SG Final Symposium

"The Complexity of Social and Economic Systems: From Models to Measures"

When: 31 October 2024 (Thursday)

Where: ETH Zurich, AudiMax F30, Main Building, Rämistr 101

Organization: Prof. David Garcia, University of Konstanz
Prof. Ingo Scholtes, Universität of Würzburg

Registration: Participation is free of charge but registration is required:
https://www.sg.ethz.ch/final-workshop-form/

Synopsis

In October 2004, Frank Schweitzer established the Chair of Systems Design at ETH Zürich. This symposium celebrates the 20th anniversary of the Chair and also marks the final one under his leadership. Each of the three sessions exemplifies, pars pro toto, the success of the Chair's interdisciplinary approach.

Invited speakers and former collaborators provide an overview of their motivations, achievements, and ongoing research questions. They will demonstrate that the diverse topics explored at the Chair over the past 20 years share a common methodological foundation in network science, agent-based modeling, system dynamics, and data science.

Thus, the complexity of social and economic systems can be effectively addressed by an interdisciplinary team equipped with the right spirit, skills, and leadership.

Program and Abstracts

09:00-09:30	**Ingo Scholtes** (University of Würzburg) *Welcome and Introduction*

| 09:30-11:00 | **Session: Coordination, Collaboration and Success** |

| 09:30-10:00 | **Marton Karsai** (Central European University, Vienna) |

Invited talk: *Memory, Causality and Their Consequences in Temporal Networks*

Temporal networks are commonly used to represent systems where connections between elements are active only for restricted periods of time, such as in telecommunication systems, biochemical reactions or social networks. Such time-varying interactions may be biased by local correlations between causally related events and commonly influenced by memory effects, which in turn lead to the emergence of mesoscale temporal motifs, long time-respecting paths, and bursty interaction dynamics. In these talk we will address the consequences of memory driven and casually related interactions on the emerging network structure and on the outcome of ongoing dynamical processes.

| 10:00-10:20 | **Christoph Gote** (Axpo Group, Baden) |

Decoding Collaboration: Predicting and Optimising Software Development through Networks

How can we predict and optimise the performance of software development teams? This talk addresses this question by leveraging insights from network science to explore the complex interplay between the technical and social structures of software projects. Looking back on the past 20 years at the Chair of Systems Design, we delve into how changes in project structure and team dynamics impact collaboration and success. By studying both open-source and proprietary software development, we examine how growth, developer turnover, and interactions shape both the technical evolution of software and the social fabric of the teams behind it. The analysis reveals patterns that can help enhance team resilience and productivity, ensuring sustainable development in diverse software ecosystems. By the end of this presentation, you'll gain a deeper understanding of how to utilise network analysis to predict key outcomes in software development and optimise collaboration for success.

| 10:20-10:40 | **Giacomo Vaccario** (Chair of Ecosystem Management, ETH Zürich) |

Knowledge in socio-economic systems: Insights from collaboration, mobility, and data-driven models

We present a simple model of a society where individuals are represented as a vector of opinions. Individuals are connected to each other in a temporal network where signed links represent a positive or negative relation between them. In a co-evolutionary dynamic setup individuals can change their opinions or change link signs. The model is phrased as a spinglas model. We study the phase diagram of the corresponding Hamiltonian and find that the "triad-statistics" that is expected from structural balance is obtained for specific parameter values. We compare the theoretical results to data obtained from actual social networks. The exciting result is that homophilic (diadic) relations are fulle sufficient to explain the emergence of realistic social balance – a triangle based statistics.

| 10:40-11:00 | **Ingo Scholtes** (Universität of Würzburg) |

What makes teams successful? A Network Science Perspective

The convergence of social and technical systems provides us with a wealth of log data that capture the structure and dynamics of social organizations. It is tempting to utilize these data to better understand how social organizations evolve, how collaboration and communication patterns are related to their "success" or "failure", and how the position of individuals in social networks affects their performance, motivation, and productivity.
Considering examples from Open Source Software communities, scientific collaborations and peer-review processes, in this talk I will show how publicly available online data can be used to better understand how human and social aspects influence the success or failure of individuals as well as social organizations. I further exemplify how we can creatively use massive online data and network science methods to test hypotheses at the intersection of computational social science, organizational theory, and management science.

11:00-11:30	**Coffee Break**

11:30-13:00	**Session: Dependency, Risk and Resilience**

11:30-12:00	**Mauro Napoletano** (Université Côte d'Azur, Sophia-Antipolis)

Invited talk: *Extreme Events in Micro- and Macroeconomic Dynamics: Theory and Empirical Evidence*

The dynamics of real-world economies are characterized by various types of extreme events, which are typically more relevant than what is predicted by a Gaussian distribution. The talk will present recent evidence about the importance of these extreme events for the dynamics of countries' GDP and the dynamics of firms and asset prices. It will also show how agent-based models, emphasizing network interactions of heterogeneous agents can be used to explain the emergence of extreme events in various economic domains. These models can also be useful to study which policies can be more appropriate to deal with extreme economic risk and to improve the resilience of real-world economies and markets.

