

UNFOLDING AND FUSION: DEBIASED INFERENCE FOR GENERALIZED MULTILAYER LATENT SPACE MODELS

Speaker: Haoran Zhang

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Time&Venue:

SCMS Room 102, September 22 (Tuesday), 10:30-11:30

Abstract:

Multilayer networks have become increasingly ubiquitous across diverse scientific fields, yet their inferential theory remains underdeveloped. We propose a flexible latent space model for directed multilayer networks with various edge types, where each node has sender and receiver latent positions capturing its sending and receiving behaviors, together with layer-varying out- and in-degree parameters and layer-specific connection matrices. Through nonlinear link functions, the model induces a Tucker low-rank tensor structure in which the structural latent spaces are intertwined with the degree-effect subspaces, creating challenges for estimation and inference. To address these challenges, we develop a novel unfolding and fusion method, coupled with two-sided centering to partial out degree effects. We establish consistency and asymptotic normality for the latent-position estimators. For the connection matrices, we uncover a non-negligible second-order bias induced by fusing two separately estimated unfolding components, derive its explicit representation, and construct a feasible plug-in correction. The resulting debiased estimator is asymptotically normal. Together, these results enable confidence regions for latent positions and tests of whether two network layers share the same structure. Extensive simulation studies validate the proposed method, and a real-world data analysis demonstrates its practical utility.

Biography:

Haoran Zhang is currently an Assistant Professor in the Department of Statistics and Data Science at Southern University of Science and Technology. From 2021 to 2023, he conducted postdoctoral research at City University of Hong Kong and The Chinese University of Hong Kong. He received his Ph.D. in Statistics from Fudan University in 2021 and his bachelor's degree from Fudan University in 2016. From 2017 to 2019, he was a visiting scholar at the Department of Statistics, Columbia University. His research interests include network data analysis, ranking problems, graphical models, high-dimensional factor analysis, and prediction-powered inference. His work has been published in journals such as JASA, Psychometrika, JMLR, and Statistica Sinica.