Complex Networks and Big Data

Komplexa nätverk och stora datamängder
6 credits

Programme course

TSKS33

Valid from: 2026 Spring semester

Determined by	**Main field of study**	
Board of Studies for Electrical Engineering, Physics and Mathematics	Information Technology, Computer Science and Engineering, Computer Science, Electrical Engineering	
Date determined	**Course level**	**Progressive specialisation**
2025-08-28	Second cycle	A1N
Revised by	**Disciplinary domain**	
	Technology	
Revision date	**Subject group**	
	Electrical Engineering	
Offered first time	**Offered for the last time**	
Autumn semester 2020		
Department	**Replaced by**	
Institutionen för systemteknik		

Course offered for

- Master of Science in Information Technology
- Master of Science in Computer Science and Software Engineering
- Master of Science in Applied Physics and Electrical Engineering - International
- Master of Science in Computer Science and Engineering
- Master of Science in Industrial Engineering and Management - International
- Master of Science in Applied Physics and Electrical Engineering
- Master of Science in Industrial Engineering and Management
- Bachelor's Programme in Mathematics
- Master's Programme in Computer Science
- Master's Programme in Mathematics
- Master's Programme in Data Science and Information Engineering

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

1. 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".
2. 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.
3. 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 for examination modules are decided in accordance with the assessment criteria presented at the start of the course.

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 could be given in Swedish, or partly in English. Examination language is Swedish, but parts of the examination can be in English.
- If teaching language is “English”, the course as a whole is taught in English. Examination language is English.
- 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.

Other

The course is conducted in such a way that there are equal opportunities with regard to sex, transgender identity or expression, ethnicity, religion or other belief, disability, sexual orientation and age.

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.

The course is campus-based at the location specified for the course, unless otherwise stated under “Teaching and working methods”. Please note, in a campus-based course occasional remote sessions could be included.