Topics in spectral theory for network analysis

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Timetable: 12 hrs. First lecture on November 8th, 2016, 11:00 (dates already fixed see calendar), Torre Archimede, Room 2BC/30.

Course requirements: Background in numerical linear algebra, numerical and mathematical analysis.

Examination and grading: Oral presentation or written essay

SSD: MAT/08 Numerical Analysis; INF/01 ComputerScience; MAT/05 Mathematical Analysis

Aim: Provide an introduction to some fundamental topics of spectral theory for graph analysis, addressing some classical and some state-of-the-art models and techniques.

Course contents: Many mathematical models and numerical methods for handling network problems are based on spectral theory of linear operators. However, more recently, the introduction of nonlinear operators, the use of matrix functions, and the associated spectral theories has allowed for more general, accurate and efficient models and techniques.

The course will introduce to modern spectral-oriented network analysis by touching the following topics:

- Eigenvector centrality and centrality based on matrix functions
- Centrality in higher order networks (time-varying, multilayer, hypergraphs)
- Graph Laplacian and spectral partitioning
- p-Laplacian and nonlinear spectral clustering
- Nonlinear power method

References:

1. Estrada, Ernesto and Knight, Philip, *A first course in network theory*, 2015, Oxford University Press, USA
2. Gallier, Jean, *Spectral Theory of Unsigned and Signed Graphs. Applications to Graph Clustering: a Survey*, arXiv:1601.04692, 2016.