CoCo Seminar Series Spring 2023

Shortest Paths and Distance Backbones in Multilayer Networks with Incomparable Layers

Dr. Jordan Rozum, Postdoctoral Researcher, Systems Science and Industrial Engineering, Binghamton University

Wednesday January 25, 2023 12:00-1:00pm EST
Hybrid (EB-T1 & Zoom; meeting link available on http://coco.binghamton.edu/)

The distance backbone of a network is the smallest subgraph that contains all shortests paths, and it is a powerful sparsification tool that highlights the structural core of a network. In many applications, however, the edges between the nodes of a network may have qualitatively distinct meaning and comparing their edge weights is not straightforward. For example, a transportation network may be built from a combination of bus routes, train routes, and walkways; a gene regulatory network can be constructed using experiments in different organisms or cell lines; or a social network may have ties corresponding to myriad social media platforms. Furthermore, each edge may have multiple costs associated with it: e.g., riding a train incurs the financial cost of the ticket, the temporal cost of the journey, the environmental cost of the carbon emissions, etc. The distance backbone does not accommodate such considerations, and requires edge aggregation, or separate consideration of multiple independent networks. In this presentation, I will discuss a Pareto optimization approach to these challenges. I will review the distance backbone and its properties, and discuss the need for a new generalization to multilayer and multi-weight networks. My approach follows from the assumption that different types of edge costs are fundamentally incomparable, and then applying basic ideas from Pareto optimization. My focus will be on the simplest case, which is equivalent to weighted multigraphs, but I will also discuss more complicated multilayer networks as well, highlighting which results apply generally. Finally, I will briefly showcase a few ongoing areas of application of these methods, including in social media knowledge networks, drug-drug interaction graphs, and multi-organism gene regulatory networks.

Dr. Jordan Rozum is a postdoctoral researcher in Luis Rocha's Complex Adaptive Systems and Computational Intelligence (CASCI) lab in the Binghamton University SSIE department where he works on problems in biomedical complexity at the cellular and social scales using tools from network science and dynamical systems theory. He earned his PhD in Physics in 2022, under the advisement of Réka Albert, from Penn State University, where he studied the dynamics of feedback loops in genetic circuitry. His research interests include the control of gene regulatory networks, phase transitions in Boolean networks, and sparsification of health-related knowledge networks.

For more information, contact Hiroki Sayama (sayama@binghamton.edu). http://coco.binghamton.edu/