Study programme(s): Computer Science	
Level: Master of Science	
Course title: Complex Network Analysis	
Lecturer: Miloš Savić	
Status: elective	
ECTS: 8	
Requirements: Graph Theory, Discrete Probability and Statistics, Data Structures and Algorithms 2	

Learning objectives

The main objective of the course is to introduce students to algorithms, methods and techniques for analysis of large-scale complex networks from various domains.

Learning outcomes

Minimum: Successful students should be capable of applying basic complex network analysis techniques to an illustrative example of a complex network.

Desirable: At the end of the course it is expected that successful students understand algorithms, methods and techniques for complex network analysis and are able to extend and apply them to analyze large-scale complex networks from various domains.

Syllabus

Theoretical instruction

Introduction to network science and its relation to other scientific disciplines. Complex networks in nature, technology and social sciences. Analysis of connected components and bow-tie structures. Node and group centrality metrics and link analysis algorithms. Scale-free networks and degree distribution analysis. Mixing patterns in complex networks. Structural decomposition of complex networks. Mathematical models of complex networks. Stochastic block models. Detection and analysis of non-overlapping and overlapping clusters and hierarchical structures in complex networks. Evaluation of network clustering algorithms. Dynamical processes in complex networks and analysis of network flow data. Probabilistic models of information diffusion. Evolution of complex networks and link prediction algorithms. Analysis of spatial and temporal networks.

Practical instruction

Acquaintance with complex network analysis libraries in Python and R (iGraph, NetworkX, SNAP). Case studies realized using programs based on previously mentioned libraries.

Literature

Recomended

Ulrik Brandes, Thomas Erlebach (Eds.). *Network Analysis - Methodological Foundations*. Springer-Verlag Berlin Heidelberg, 2005.

Mark Newman, Albert-László Barabási Barabasi and Duncan Watts. *The Structure and Dynamics of Networks*. Princeton University Press, 2006.

Eric D. Kolaczyk. *Statistical Analysis of Network Data - Methods and Models*. Springer-Verlag New York, 2009.

Albert-László Barabási. *Network Science*. Cambridge University Press, 2016.

Weekly teaching load

Lectures: 2	Exercises: 1	Practical Exercises: 2	Student research:	Other:

Teaching methodology

Theoretical classes are based on the classical teaching model involving a projector. At theoretical exercises, case studies in analysis of complex networks from various domains are presented and discussed with students. Also, study examples are practiced on the computer, through acquaintance with the use of recommended libraries. To approach the oral exam students have to pass a theoretical test and realize a practical project. At the oral exam students are expected to demonstrate the in-depth understanding of the topics covered by the course.

Grading method (maximal number of points 100)

Pre-exam oblications	points	Final exam	points
Test	20	Oral examination	40
Practical project	40		