Invited Speakers and Abstracts

Jesús Arroyo
Department of Statistics, https://jesus-arroyo.github.io/

Title: Community detection in multilayer networks

Abstract: Network data often comprise multiple layers, such as different views, time-varying graphs, or independent samples, resulting in collections of networks over the same set of vertices. This talk considers the community detection problem, where the goal is to partition the vertices of the networks into coherent groups. Spectral methods, which are based on the eigenvalues and eigenvectors of appropriately defined matrices, have emerged as a popular tool for analyzing network data due to their flexibility and computational tractability. We present joint spectral methods for community detection in multilayer networks that lead to accurate estimation of community memberships. The methods are illustrated in a time series of flight network data and in the analysis of human brain networks constructed from fMRI.

Astrid Layton
Department of Mechanical Engineering, https://astridlayton.com/

Title: Bio-Inspired Network Design: Using Nature's Ecosystems to Design Resilience and Sustainable Human Networks

Abstract: Inspiration from nature has produced some fascinating, novel, and life changing solutions for the human world. Most of these bio-inspired designs however have been product based. Taking a systems perspective when we look to nature taps inspirations that can improve the critical *networks* we depend on. This talk focuses on biological ecosystems in particular, complex networks of interacting species that are able to support individual needs while maintaining system-level functions. These networks offer inspiration for achieving both sustainability AND resilience in the design of our human engineered networks. Quantitative ecosystem descriptors and analysis techniques adapted from ecology enable desirable ecosystem characteristics to be used as design guides for things like industrial resource networks, water networks, supply chains, and power grids.

Victoria Crawford
Department of Computer Science and Engineering, https://people.tamu.edu/~vcrawford/

Title: Submodular Functions in Network Applications

Abstract: Submodularity, a diminishing returns property of set functions, arises in many network analysis tasks. For example, submodular functions appear when identifying the most effective nodes for the spread of information in a social network, when finding key edges whose removal would disrupt a network, or when deciding where to monitor to most quickly detect the spread of some contaminant. In particular, these tasks can be formulated as the optimization of a submodular objective, for which there exists a wealth of scalable algorithms with proven performance guarantees. In this talk I will discuss the network applications of submodularity, and give an overview of existing algorithms available for this interesting class of functions.

Adam Birchfield
Department of Electrical and Computer Engineering, https://birchfield.engr.tamu.edu/

Title: The Electric Grid as A Complex Network: Characterization and Creating Synthetic Datasets

Abstract: The electric grid is a vast network of transmission lines, transformers, generators, and other equipment that delivers bulk electric power to industrial, commercial, and residential customers over a wide area. Growing reliance of society upon this system, along with growing concerns about natural and human-induced extreme event impacts, has driven much interest in understanding this complex network and the associated system resilience and fragility. In this presentation, we will discuss characterizing the electric grid as a complex network and building synthetic datasets for research and development. We will explain the interaction among a number of system metrics from graph theory, network science, computational geometry, and engineering analysis. This characterization underlies the methodology for creating synthetic grids, which are fictitious datasets that provide test cases for research and development, spurring innovation and supporting research reproducibility, since much actual grid data is considered critical energy infrastructure information (CEII) and cannot be published. The synthesis methodology consists of a heuristic balance of graph generation, discrete optimization, and engineering planning emulation to produce high-quality, realistic, large-scale synthetic electric grid test cases.

Sharmistha Guha
Department of Statistics, https://sites.google.com/view/sharmisthaguha

Title: A Bayesian Approach to Network Classification

Abstract: We propose a novel Bayesian binary classification framework for networks with labeled nodes. Our approach is motivated by applications in brain connectome studies, where the overarching goal is to identify both regions of interest (ROIs) in the brain and connections between ROIs that influence how study subjects are classified. We propose a novel binary logistic regression framework with the network as the predictor, and model the associated network coefficient using a novel class of global-local network shrinkage priors. Two representative members from this class of priors, the Network Lasso prior and the Network Horseshoe prior, are implemented using an efficient Markov Chain Monte Carlo algorithm, and empirically evaluated through simulation studies and the analysis of a real brain connectome dataset.

Tim Davis
Department of Computer Science and Engineering,
https://people.engr.tamu.edu/davis/welcome.html

Title: SuiteSparse:GraphBLAS: Graph Algorithms in the Language of Sparse Linear Algebra

Absract: SuiteSparse:GraphBLAS is a full implementation of the GraphBLAS standard, which defines a set of sparse matrix operations on an extended algebra of semirings using an almost unlimited variety of operators and types. When applied to sparse adjacency matrices, these algebraic operations are equivalent to computations on graphs. GraphBLAS provides a powerful and expressive framework for creating graph algorithms based on the elegant mathematics of sparse matrix operations on a semiring. Key features and performance of the SuiteSparse implementation of GraphBLAS package are described. The implementation appears in Linux distros, forms the basis of the RedisGraph module of Redis (a commercial graph database system), appears as C=A*B in MATLAB, and will become the core sparse matrix package in the Julia Language. In terms of performance, graph algorithms written in GraphBLAS can rival or even outperform highly-tuned specialized kernels, while being far simpler for the end user to write.