# SOE 15: Networks: From Topology to Dynamics III (joint session SOE/DY)

Time: Thursday 10:00–10:45 Location: ZEU 260

SOE 15.1 Thu 10:00 ZEU 260

**Understanding Braess' Paradox in power grids** — •Benjamin Schäfer[1], Thiemo Pesch[2], Debsankha Manik[3], Julian Gollenstede[4], Guosong Lin[4], Hans-Peter Beck[4], Dirk Witthaut[2], and Marc Timme[5,3] — [1]Karlsruhe Institute of Technology — [2]Forschungszentrum Jülich — [3]Max Planck Institute for Dynamics and Self-Organization — [4]Clausthal University of Technology — [5]Technical University of Dresden

The ongoing energy transition requires power grid extensions to connect renewable generators to consumers and to transfer power among distant areas. The process of grid extension requires a large investment of resources and is supposed to make grid operation more robust. Yet, counter-intuitively, increasing the capacity of existing lines or adding new lines may also reduce the overall system performance and even promote blackouts due to Braess' paradox. Braess' paradox was theoretically modeled but not yet proven in realistically scaled power grids. Here, we present an experimental setup demonstrating Braess' paradox in an AC power grid and show how it constrains ongoing large-scale grid extension projects. We present a topological theory that reveals the key mechanism and predicts Braessian grid extensions from the network structure. These results offer a theoretical method to understand and practical guidelines in support of preventing unsuitable infrastructures and the systemic planning of grid extensions.

SOE 15.2 Thu 10:15 ZEU 260

**Evolutionary Optimization of networks towards complexity: role of link distribution and cross-consistency of network complexity measures** — Archan Mukhopadhyay and •Jens Christian Claussen — University of Birmingham, UK

In a framework utilizing complexity measures for optimizing graphs and networks towards complexity, we use one complexity measure as fitness function of an evolutionary algorithm, and evaluate the resulting graphs through other complexity measures and network properties. We consider both evolution of graphs where the total number of links can evolve, as well as the case of constrained number of links. We find that in a certain range MAg optimizes towards degree-regular graphs, which is not observed for other complexity measures. We also investigate the consistency among the complexity measures on artificial and real-world datasets.

SOE 15.3 Thu 10:30 ZEU 260

**On the role of deleterious mutant regime in steering long-term evolution** — Nikhil Sharma[1], •Joachim Krug[2], and Arne Traulsen[1] — [1]Department of Evolutionary Theory, Max Planck Institute for Evolutionary Biology, 24306 Plön, Germany — [2]Institute for Biological Physics, University of Cologne, Köln, Germany

Evolutionary Graph Theory aims to understand the interplay of natural selection and genetic drift on spatial structures. A spatial structure is modeled as a graph with nodes representing asexually reproducing individuals, and edges dictate the interaction among these individuals. Based on the fixation probabilities of mutants on graphs, graphs are mainly categorised as amplifiers of selection and suppressors of selection. We study Moran Birth-death origin fixation dynamics on graphs, see https://doi.org/10.1073/pnas.2205424119. As expected, amplifiers of selection attain higher steady-state average fitness than the complete graph. However, we found that a suppressor of fixation, having a lower probability of fixing mutants regardless of their fitness values compared to the complete graph, beats the complete graph in the long term by attaining higher average fitness. It happens because of the suppressor's ability to reject deleterious mutants more efficiently. Similarly, an amplifier of fixation, a structure with a higher probability of fixing mutants regardless of their fitness values, attains lower steady-state average fitness. It happens because of the amplifier's poor ability to reject deleterious mutants. These two examples illustrate the importance of the deleterious mutant regime in steering long-term evolution, which, to our knowledge, has been overlooked in the literature.