



**Title:** The Good, the Bad, the Pragmatic: Tensor Methods for Network Learning

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**WISPER record number:** MSN251318

**Abstract:** The prevailing theme in the proposal is to develop powerful tensor methods for high-dimensional network analysis. Higher-order tensors have recently received increasing attention in many fields such as neuroscience, social networks, and computer vision. One important reason for such appreciation is the effective representation of multiway data using tensor structure. Rapid developments in modern technologies have made large-scale multi-layer network data readily available.

A central step in network analysis is to find a low-dimensional representation to better understand the key structure buried in noisy observations. Modern networks are not only large in size, but they also have intricate structure. It is therefore of great importance to identify meaningful low-dimensional structure within the high-dimensional data. The PI will develop a framework --- of statistical models, spectral algorithms, and softwares --- to analyze multi-layer network data. Previous literature has advocated unfolding the tensor into a matrix and applying classical methods developed for matrices. Despite the popularity of such techniques, tensor method provides more powerful tools to capture complex structures in data that lower-order methods fail to exploit. The research goal goes beyond the traditional network analysis; we aim to characterize probabilistic distributions over multi-layer edge connections, while taking into accounting the higher-order structures such as transitivity, balance, and community. This will allow researchers to examine complex interactions among entities in a context-specific manner, thereby providing solutions to questions that were previously impossible. The software packages resulting from this proposal, will be released freely, as well as related visualization tools for network analyses.