SOE 7: Networks: From Topology to Dynamics I (joint session SOE/DY)

Time: Tuesday 11:00–12:15 Location: ZEU 260

SOE 7.1 Tue 11:00 ZEU 260

Modelling the perception of music in brain network dynamics — •Jakub Sawicki[1,2,3,4], Lenz Hartmann[5], Rolf Bader[5], and Eckehard Schöll[1,4,6] — [1]Potsdam Institute for Climate Impact Research — [2]Institut für Musikpädagogik, Universität der Künste Berlin — [3]Fachhochschule Nordwestschweiz FHNW, Basel, Switzerland — [4]Institut für Theoretische Physik, TU Berlin — [5]Institute of Systematic Musicology, University of Hamburg — [6]Bernstein Center for Computational Neuroscience Berlin

We analyze the influence of music in a network of FitzHugh-Nagumo oscillators with empirical structural connectivity measured in healthy human subjects [1]. We report an increase of coherence between the global dynamics in our network and the input signal induced by a specific music song. We show that the level of coherence depends crucially on the frequency band. We compare our results with experimental data, which also describe global neural synchronization between different brain regions in the gamma-band range and its increase just before transitions between different parts of the musical form (musical high-level events). The results also suggest a separation in musical form-related brain synchronization between high brain frequencies, associated with neocortical activity, and low frequencies in the range of dance movements, associated with interactivity between cortical and subcortical regions. [1] Sawicki, J., Hartmann, L., Bader, R., Schöll, E., Front. Netw. Physiol. 2, 910920 (2022).

SOE 7.2 Tue 11:15 ZEU 260

Order-disorder transition in the zero-temperature Ising model on random graphs — Armin Pournaki[1,2], Eckehard Olbrich[2], Sven Banisch[3], and •Konstantin Klemm[4] — [1]Laboratoire Lattice, CNRS & ENS-PSL, Paris — [2]Max Planck Institute for Mathematics in the Sciences, Leipzig — [3]Karlsruhe Institute for Technology — [4]IFISC (UIB-CSIC), Palma de Mallorca, Spain

The zero-temperature Ising model is known to reach a fully ordered ground state in sufficiently dense graphs. In sparse random graphs, the dynamics gets absorbed in disordered local minima at magnetization close to zero. Here we find that the non-equilibrium transition between the ordered and the disordered regime occurs at an average degree that slowly grows with the system size. The system shows bistability: the distribution of the absolute magnetization in the absorbing state reached is bimodal with peaks only at zero and unity. For fixed system size, the average time to absorption behaves non-monotonically as a function of average degree. The peak value of the average absorption time grows as a power law of system size. These findings have relevance for community detection, opinion dynamics and games on networks. Full manuscript available at https://arxiv.org/abs/2209.09325

SOE 7.3 Tue 11:30 ZEU 260

Analytical methods to stochastic binary-state dynamics on networks. — •Antonio Fernandez Peralta[1] and Raul Toral[2] — [1]Central European University, Vienna, Austria — [2]IFISC (Instituto de Física Interdisciplinar y Sistemas Complejos), Palma de Mallorca, Spain

Recently, there has been a lot of effort in the development of highly accurate mathematical descriptions of the dynamics of binary-state models defined on complex networks. There are two main approaches: (i) individual based-approaches where the variables are the state of each node, and (ii) compartmental approaches where nodes are aggregated based on some topological property such as, for example, the number of neighbors in the network. Except in a few cases where stochastic effects are taken into account at some extent, the approaches are usually followed by a deterministic description, neglecting the stochastic nature of the models defined by the individual transitions rates. Stochastic effects may become relevant even for extremely large system sizes, specially if the system is close to a critical point, or the network has high degree heterogeneity. Besides, there are some models where the deterministic approach does not provide the relevant information sought. For instance, the noisy-voter (Kirman) model, the contact process or the Threshold model, are examples of relevance in which the stochastic effects greatly dominate the dynamics. The main aim of this work is to give a general theoretical approach to binary-state models on complex networks that takes into account stochastic effects, going beyond incomplete deterministic approaches.

SOE 7.4 Tue 11:45 ZEU 260

Infinite sequence of explosive transitions in network robustness — •Laura Barth[1,2,3] and Thilo Gross[1,2,3] — [1]Helmholtz Institute for Functional Marine Biodiversity (HIFMB), Oldenburg, Germany — [2]Alfred-Wegener Institute (AWI), Helmholtz Center for Polar and Marine Research, Bremerhaven, Germany — [3]Institute for Chemistry and Biology of the Marine Environment (ICBM), Carl-von-Ossietzky University, Oldenburg, Germany

Explosive transitions in networks have recently received much attention. Here we show that such transitions also appear in one of the most fundamental problems in network science if it is considered from a certain angle. This problem is the fragmentation of networks under node or link removal, which has been studied extensively in the context of social networks. One key property in this context is v, the probability that a random link of a random node does not connect to the giant component. Now suppose we are constructing a random graph with a prescribed mean degree. How would we choose the degree distribution such that v is minimal after the attack? We show that the optimal degree distributions undergo an infinite sequence of discontinuous transitions as the size of the attack is changed.

SOE 7.5 Tue 12:00 ZEU 260

Information parity to measure the consonance of influence in complex networks — Aline Viol[1] and •Philipp Hövel[2] — [1]Scuola Internazionale Superiore di Studi Avanzati, Italy — [2]Christians-Albrechts-Universität zu Kiel, Germany

We discuss a new analytical tool to quantify the consonance of influence between nodes with respect to the whole network architecture: information parity. Unlike traditional approaches to quantitative network analysis that consider only local or global scales, information parity instead quantifies pairwise statistical similarities over the entire network structure. Based on information theory and using the statistics of geodesic distances, information parity assesses how similarly a pair of nodes can influence and be influenced by the network. This allows us to quantify the access of information gathered by the nodes. To demonstrate the method's potential, we evaluate a social network and human brain networks. Our results indicate that emerging phenomena like an ideological orientation of nodes in social networks can be shaped by their information parities. We also show the potential of information parity to identify central network regions in structural brain networks placed near the mid-sagittal plane. We find that functional networks have, on average, greater information parity for inter-hemispheric homologous regions in comparison to the whole network. Finally, we explore functional brain networks under influence of a psychedelic substance.