

## **A Novel Framework for Community Detection in Large Networks**

Summary: The objective of this project is to invent better models and community detection methods through extensive study of different networked systems using game-theoretic models, network entropy spectral metrics, and eigenvalue analysis. We propose to study the structure and dynamics of communities, with the goal of inventing novel network community detection methods and a game-theoretic model of community evolution. This work will lead to new insights into community structure of large networks, new theoretical models for understanding such structures and algorithms to harness them. We will make novel discoveries about connectivity structure of groups in networks. Such discoveries will allow us to explore mathematical and statistical models of network community structure and evolution, and also invent principled and scalable computational tools for community detection. This research will have strong societal and educational impacts: 1) The interest in network communities reaches beyond computing science to other areas like systems biology and social science, and this proposal has the potential to transform how we think about functional modules in large networks and communities in social contexts. 2) The impact of this project extends to academia through educational efforts, including training for graduate and undergraduate students, curriculum development, seminars, and outreach. 3) This research will improve the human performance in Army networks in which the critical nodes are the soldiers and leaders who seek and use complex information from networks, must quickly make decisions based on that information and communicate and collaborate with subordinates, peers, and superiors over the network, and control actions and equipment on other network nodes. 4) This research will benefit national defense by being able to more precisely detect a certain community, such as insurgency community, and being better able to predict where and how insurgency and social unrest will occur, and to develop effective counter-insurgency and diplomatic solutions that can help win over adversarial populations with less use of kinetic weapons.