SOE 5: Social Systems, Opinion and Group Dynamics

Time: Monday 12:30–13:30 Location: H11

SOE 5.1 Mon 12:30 H11

Bounded rational agents playing a public goods game — •Prakhar Godara, Tilman Diego Aleman, and Stephan Herminghaus — Max Planck Institute for Dynamics and Self-Organization (MPIDS), 37077 Goettingen, Germany

An agent-based model for human behavior in the well-known public goods game (PGG) is developed making use of bounded rationality, but without invoking mechanisms of learning. The underlying Markov decision process is driven by a path integral formulation of reward maximization. The parameters of the model can be related to human preferences accessible to measurement. Fitting simulated game trajectories to available experimental data, we demonstrate that our agents are capable of modeling human behavior in PGG quite well, including aspects of cooperation emerging from the game. We find that only two fitting parameters are relevant to account for the variations in playing behavior observed in 16 cities from all over the world. We thereby find that learning is not a necessary ingredient to account for empirical data.

SOE 5.2 Mon 12:45 H11

Social nucleation: Group formation as a phase transition — Frank Schweitzer and •Georges Andres — ETH Zürich, Chair of Systems Design, Switzerland

The spontaneous formation and subsequent growth, dissolution, merger, and competition of social groups bear similarities to physical phase transitions in metastable finite systems. In this talk, I will examine three different scenarios, percolation, spinodal decomposition, and nucleation, to describe the formation of social groups of varying size and density. In an agent-based model, I will present a feedback between the opinions of agents and their ability to establish links. Groups can restrict further link formation, but agents can also leave if costs exceed the group benefits. I will show how to identify the critical parameters for costs and benefits and social influence to obtain either one large group or the stable coexistence of several groups with different opinions. Analytic investigations then allow to derive different critical densities that control the formation and coexistence of groups. This approach sheds light on the much-neglected early stage of network growth and the emergence of large connected components.

SOE 5.3 Mon 13:00 H11

Multiscale Causal Structure in Armed Conflict — •Niraj Kushwaha and Edward Lee — Complexity Science Hub Vienna, Josefstädter Straße 39, 1080 Vienna, Austria

Armed conflict is a major and ongoing problem around the world today. The very features of conflict that makes it important, its multiscale and multidimensional impact, render it difficult to understand quantitatively. Here, we introduce a first principles approach to conflict by clustering sequences of conflict events into causal conflict avalanches. We rely on armed conflict data from the ACLED project, occurring from the years 1996-2021 in Africa. We investigate different spatial and temporal scales with a systematic coarse-graining procedure. For space, we tile the region with semi-regular bins that constitute our level of resolution, and for time we group days into discrete intervals. This formalism bridges the gap between microscopic and macroscopic descriptions of armed conflict. To infer causal relationships between different spatial bins we use a standard nonlinear measure of statistical dependency called transfer entropy. Using transfer entropy, we extract a directed causal network that links adjacent geographic locations. We then leverage this causal structure to join two conflict events if they are adjacent in time and belong to adjacent and causally connected spatial bins. We call the resulting sequences of conflict events, conflict avalanches. Further statistical and dynamical analysis reveal that many conflict avalanche features follow power-law distributions. Our work paves way for future investigation on classes of models which can explain the emergence of scaling in conflict across different scales.

SOE 5.4 Mon 13:15 H11

Ordering dynamics and path to consensus in multi-state voter models — Lucía Ramirez, Maxi San Miguel, and •Tobias Galla — Instituto de Física Interdisciplinary Sistemas Complejos, IFISC (CSIC-UIB), Campus Universitat Illes Balears, E-07122 Palma de Mallorca, Spain

We investigate the time evolution of the density of active interfaces and of the entropy of the distribution of agents among opinions in multi-state voter models. Individual realisations undergo a sequence of extinctions until consensus is reached. After each elimination the population remains in a meta-stable state. The density of active interfaces and the entropy in these states varies from realisation to realisation. Making some simple assumptions we are able to analytically calculate the average density of active interfaces and the average entropy in each of these states. We also show that, averaged over realisations, the density of active interfaces decays exponentially, with a time scale set by the size and geometry of the interaction graph, but independent of the initial number of opinion states. The decay of the average entropy is exponential only at long times when there are at most two opinions left in the network. Finally, we show how meta-stable states comprised of only a subset of opinions can be engineered as genuinely stationary states by introducing precisely one zealot in each of the prevailing opinions.