12:00-12:20	**Rebekka Burkholz** (Center for Information Security, Saarbrücken)

Cascade Processes for Sparse Machine Learning

What could seemingly distinct phenomena like a financial crisis, a global pandemic, or the sudden increase of wheat prizes have in common? On an abstract level, they all can emerge as result of a cascade process that evolves on a complex network of interdependent actors. Another well known example of a cascade process, yet, largely disregarded in the context of systemic risk analyses, is the evaluation of a deep neural network, i.e., the work horse of the ongoing revolution by modern machine learning and AI. We will discuss how fundamental insights into the nature of cascade dynamics cannot only guide the design of more robust systems but also inspire us to build efficient AI.

12:20-12:40	**Stefano Battiston** (University Ca Foscari, Venice)

Climate change and financial risk

Climate change is one the defining emerging challenges of our times. The relation between climate change and finance is two-sided. On the one hand, climate change poses a new type of risk for finance, which traditional approaches are not well-suited to describe. On the other hand, finance's perception of climate risk has an impact on investments that support climate change mitigation and adaptation. Therefore, an adequate assessment of climate risk by the financial sector is key to avoid under-investments in climate action. This talk provides an overview of the state-of-art on the subject and why it matters for citizens and academics outside the finance discipline.

12:40-13:00	**Giona Casiraghi** (Chair of Systems Design, ETH Zürich)

Quantifying Resilience in Complex Systems: From Robustness to Adaptivity

Real-world systems are inherently adaptive, capable of recovering and reorganising after disruptions. To truly understand and enhance resilience, we must quantify such adaptivity. Achieving this requires high-resolution, real-time data and mathematical models that capture not only the impact of disruptions but also the system's capacity to respond and change. By integrating agent-based models with network analytics, we can track disruptions as they occur, predict failure cascades, and design more effective recovery strategies. This approach is especially crucial for infrastructures like drug supply chains, where real-time adaptation is key to mitigating shortages and ensuring the continuous delivery of pharmaceuticals to patients. In this talk, we demonstrate how moving beyond static resilience measures allows us to develop more comprehensive metrics that capture a system's robustness and adaptive capacity, providing deeper insights into how they withstand and recover from shocks.

13:00-14:30	**Lunch Break**

14:30-16:00	**Session: Emotions, Opinions and Polarization**

14:30-15:00	**Andreas Flache** (University of Groningen)

Invited talk: *The Complexity of Social Polarization: Connecting Individual Opinions and Societal Dynamics with Agent-Based Models and Experiments*

Recently, many societies seem to shift towards more polarization and volatility in opinions, for example in attitudes about immigration or climate change. Underlying reasons of this development are hard to unravel. A key obstacle is that opinion dynamics in society involve a complex micro-macro interaction between interpersonal processes, meso-level conditions such as network structures, and macro-level outcomes, such as polarization in opinion distributions. Agent-based simulation models (ABM) offer powerful tools to address this challenge. Different types of ABM will be presented that demonstrate how and under which conditions polarization and intergroup animosity could arise as unintended result of fundamental and prevalent interpersonal processes, for example homophily and social influence. Drawing on recent research, it will then be shown how competing models of polarization dynamics can be compared and informed with data from lab experiments and social network studies.

15:00-15:20	**Jan Lorenz** (Constructor University Bremen)

Opinion Distributions in the Real World

Models and mechanisms for the dynamics of opinion dynamics are an intriguing topic where complex systems research wants to contribute to our understanding of the phenomenon of polarization. A problem is that social processes and in particular opinion dynamics in the real world do not unfold in isolation, also other factors than just local interaction about opinions determine the opinions of individuals. In the talk I will present opinion distributions from movie ratings and attitude surveys and showcase some directions for a complementary more data-driven modeling approach.

15:20-15:40	**Laurence Brandenberger** (University of Zurich)

The Rise of Extremes: Tracing the Surge in Swiss Political Polarization

Are we truly witnessing an era of unprecedented polarization? While many researchers contend that political polarization—particularly among elites—has intensified worldwide, much of the empirical research relies on short-term analyses. This begs the question: could elite polarization have fluctuated throughout history, following a natural ebb and flow?
In this talk, I explore the evolution of ideological polarization within the Swiss National Parliament, spanning from 1891 to the present. By constructing a unified ideological space, we trace party positions over the last 130 years. Our findings suggest that today's polarization levels are historically unmatched.
The data reveals a dramatic increase in polarization within the Swiss Parliament, beginning in the 1970s and accelerating in the 1990s. These shifts align with the rise of the Swiss People's Party and Switzerland's growing engagement with Europe during that same period.

15:40-16:00	**David Garcia** (University of Konstanz)

Online emotions and how to measure them

Our online life generates a vast amount of digital traces, for example when we use our phone or talk with others on social media. These traces can be used to study aspects of emotional life that were very difficult to study with experiments or surveys. I will present work on the development and application of digital trace data analysis to study emotions at various levels. I will present LEIA, a language model to identify individual emotions from social media text and how text analysis methods can be applied to create emotion macroscopes of society at large.

16:00-16:10	**David Garcia** (University of Konstanz) *Closing Remarks*
16:10-16:30	**Coffee Break**

EINLADUNG

Abschiedsvorlesung von Prof. Dr. Dr. Frank Schweitzer
Professur für Systemgestaltung · www.sg.ethz.ch

Dämmerung

31 Oktober 2024 · 17 Uhr c.t.
ETH Zürich · Audi Max HG F30 · Rämistrasse 101 · 8092 Zürich
Apéro im Anschluss an die Veranstaltung