SOE 5: Network Science

Time: Tuesday 9:30–10:30 Location: GÖR/0226

Invited Talk SOE 5.1 Tue 9:30 GÖR/0226

Network Science in Criminology: Insights from Empirical Case Studies — •Masarah Paquet-Clouston — University of Montreal, Montreal, Canada

Network science has become a central tool in criminology, offering powerful ways to model illicit relationships and hidden organizational structures. This presentation draws on three empirical case studies that apply network-based methods to real-world criminological problems: mapping how cybercrime forum users connect with specific topics, tracing money flows in illicit cryptocurrency transactions, and identifying links among corporate secrecy vehicles.

These examples highlight both the analytical potential of network-based approaches and the methodological challenges inherent to criminological data. I will conclude by identifying open research questions that advances in related fields, such as complexity science, could help address.

SOE 5.2 Tue 10:00 GÖR/0226

Collective decision making with biases - Role of network topology — Yunus Sevinchan[1], Petro Sarkanych[2], Archili Sakevarashvili[1], Yurij Holovatch[2,3], and •Pawel Romanczuk[1] — [1]Institute for Theoretical Biology, Dept. of Biology, Humboldt Universität zu Berlin — [2]Yukhnovskii Institute for Condensed Matter Physics of the National Academy of Sciences of Ukraine, Lviv, Ukraine; 𝕃4 Collaboration and Doctoral College for the Statistical Physics of Complex Systems, Lviv-Leipzig-Lorraine-Coventry, Europe — [3]Complexity Science Hub, Vienna, Austria

The accuracy of collective decision-making in groups depends on a complex interplay of factors, including prior information, biases, social influence, group composition, and the structure of the interaction network. In this work, we study a spin-type model in which interactions are mediated through a social field generated by an agent's neighbors, allowing for heterogeneous individual preferences. Building on previous results [1], we examine how network topology affects consensus formation. We show that, unlike the Ising model, the social-field model exhibits fundamentally similar behavior on both scale-free and Erdős-Rényi networks, a result that can be attributed to weaker hub-hub interactions. Finally, we investigate the extent to which a strongly biased minority can dominate the collective decision, even in the presence of an oppositely biased majority.

[1] Sarkanych *et al*, Phys Biol 20 (2023); Sarkanych *et al*, Cond Matt Phys 27 (2024); Sevinchan *et al*, Phys Rev Res 7 (2025)

SOE 5.3 Tue 10:15 GÖR/0226

Operational time and criticality in physics co-authorship networks — •Pouria Mirelmi[1] and Haiko Lietz[2] — [1]Leiden University, Leiden, The Netherlands — [2]GESIS – Leibniz Institute for the Social Sciences, Cologne, Germany

Many real-world complex networks display either fractal or small-world structure, but rarely both. Prior work explains this incompatibility through static architectural constraints: fractality emerges from critical branching trees, whereas small-world structure requires supercritical expansion supported by long-range shortcuts. Here we show that this dichotomy is not merely structural but dynamical. Using more than a century of APS co-authorship data, we construct a sequence of network time slices by tuning aggregation to the percolation transition. Measuring a set of macro-level parameters – including percolation observables and small-world indicators – we find that all scale as power laws with the networks' distance from criticality. Networks remain fractal near criticality but acquire small-world shortcuts only when aggregated beyond the critical point. We further show that the critical time scale emerging from this aggregation procedure constitutes an operational time to which the system self-organizes: citation avalanches obey dynamical scaling theory only when defined in this intrinsic time. These results indicate that static analyses are insufficient whenever the evolutionary time scale of a network is empirically accessible. A dynamical scaling framework is required to correctly identify and characterize critical and supercritical network states.