Spectral Graph Theory (E12)

Non-Examinable (Graduate Level)

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Spectral graph theory explores the relationship between the structural properties of graphs and the spectral characteristics of certain operators associated with them, such as the adjacency operator and the Laplacian operator. In this course, we will explore some important results in the field and discuss some applicaitons in Combinatorics and in Computer Science.

Time permiting, the following topics will be discussed:

- Eigenvalues of the adjacency and Laplacian operators
- Hoffman's bound and independent sets
- Expansion and Cheeger's inequality
- Fast mixing of random walks on graphs
- Random matrices and the spectrum of random graphs
- Construction of expander and Ramanujan graphs
- Non-localisation of eigenfunctions
- Applications in combinatorics and computer science

Prerequisites

The only prerequisites are the very basic concepts of graph theory and linear algebra.

Literature

1. B. Bollobás. *Modern Graph Theory*, Graduate Texts in Mathematics, Springer, 1998.
2. G. Davidoff, P. Sarnak, A. Valette. *Elementary Number Theory, Group Theory and Ramanujan Graphs*, Cambridge University Press, 2003.
3. D. Spielman. *Spectral and Algebraic Graph Theory*, 2019. Available at http://cs-www.cs.yale.edu/homes/spielman/sagt/sagt.pdf.
4. S. Hoory, N. Linial, and A. Wigderson. *Expander graphs and their applications*, Bulletin of the American Mathematical Society 43 (2006), 439–561.