SOE 2: Networks and Social Dynamics

Time: Monday 14:00–16:00 Location: SOEa

SOE 2.1 Mon 14:00 SOEa

Degree irregularity and rank probability bias in network-meta analysis — •Annabel L Davies[1] and Tobias Galla[1,2] — [1]The University of Manchester, Manchester, United Kingdom — [2]Instituto de Fisica Interdisciplinar y Sistemas Complejos, IFISC (CSIC-UIB), Palma de Mallorca, Spain

Network meta-analysis (NMA) is a statistical technique for the comparison of treatment options. The nodes of the network graph are the competing treatments and the edges represent comparisons made between the treatments in the trials. Outcomes of Bayesian NMA include estimates of treatment effects, and the probabilities that each treatment is ranked best, second best and so on. How exactly network topology affects the accuracy and precision of these outcomes is not fully understood. We conduct a simulation study and find that disparity in the number of trials involving different treatments leads to a systematic bias in estimated rank probabilities. This bias is associated with an increased variation in the precision of treatment effect estimates. Using ideas from network theory, we define a measure of 'degree irregularity' to quantify asymmetry in the number of studies involving each treatment. Our simulations indicate that more regular networks have more precise treatment effect estimates and smaller bias of rank probabilities. We also find that degree regularity is a better indicator for the accuracy and precision of parameter estimates in NMA than both the total number of studies in a network and the disparity in the number of trials per comparison. Reference: A. L. Davies, T. Galla, Research Synthesis Methods 2020, 1-17, https://doi.org/10.1002/jrsm.1454

SOE 2.2 Mon 14:20 SOEa

Revealing network size from the dynamics of a single node? — •Georg Börner, Hauke Haehne, Jose Casadiego, and Marc Timme — Chair for Network Dynamics, Institute for Theoretical Physics and Center for Advancing Electronics Dresden (cfaed), TU Dresden

Networks are ubiquitous in the natural and human-made world and their dynamics fundamentally underlie the function of a variety of systems, from gene regulation in the cell and the activity of neuronal circuits to the distribution of electric power and the transport of people and goods.

Recent work [1] introduced a method to infer the size of a network, its number of dynamical variables, from measuring times series of a fraction of the its units only. Here we demonstrate that size inference is possible even from the observed time series of a single unit. We state mathematical conditions required for such inference in principle and show that, in practice, the success depends strongly on numerical constraints as well as on experimental decisions. We illustrate successful size inference for systems of $N = 20$ variables and point to ways for improving the reliability and power of the reconstruction. We briefly comment on how the success of the approach depends on the quality and quantity of collected data and formulate some general rules of thumb on how to approach the measurement of a given system.

[1] H. Haehne et al., Detecting Hidden Units and Network Size from Perceptible Dynamics Phys. Rev. Lett. 122:158301 (2019).

SOE 2.3 Mon 14:40 SOEa

Blind identification of stochastic block models from dynamical observations — •Michael Schaub — RWTH Aachen University, Aachen, Germany

In many applications we are confronted with the following system identification problem: we observe a dynamical process that describes the state of a system at particular times. Based on these observations we want to infer the (dynamical) interactions between the entities we observe. In the context of a distributed system, this typically corresponds to a "network identification" task: find the edges of the graph of interconnections.

However, often the number of samples we can obtain from such a process are far too few to identify the edges of the network exactly. Can we still reliably infer some aspects of the underlying system?

Motivated by this question we consider the following identification problem: instead of trying to infer the exact network, we aim to recover a (low-dimensional) statistical model of the network based on the observed signals on the nodes. More concretely, here we focus on observations that consist of snapshots of a diffusive process that evolves over the unknown network. We model the (unobserved) network as generated from an independent draw from a latent stochastic blockmodel (SBM), and our goal is to infer both the partition of the nodes into blocks, as well as the parameters of this SBM. We present simple spectral algorithms that provably solve the partition and parameter inference problems with high-accuracy. We further discuss some possible variations and extensions of this problem setup.

SOE 2.4 Mon 15:00 SOEa

Detection and Analysis of Fake News on Twitter — Zahra Ghadiri, Sima Hashemi, Milad Ranjbar, •Fakhteh Ghanbarnejad, and Sadegh Raeisi — Sharif University of Technology, Tehran, Iran

Fake news on social media has become a major problem that impacts many aspects of our lives. In this work, we try to combine ideas from complex systems and networks with techniques from natural language processing (NLP) to develop intelligent agents that can distinguish real and fake news. Our approach is based on the intuition that one of the more effective ways to detect fake news is to cross-check with reliable sources such as well-established news agencies. To this end, first we collect tweets from the Twitter accounts of official news agencies which are posted around the posting time of the target tweets. We use clustering algorithms to cluster tweets based on the topic and content. Next we identify the cluster that best matches the target tweet. Then we extract features from our tweets and train a classifier that based on the comparison with the corresponding cluster would identify fake tweets. This provides a NLP tool that enables us to check a posted tweet with news from news agencies or any other reliable source of information based on the content. We also build and investigate the evolution/dynamic trees of retweets. We analyze the topological features of the trees as well as the dynamical properties. We should note that there are challenges associated with the reconstruction of the network and dynamics of a tweet on Twitter that could potentially influence our results and conclusion.

SOE 2.5 Mon 15:20 SOEa

A physics of governance networks: critical transitions in contagion dynamics on multilayer adaptive networks with application to the sustainable use of renewable resources — •Jonathan Donges[1,2], Fabian Geier[1], Wolfram Barfuss[1,3], and Marc Wiedermann[1] — [1]Potsdam Institute for Climate Impact Research, Potsdam, Germany — [2]Stockholm Resilience Centre, Stockholm University, Stockholm, Sweden — [3]School of Mathematics, University of Leeds, Leeds, United Kingdom

Adaptive network models are promising tools to analyze complex interactions in coupled human-economy-nature systems in the context of climate change mitigation and sustainability transformations. Here, we focus on a three-layer adaptive network model, where a polycentric governance network interacts with a social network of resource users which in turn interacts with an ecological network of renewable resources. We uncover that sustainability is favored for slow interaction timescales, large homophilic network adaptation rate (as long it is below the fragmentation threshold) and high taxation rates. We also observe a trade-off between an eco-dictatorship and the polycentric governance network of multiple actors. In the latter setup, sustainability is enhanced for low but hindered for high tax rates compared to the eco-dictatorship case. These results highlight mechanisms generating emergent critical transitions in contagion dynamics on multilayer adaptive networks and show how these can be understood and approximated analytically, relevant for understanding complex adaptive systems from various disciplines ranging from physics to epidemiology.

SOE 2.6 Mon 15:40 SOEa

Public goods games on networks: endogeneous reference groups — •Adrian Fessel[1], Martin Kocher[2], and Hans-Günther Döbereiner[1] — [1]Institute for Biophysics, University of Bremen, Bremen, Germany — [2]Department of Economics, University of Vienna, Vienna, Austria

Public goods games are a paradigm for understanding cooperative behavior within some reference group, whereas the field of complex networks provides powerful frameworks for modeling the dynamics and structure of interactions between individual agents. Combining these approaches, we study the formation and evolution of endogeneous reference groups in a network model. Between iterations of public goods games played within each connected component, the model evolves by edge addition or removal based on expected utility. In simulations, we observe fragmented or percolated states depending on the set of parameters, as well as dynamical solutions characterized by oscillations of the network structure.