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Channing Network Science Seminar

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Analysis of Non-Markovian Temporal Networks: Spectral Methods and Centrality Measures

Abstract: Recent research has highlighted limitations of studying complex systems with time-varying topologies from the perspective of static, time-aggregated networks. Non-Markovian characteristics resulting from the specific ordering of interactions in temporal networks were identified as one important mechanism that alters causality and affects dynamical processes. So far, an analytical explanation for this phenomenon and for the significant variations observed across different systems is missing. Summarizing our recent research in this area, in this talk I will introduce a framework that allows to analyze temporal networks with non-Markovian characteristics. The framework is based on higher-order aggregate networks, a simple generalization of the commonly used static representation of temporal network data. I will show that spectral properties of such higher-order aggregate networks can explain the slow-down of diffusion processes compared to aggregate networks, which has been observed in a number of empirical data sets. I further show that we can derive an exact analytical prediction for the magnitude of this change compared to the weighted, time-aggregate network. I finally present recent results on the analysis of node centralities in non-Markovian temporal networks, concluding that this approach provides interesting perspectives for (i) temporal community detection by spectral clustering, (ii) refined measures of centrality for time-evolving networks, and (iii) analytical studies of dynamical processes in complex systems with time-evolving interaction topologies.

Bio: Ingo Scholtes is a senior researcher at the Chair of Systems Design at ETH Zürich. Following studies in computer science and mathematics, he completed his doctorate studies in the Systems Software and Distributed Systems group at the University of Trier in 2011. He was involved in the Large Hadron Collider experiment at CERN, designing and implementing a Peer-to-Peer-based framework for large-scale data distribution which is since being used to monitor particle collision data from the ATLAS detector. Inspired by this experience, he turned his attention to the modeling and analysis of complex networked systems. His latest research addresses applications of network science in the analysis of data from socio-technical systems, but also from biology and sociology. In a theoretical line of research he further studies new methods in the analysis of time-stamped network data. At ETH Zürich he developed a course on network science which bridges the curricula of engineering and natural sciences. He previously held a scholarship from the Studienstiftung des Deutschen Volkes and was awarded a Junior-Fellowship from the Gesellschaft für Informatik in 2014.

Hosted by Yang-Yu Liu