Study program: Artificial Intelligence

Name of the subject: Complex Network Analysis

Teacher(s): Miloš Savić

Status of the subject: obligatory

Number of ECTS credits: 5

Conditions: none

Subject goal

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.

Outcome of the subject

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.

Subject content

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.

Practical learning

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

Literature

Recommended

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.

Number of active teaching classes	**Theoretical teaching:2**	**Practical teaching:2**

Method of carrying out the teaching

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.

Evaluation of knowledge (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
Test	20	Oral exam	40
Practical project	40		