Complex networks and big data

Programme course

6 credits

Komplexa nätverk och stora datamängder

TSKS33

Valid from: 2021 Spring semester

Determined by
Board of Studies for Electrical Engineering, Physics and Mathematics

Date determined
2020-09-29

Main field of study
Information Technology, Computer Science and Engineering, Computer Science, Electrical Engineering

Course level
Second cycle

Advancement level
A1X

Course offered for
- Master of Science in Computer Science and Engineering
- Master of Science in Industrial Engineering and Management
- Master of Science in Industrial Engineering and Management - International
- Master of Science in Information Technology
- Master of Science in Applied Physics and Electrical Engineering
- Master of Science in Applied Physics and Electrical Engineering - International
- Bachelor's Programme in Mathematics
- Master of Science in Computer Science and Software Engineering
- Master's Programme in Mathematics
- Master's Programme in Communication Systems

Specific information
Replaces TSKS11.

Prerequisites
Linear algebra. Basic knowledge and understanding of probability theory/statistics. Programming skills in Python and Matlab.

Intended learning outcomes
After completing the course the students should
- with adequate terminology, in a well-structured manner and logically coherent, be able to describe and conduct simpler calculations that relate to the specific concepts listed under "course contents".
- be able to describe, apply, and implement in a conventional programming language, and show engineering understanding of the theory and models used in the course.
- be able to, in a structured manner, and using adequate language and terminology, orally report computer laboratory work.

Course content

Introduction to complex networks and network science. Graph representation of networks, adjacency matrix, degree sequence and degree distribution. Walks, paths and network motifs. Laplacian and its properties. Signed networks, bipartite, affiliation and tripartite networks. Similarity and clustering metrics. Centrality metrics, eigenvector centrality, Katz, PageRank, hubs and authorities. Sampling of networks, random walks, and friendship paradoxes. Assortativity metrics, modularity and degree correlations. Community detection and partitioning: Kernighan-Lin, Girvan-Newman and spectral algorithms. Network formation models: Poisson random networks, configuration model, preferential attachment, power-laws and scale-free networks, cutoffs. Watts-Strogatz model, Kleinberg model, small-world phenomena, searchability and reachability. Cascades, linear threshold models, DeGroot dynamic models and diffusion. Introduction to graph learning and graph signal processing.

Teaching and working methods

The course consists of 12 lectures, 7 tutorials and a series of computer laboratories. In-class examination of the computer laboratory work.

Examination

TEN1	Written examination	4 credits	U, 3, 4, 5
LAB1	Laboratory work	2 credits	U, G

Grades

Four-grade scale, LiU, U, 3, 4, 5

Other information

Supplementary courses: Courses in computer, information and communication networks, Internet and web technology, social networks, graph theory, machine learning and network analysis.

About teaching and examination language

The teaching language is presented in the Overview tab for each course. The examination language relates to the teaching language as follows:

- If teaching language is Swedish, the course as a whole or in large parts, is taught in Swedish. Please note that although teaching language is Swedish, parts of the course could be given in English. Examination language is Swedish.
- If teaching language is Swedish/English, the course as a whole will be taught in English if students without prior knowledge of the Swedish language participate. Examination language is Swedish or English (depending on teaching language).
- If teaching language is English, the course as a whole is taught in English. Examination language is English.

Other

The course is conducted in a manner where both men's and women's experience and knowledge are made visible and developed.

The planning and implementation of a course should correspond to the course syllabus. The course evaluation should therefore be conducted with the course syllabus as a starting point.

Department

Institutionen för systemteknik

Director of Studies or equivalent

Lasse Alfredsson

Examiner

Erik G. Larsson

Education components

Preliminary scheduled hours: 54 h
Recommended self-study hours: 106 h

Course literature

Regulary literature

Books

Latora, Vito, Nicosia, Vincenzo, Russo, Giovanni, (2017) *Complex networks : principles, methods and applications* Cambridge : Cambridge University Press, 2017.
ISBN: 9781107103184, 1107103185, 9781108299961

Additional literature

Compendia

Supplementary notes by E. G. Larsson.