Course Unit Descriptor

Study Programme: Computer Science – Master	
Course Unit Title: Complex Network Analysis	
Course Unit Code: CS716	
Name of Lecturer(s): Miloš Savić	
Type and Level of Studies: Master Academic Degree	
Course Status (compulsory/elective): Elective	
Semester (winter/summer): Summer	
Language of instruction: Serbian (primary), English (secondary)	
Mode of course unit delivery (face-to-face/distance learning): Face-to-face	
Number of ECTS Allocated: 8	
Prerequisites: Graph theory, Discrete probability and statistics, Data structures and algorithms 2	

Course Aims:

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:

Theory

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.

Practice

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

Required Reading:

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 Contact Hours: 4	**Lectures:** 2	**Practical work:** 2

Teaching Methods:

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.

Knowledge Assessment (maximum of 100 points):

Pre-exam obligations	points	Final exam	points
Test	20	Seminar paper	40
Practical project	40		

The methods of knowledge assessment may differ; the table presents only some of the options: written exam, oral exam, project presentation, seminars, etc.