Collective Social Dynamics from Animals to Humans (SYSO)

jointly organised by
the Physics of Socio-economic Systems Division (SOE),
the Dynamics and Statistical Physics Division (DY), and
the Biological Physics Division (BP)

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Collective opinion formation, emergence of hierarchies and collective dynamics on markets are typical phenomena both of bacterial and animal as well as of socio-ecomomic communities. Statistical physics concepts widely contributed to the understanding of such nonlinear collective phenomena. Collective movement of humans in public space have been an early studied dynamics of active Brownian motion. This symposium integrates individual modeling of human and animal behaviour, movement and mobility, opinion formation, information processing and group interations towards an understanding of the self-organizing dynamics in societies.

Overview of Invited Talks and Sessions

(Lecture hall H1)

Invited Talks

SYSO 1.1	Thu	9:30–10:00	H1	**Capturing group interactions: The next frontier of modeling social and biological systems** — •Frank Schweitzer
SYSO 1.2	Thu	10:00–10:30	H1	**Modelling Individual Mobility Behavior** — •Laura Maria Alessandretti
SYSO 1.3	Thu	10:30–11:00	H1	**Validating argument-based opinion dynamics with survey experiments** — •Sven Banisch
SYSO 1.4	Thu	11:15–11:45	H1	**Self-organization, Criticality and Collective Information Processing in Animal Groups** — •Pawel Romanczuk
SYSO 1.5	Thu	11:45–12:15	H1	**Collective dynamics and physiological interactions in bird colonies** — •Hanja Brandl

Sessions

SYSO 1.1–1.5	Thu	9:30–12:15	H1	**Collective social dynamics from animals to humans**

SYSO 1: Collective social dynamics from animals to humans

Time: Thursday 9:30–12:15 Location: H1

Invited Talk SYSO 1.1 Thu 9:30 H1

Capturing group interactions: The next frontier of modeling social and biological systems — •Frank Schweitzer — Chair of Systems Design, ETH Zürich, Switzerland

Complex social and biological systems comprised of many interacting agents are often represented as networks. This implies to decompose interactions between many agents into concurrent dyadic interactions of pairs of agents. Such a reduction is recently challenged with different approaches, which are addressed in this talk: (i) temporal network models reflect the causal relation between interactions occuring at different time steps, (ii) hyperedge network models capture group interactions by constructing higher-order networks, (iii) inference network models reveal information hidden behind observed interaction patterns. Combined, we obtain a very rich picture of social structures that emerge and adapt at different time scales and at different size levels (dyads, groups, communities, networks). Two examples of real-world social organizations (Bechstein bats, software developers) are used to illustrate our insights.

Invited Talk SYSO 1.2 Thu 10:00 H1

Modelling Individual Mobility Behavior — •Laura Maria Alessandretti — Technical University of Denmark, Copenhagen, Denmark

From choosing a restaurant for dinner, to deciding whether to cycle or drive, spatial decisions are ubiquitous in human day-to-day lives. Taken together, these choices underlie critical societal phenomena, including the spread of epidemics, traffic congestion, and the emergence of urban segregation. In this talk, I will present recent empirical findings on the mechanisms underlying individual mobility behaviour, made possible by the study of comprehensive, high-resolution mobility data, and modelling approaches. The talk will touch upon key aspects in mobility, such as the interplay between exploration and exploitation, the effect of cognitive constraints, the relation between social and spatial behavior, and the effect of spatial scales. I will conclude with a perspective on open questions and future directions.

Invited Talk SYSO 1.3 Thu 10:30 H1

Validating argument-based opinion dynamics with survey experiments — •Sven Banisch — Karlsruhe Institute of Technology, Institute of Technology Futures, Germany

We combine experimental research on the biased processing of arguments with a computational theory of collective opinion dynamics. While the biased processing of arguments has been frequently reported in social-psychological literature, its integration into argument-based models of opinion dynamics has been missing. In this paper we operationalize the argument communication process employed in these models in conjunction with an experimental design developed to measure biased processing and the resulting attitude changes in the context of energy production technologies. This allows us to analytically compute the expected attitude change through exposure to an unbiased set of arguments for different strengths of biased processing. Calibrating the microlevel assumptions with the experimental data shows a clear signature of moderate biased processing. We further extend the model by incorporating an unbiased external information source providing random arguments at a certain rate (as opposed to receiving arguments from others). The macroscopic opinion distributions emerging from this at the collective level are one-sided clearly in favor (green) or against (coal) a technology and match the surveyed attitudes if we control for the impact of social influence. Sociological model-building reveals that the relationship between biased processing and attitude polarization is not as direct as typical assumed in the psychological literature.

15 min. break

Invited Talk SYSO 1.4 Thu 11:15 H1

Self-organization, Criticality and Collective Information Processing in Animal Groups — •Pawel Romanczuk — Insitute for Theoretical Biology, Department of Biology, Humboldt Universität zu Berlin, Germany — Bernstein Center for Computational Neuroscience, Berlin — Research Cluster of Excellence "Science of Intelligence", Berlin

Collective behavior of animals is a fascinating example of self-organization in biology. In contrast to non-living physical systems, collective animal behavior and the underlying social interactions are the result of evolutionary adaptations. Being and acting in a group is believed to confer fitness benefits to individuals, for example by promoting exchange of social information, accurate collective decisions, or protection from predators. In this context, it has been argued that animal collectives should operate in a special parameter region close to critical points, i.e. close to phase transitions between different collective states, where various aspects of collective information processing become optimal. Here, we will investigate the *criticality hypothesis* for animal collective behavior from different angles by combining model simulations together with laboratory and field experiments on collective predator response in fish.

Invited Talk SYSO 1.5 Thu 11:45 H1

Collective dynamics and physiological interactions in bird colonies — •Hanja Brandl — University of Konstanz, Konstanz, Germany — Max Planck Institute of Animal Behavior, Konstanz, Germany — University of Zurich, Zurich, Switzerland

Social behaviours can help animals survive in harsh and unpredictable environments by giving them access to information about where resources are or the presence of predators. To reap these benefits requires individuals to form and maintain social bonds with others, then enabling them to coordinate key activities such as foraging together or to synchronise reproduction. However, the social networks that form among individuals promote not only benefits. Social connectivity can also have negative consequences, such as the transmission of physiological stress from one individual to another. As humans, we have all experienced situations where interacting with stressed friends or family members has made us feel stressed ourselves. As the stress response is highly conserved across vertebrates, it is highly likely that stress transmission is common in other animal societies and could amplify the effects of stress exposure in animal collectives; yet, its consequences remain almost completely unexplored.

In this talk, I present findings from my research on avian societies in the wild and the laboratory, using behavioural experiments and fine-scale tracking to unravel the mechanisms, functions, and consequences of birds' social bonds. I discuss methods, frameworks, and limitations in studying animal social networks using examples from my work on zebra finches, but will also give an outlook into other study systems.