Recovery of spatial vertex features in noisy SPA model graphs

Jordan Barrett[(1)], Jeannette Janssen[(1)], Aaron Smith[(2)]

[(1)] Dalhousie University, Halifax, Canada
[(2)] University of Ottawa, Ottawa, Canada

The graph matching problem is that of identifying vertices in two graphs that are independent perturbations of a single random graph. Inspired by an approach recently introduced in a paper by Liu and Austern [1], we consider graphs generated via a geometric random graph model. In particular, features associated with each vertex can be interpreted as giving the spatial position of the vertex, and the formation of the graph is informed by the positions of the vertices. Noisy versions of the vertex features are assumed to be given; an important step in graph matching is then that of estimating the true positions of the vertices. We apply this approach to the spatial preferential attachment (SPA) model [2], which generates sparse spatial graphs with a power law degree distribution. We propose a two-step approach to estimating the spatial positions of the vertices, and derive bounds on the noise parameters under which our method is an efficient estimator for the positions.

References

[1] S. Liu, M. Austern, Perfect Recovery for Random Geometric Graph Matching with Shallow Graph Neural Networks, *arXiv:2402.07340* (2025).

[2] W. Aiello, A. Bonato, C. Cooper, J.Janssen, P. Prałat , A spatial web graph model with local influence regions, *Internet Mathematics* 5 (2009), pp. 175–196.