-based policymaking and citizen engagement in complex societal issues.

SOE 3.10 Mon 17:30 P4

Multisensory processing in superior colliculus and primary sensory cortex — •Daniel Gerber[1], Peter Severin Graff[1,2], Björn Kampa[2], and Simon Musall[1,2,3] — [1]Institute of Biological Information Processing (IBI-3), Forschungszentrum Jülich, Jülich, Germany — [2]Department of Systems Neurophysiology, Institute for Zoology, RWTH Aachen University, Aachen, Germany — [3]Institute of Experimental Epileptology and Cognition Research, University of Bonn Medical Center, Bonn, Germany

The superior colliculus (SC) plays a crucial role in integrating multisensory stimuli and is associated with various cognitive functions, such as decision-making. It receives inputs from different sensory modalities, either directly from sensory organs or from primary sensory regions in the cortex. However, the distinctions between multisensory integration in the SC and the cortex remain unclear. To study the physiological underpinning of multisensory integration in these areas, awake mice were exposed to visual, tactile, and multisensory stimuli, while neural activity was recorded in primary visual cortex (V1), primary somatosensory cortex (S1) and the SC simultaneously using high-density Neuropixels electrodes. To investigate the influence of the cortical projection to the SC, in some trials V1 and/or S1 were optogenetically inhibited. A generalized linear model is used to analyse the spiking activity. We present that SC is modulated by cortical input but does not strongly rely on it. We also present the change in neural activity over the course of repeated stimulus.