

COURSE DESCRIPTION

General information		
Lead instructor	Professor Janez Povh Associate Professor Robert Kopal	
Course name	CDS-12: Probabilistic methods for the analysis of complex networks	
Study programme	Computer and Data Science, third cycle Doctoral Study Programme	
Course status	Optional	
Year	First or Second	
Number of credits and mode of delivery	ECTS student workload coefficient	10
	Number of hours (L+P+S)	40/-/260

Course description
<i>1.1. Course goals</i>
<p>The instructional unit contributes to the development of the following general and subject-specific competences:</p> <p>General competences:</p> <ul style="list-style-type: none"> - Familiarity with the notion of quality and standards for professional quality through autonomy, (self-) criticism, (self-) reflection and (self-) evaluation. - Ability to create new knowledge, which represents a contribution to science. - Mastery of standard research methods, procedures and processes in diverse scientific fields. - Commitment to professional ethics. <p>Subject-specific competences:</p> <ul style="list-style-type: none"> - familiarity with advanced aspects of probability and graph theory, - familiarity with the principles of random processes in discrete and continuous time, and some applications of these processes, - ability to use appropriate methods and suitable software to solve probability problems on complex networks.
<i>1.2. Course enrolment requirements</i>
Prior knowledge of probability theory.
<i>1.3. Intended course learning outcomes</i>
<p>Knowledge and understanding:</p> <p>The student:</p> <ul style="list-style-type: none"> - becomes familiar with some of the most important applications of probability,

- understands the definition of a random graph (network) and knows the important properties of such graphs and probabilistic methods on graphs (networks),
- understands the random processes, the branching processes, and the concepts of Markov chains,
- is able to use advanced software to apply the knowledge acquired,
- is able to reflect and critically evaluate the appropriateness of certain research methods for the analysis of concrete problems.

1.4. Course content

- Probabilistic methods in networks: random variables, important convergence theorems, coupling of random variables, stochastic order, probability bounds, martingales
- Sequences of networks: scale-free networks, small world networks, Erdos-Renyi networks.
- Random processes and walks, Markov chains in discrete and continuous time and their applications
- Clustering in networks: definition of the problem, review of methods and measures for evaluating the quality of clustering.
- Branching processes: survival or extinction, random walk prospective, supercritical branching processes, binomial and Poisson branching processes.
- Phase transitions in random networks: introduction, comparison with branching processes, phase transitions of Erdos-Renyi random graphs.

1.5. Modes of delivery (mark the appropriate boxes with an X)	<input checked="" type="checkbox"/> lectures	<input checked="" type="checkbox"/> independent work
	<input type="checkbox"/> seminars and workshops	<input type="checkbox"/> multimedia and network
	<input checked="" type="checkbox"/> practicals	<input type="checkbox"/> laboratory
	<input type="checkbox"/> remote learning	<input type="checkbox"/> supervision
	<input type="checkbox"/> field work	<input type="checkbox"/> other _____

1.6. Student obligations

1.7. Monitoring student work (mark the appropriate boxes with an X)

Class attendance	Participation in class	Seminar paper	Experimental work
Written exam	Oral exam	Essay	Research
Project	Continuous assessment of knowledge	Student report	Practical work
Portfolio	Schoolwork	Homework	

1.8. Assessment and evaluation of student work during classes and the final exam

Type (examination, oral, coursework, project):

- project work, 50%
- oral exam, 50%

1.9. Required readings and number of copies relative to the number of students currently taking the course

Title	Number of copies	Number of students
Van Der Hofstad, R. (2017). Random graphs and complex networks (Vol. 43). Cambridge university press.		

Grimmett, G. R., & Stirzaker, D. R. (2020). Probability and Random Processes, 4th Edition. New York: Oxford University Press.		
Rice, J.A. (2021). Mathematical Statistics and Data Analysis, 3rd Revised Edition. California: Cengage Learning.		
<i>1.10. Supplementary readings</i>		
<i>1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.</i>		