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Nonbacktracking Spectral Clustering of Nonuniform Hypergraphs

Spectral methods offer a tractable, global framework for clustering in graphs via eigenvector computations on graph matrices. Hypergraph data, in which entities interact on edges of arbitrary size, poses challenges for matrix representations and therefore for spectral clustering methods. Some spectral methods exist for hypergraphs in which all edges have the same size, but many data sets are nonuniform and violate this restriction. We study spectral clustering for nonuniform hypergraphs based on the hypergraph nonbacktracking operator. After reviewing the definition of this operator and its basic properties, we prove a theorem of Ihara-Bass type to enable faster computation of eigenpairs. We then propose an approximate coordinate ascent algorithm for inference in a hypergraph stochastic blockmodel via linearized belief-propagation. Based on this algorithm, we pose a conjecture about detectability thresholds in nonuniform hypergraph stochastic blockmodels. We perform experiments in real and synthetic data that underscore the benefits of hypergraph methods (over graph-based methods) when interactions of different sizes carry different information about cluster structure.

Joint work with Jamie Haddock (Harvey Mudd College) and Nicole Eikmeier (Grinnell College)