Complex Systems 2018-2020

Professor in charge: Professor Jari Saramäki

Extent: 60 credits

Abbreviation: CS

Code: SCI3060

Objectives

The aim is to give the students a strong computational and theoretical background for understanding complex systems, from the human brain to a diversity of biological and social systems. The major has been structured such that the student can choose to emphasize the theory of complex systems or data science. Further, it is possible to add courses from other Life Science Technologies majors: e.g. the student can have a degree with 20 cr of data science and networks courses together with 25 cr of neuroscience courses. After completing their studies, the students have the necessary skills for interdisciplinary scientific careers, or, e.g. for data scientist positions in the industry.

Content and structure

The major has been structured to allow flexibility, and the student may emphasize chosen areas of interest. In addition to courses common to all Life Science Technologies masters, the major has a set of seven courses (35 cr) out of which at least five (25 cr) have to be chosen. After this, the student is free to choose the rest from two themes (Networks and Systems, Data Science and Machine Learning) as well as from other Life Science Technologies majors. It is, therefore, entirely possible to build a major that contains the fundamentals of complex systems and a number of neuroscience courses, or a combination of network science and machine learning, or a more mathematical networks track including courses from the department of mathematics. The student can also suggest other topics (economics, social sciences, etc); we are flexible and willing to tailor degrees that match the needs of the student.

NOTE: teaching period of CS-E4555 Combinatorics has changed from III-IV to V. Curriculum has been updated 3.6.2019.

Code	Course	Credits	Period/Year
Compulsory common courses of the programme (15 credits):			
MS-E2115	Experimental and Statistical Methods in Biological Sciences	5	I-II/1
JOIN-E3000	Life Science Technologies Project Course	10	III-V/1
Compulsory courses of the major (pick at least 25 credits)			
CS-E5740	Complex Networks (recommended)	5	I-II/1
CS-E5795	Computational Methods in Stochastics	5	I-II/1
MS-C2111	Stochastic Processes	5	II/1
CS-E5745	Mathematical Methods for Network Science	5	III/1
MS-E2112	Multivariate statistical analysis	5	III-IV/1
CS-E5755	Nonlinear Dynamics and Chaos	5	III-IV/1
CS-E5700	Hands-on Network Analysis	5	IV-V/1
Elective courses of the major (pick enough courses for 60 credits in total)			
Theme I: Network and systems			
CS-E5885	Modeling Biological Networks	5	III/1
MS-E1603	Random Graphs and Network Statistics	5	I/2

MS-E2122	Nonlinear Optimization	5	II/1 or 2
MS-E1602	Large Random Systems	5	IV/1
MS-E1050	Graph Theory	5	I/1 or 2
CS-E4555	Combinatorics	5	V/1
CS-E5780	Special Assignment in Complex Systems	5-10	I-V (on request)
CS-E5770	Special Course in Complex Systems	1-10	I-V/1
Theme II: Data science and machine learning			
CS-E4840	Information Visualization	5	IV/1
CS-E3210	Machine Learning: Basic Principles	5	I/2
CS-E5710	Bayesian Data Analysis	5	I-II/1
CS-E4600	Algorithmic Methods of Data Mining	5	I/1 or 2
CS-E4890	Deep Learning	5	IV-V/1
CS-E4640	Big Data Platforms	5	I-II/2
Theme III: pick any courses from other Life Science Technologies majors			

Recommendations for elective studies

In their elective studies, the students are encouraged to take courses from other majors of the LifeTech programme, according to their interests. Courses in the field of information and computer science are also recommended. Also internship is recommended in elective studies.