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Quantifying Uncertainty in Complex Systems with Applications to Brain Connectomics

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ABSTRACT

From social networks to neurosciences, graphs have rapidly become ubiquitous by offering a versatile modeling framework in which data points are represented as nodes, and various aspects of the underlying organization of the data are captured through edges. Brain Connectomics —— a developing field in cognitive neuroscience —— is a case in point, as it strives to understand cognitive processes and psychiatric diseases through the analysis of interactions between brain regions. However, in the high-dimensional, low-sample, and noisy regimes that typically characterize fMRI data, the recovery of such interactions remains an ongoing challenge: how can we discover robust patterns of co-activity between brain regions that could then be associated to cognitive processes or psychiatric disorders? How can we quantify the uncertainty associated to these discoveries? In this talk, we investigate a constrained Bayesian Independent Component Analyis (ICA) approach which simultaneously allows (a) the flexible integration of multiple sources of information (fMRI, DWI, anatomical, etc.), (b) an automatic and parameter-free selection of the appropriate sparsity level and number of connected submodules and (c) the provision of estimates on the uncertainty of the recovered interactions. Our experiments, both on synthetic and real-life data, validate the flexibility of our method and highlight the benefits of integrating anatomical information for connectome inference.

For further information and inquiries about building access for persons with disabilities, please contact Jonathan Rodriguez at 773.702.8333 or send him an email at jgrodriguez@galton.uchicago.edu. If you wish to subscribe to our email list, please visit the following website: https://lists.uchicago.edu/web/subscribe/statseminars.