Fall 2016 Mathematical Sciences Colloquium

"Detectability of Community Structure in Multilayer and Temporal Networks Undergoing Layer Aggregation"

Abstract: Inspired by real-world networks consisting of layers that encode different types of connections, such as a social network at different instances in time, we study community structure in multilayer networks. We analyze fundamental limitations on the detectability of communities by developing random matrix theory for the dominant eigenvectors of modularity matrices that encode an aggregation of network layers. Aggregation is often beneficial when the layers are correlated, and it represents a crucial step for the discretization of time-varying network data, whereby layers are binned into time windows. We explore two methods for aggregation: summing the layers? Adjacency matrices as well as thresholding this summation at some value. We develop theory for both large-and small-scale communities and analyze detectability phase transitions that are onset by varying either the density of within-community edges or community size. We identify layer-aggregation strategies that are optimal in that they minimize the detectability limit. Our results indicate good practices in the context of community detection for how to aggregate network layers, threshold pairwise-interaction data matrices, and discretize time-varying network data. We apply these results to synthetic and empirical networks, including a study of anomaly detection for the Enron email corpus.

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Thursday, December 1, 2016

4:00-5:00pm in Lally 104