Final project proposal

Zhengyu Zou Kaicheng Guo

In this final project, we are interested in the application of spectral graph theory in the field of theoretical computer science, specifically in building a bridge between combinatorial algorithms on graphs and continuous optimization algorithms. Specifically, we will explore the underlying intuitions of the properties of the Laplace matrix of a graph (positive semi-definiteness, rank, eigenvalues, eigenvectors) and its combinatorial interpretations (clusters on the graph, adjacent vertices, edge flux). In addition, we would also like to investigate how the result of Cheeger's inequality helps give us a more efficient algorithm on graph clustering (and potentially other applications). The scope of this project is to mainly introduce the main ideas of Cheeger's inequality, some intuitions behind the theorem, and its applications in many fields of computer science.

Citation:

1. Chang, K. C., et al. "THE 1-LAPLACIAN CHEEGER CUT: THEORY AND ALGORITHMS." *Journal of Computational Mathematics*, vol. 33, no. 5, 2015, pp. 443–67. *JSTOR*, http://www.jstor.org/stable/43693873. Accessed 7 Apr. 2023.

2. Arsić, Branko, et al. "GRAPH SPECTRAL TECHNIQUES IN COMPUTER SCIENCES." *Applicable Analysis and Discrete Mathematics*, vol. 6, no. 1, 2012, pp. 1–30. *JSTOR*, http://www.jstor.org/stable/43666153. Accessed 7 Apr. 2023.

3. Cvetković, Dragoš, and Slobodan K. Simić. "TOWARDS A SPECTRAL THEORY OF GRAPHS BASED ON THE SIGNLESS LAPLACIAN, III." *Applicable Analysis and Discrete Mathematics*, vol. 4, no. 1, 2010, pp. 156–66. *JSTOR*, http://www.jstor.org/stable/43671298. Accessed 7 Apr. 2023.