Matrix functions and network analysis: Unveiling network properties through numerical linear algebra

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Location

University of Rome "Tor Vergata", Dipartimento di Matematica, Aula Dal Passo

Schedule

- 23/01/2025, 14.30—17.30
- 24/01/2025, 10.30—13.30
- 28/01/2025, 10.30—13.30
- 29/01/2025, 10.30—12.30
- 30/01/2025, 10.30—13.30
- 04/02/2025, 10.30—13.30
- 05/02/2025, 10:30—13:30
- 06/02/2025, 12:30—13:30

Abstract

Network Analysis, linear algebra, and matrix computations are intertwined fields with fruitful outcomes. The most famous example of such a fertile interconnection is PageRank, the algorithm that originated Google. This course focuses on the connection between matrix functions, network centrality, and communicability analysis. Understanding which nodes in a network are the most important or which pair or nodes are exchanging the most information is crucial in many applications, from airport traffic to social network analysis.

After introducing the concept of matrix function and its related properties, we will discuss their application to network analysis. Algorithms for computing and approximating matrix functions are also central to the course, as numerical computations are essential to dealing with network problems of huge sizes. Moreover, the numerical techniques we will discuss (based on the Krylov subspace) can also reveal interesting network properties. The course will also include a computer laboratory part, where the students will learn to

use and code what they see in class.

Finally, a seminar will present the decay phenomenon of matrix functions and its relation with the stability of network centrality indices. Despite being a research topic, the course students will have all the theoretical basics to understand it.

References

- Benzi, Michele, and Paola Boito. "Matrix functions in network analysis." GAMM-Mitteilungen 43, no. 3 (2020): e202000012.
- Estrada, Ernesto. The structure of complex networks: theory and applications. American Chemical Society, 2012.
- Estrada, Ernesto, and Desmond J. Higham. "Network properties revealed through matrix functions." SIAM Review 52, no. 4 (2010): 696-714.
- Estrada, Ernesto, and Philip A. Knight. A first course in network theory. Oxford University Press, USA, 2015.
- Higham, Nicholas J. Functions of matrices: theory and computation. Society for Industrial and Applied Mathematics, 2008.