UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Aproksimacijski in naključnostni algoritmi
Course title:	Approximation and randomized algorithms

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni magistrski študijski program Računalništvo in matematika	ni smeri	1 in 2	prvi
Interdisciplinary Masters study programme Computer Science and Mathematics	none	1 in 2	first

Vrsta predmeta / Course type	izbirni
Univerzitetna koda predmeta / University course code:	

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
45		**30**			**105**	**6**

Nosilec predmeta / Lecturer:	Borut Robič

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski/Slovene
	Vaje / Tutorial:	slovenski/Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:	**Content (Syllabus outline):**
Predmet bo vseboval naslednje vsebine:	The course will offer the following themes: Introduction

Uvod Računska zahtevnost odločitvenih in optimizacijskih problemov NP-polni in NP-težki problemi Hevristični algoritmi, kakovost suboptimalnih rešitev, (ne)obstoj zagotovila za kakovost Približno reševanje NP-težkih probl. Aproksimacijski algoritmi Kakovost približnih rešitev Razred APX Tehnika z vrzeljo Aproksimacijske sheme Razreda PTAS in FPTAS Meje približnega reševanja Razvoj aproksimacijskih algoritmov Požrešna metoda Osredotočanje na podporobleme Zaporedno razdeljevanje Dinamično programiranje Naključnostno reševanje NP-težkih probl. Las Vegas in Monte Carlo algoritmi Razredi RP, co-RP, ZPP, PP, BPP Razvoj naključnostnih algoritmov Naključno vzorčenje	Computational complexity of decision and optimization problems NP-complete and NP-hard problems Heuristic algorithms, quality of suboptimal solutions, (non)existence of a guarantee of quality Approximate solving of NP-hard problems Approximation algorithms Quality of approximate solutions The class APX Gap technique Approximation schemes The classes PTAS and FPTAS Limits of approximate solving The design of approximation algorithms Greedy method Focusing on subproblems Iterative partitioning Dynamic programming Randomized solving of NP-hard problems Las Vegas and Monte Carlo algorithms The classes RP, co-RP, ZPP, PP, BPP The design of randomized algorithm Random sampling

Zagotavljanje obilice prič	Establishing abundance of witnesses
Naključno preurejanje vhoda	Random reordering
Zgoščanje	Hashing
Enakomerno porazdeljevanje bremen	Load balancing

Temeljni literatura in viri / Readings:

B. Robič, Aproksimacijski algoritmi, Založba FE in FRI, 2.izd., 2009.

D.P. Williamson, D.B. Shmoys, The Design of Approximation Algorithms, Cambridge University Press, 2011.

V. V. Vazirani, Approximation Algorithms, Springer, 2004.

D. Hochbaum, Approximation Algorithms for NP-hard Problems, Course Technology, 1996.

R. Motwani, P.Raghavan, Randomized Algorithms, Cambridge University Press, 1995.

M. Mitzenmacher, E. Upfal, Probability and Computing: Randomized algorithms and Probabilistic Analysis, Cambridge University Press, 2005.

Cilji in kompetence:	**Objectives and competences:**
Slušatelji bodo na teoretičnem nivoju in prek praktičnih primerov osvojili znanja za približno in naključnostno reševanje praktičnih problemov, ki so v razumnem času drugače neobvladljivi.	Students will learn, both theoretically and through practical examples, how to use approximation and randomization techniques to solve practical yet intractable computational problems.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Študent bo po opravljenem predmetu: -- razumel razloge za aproksimacijski in/ali naključnostni pristop k reševanju nekaterih, predvsem NP-težkih računskih problemov, -- razumel razliko (in povezave) med odločitvenimi in optimizacijskimi problemi, -- razumel praktične razloge za aproks. ali naklj. računanje suboptimalnih rešitev problemov,	Knowledge and understanding: After completing the course the student will: -- understand the reasons for approximative or randomized approach to solving of (mainly NP-hard) computational problems, -- understand the differences (and connections) between decision and optimization problems, -- understand the practical reasons for approx.

-- razumel osnovne pojme o aproks. in naklj. algoritmih, -- razumel razne pristope za določanje kakovosti suboptimalnih rešitev ter omejitve teh pristopov, -- razumel razrede zahtevnosti odločitvenih in optimizacijskih problemov glede na njihovo odzivnost na aproks. ali naklj. reševanje, in relacije med temi razredi, -- poznal aproks. In naklj. algoritme za izbrane pomembne NP-težke probleme, -- usposobljen uporabljati razne metode za razvoj in analizo aproks. in naklj. algoritmov -- usposobljen za samostojno iskanje in razumevanje novih raziskovalnih rezultatov s področij aproksimacijsega in naključnostnega reševanja računskih problemov.	or rand. computing of suboptimal solutions, -- understand the basic notions about approx. and rand. algorithms, -- understand different approaches to estimation of the quality of suboptimal solutions, and their limitations, -- undertand the complexity classes of decision and optimizations problems according to their amenability to approx. or rand. solving, and the relations between the classes, -- know approx. or rand. algorithms for selected importand NP-hard problems, -- be able to use different methods of the design and analysis of approx. and rand. algorithms, -- be able to follow and understand the new research results in the area of approximation and randomized algorithms

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, domače naloge, seminarski način dela pri vajah.	Lectures, homeworks, and exercise groups.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, naloge, projekt) Sprotno preverjanje (domače naloge, praktično delo)	50% 50%	Type (examination, coursework, project): Continuing (homework, practical work) Final (written exam)

Končno preverjanje (pisni izpit) Ocene: 6-10 pozitivno, 5 negativno (skladno s Statutom UL).		Grading: 6-10 pass, 5 fail (in accordance with the rules of the University of Ljubljana).

Reference nosilca / Lecturer's references:

Borut Robič:

– MIHELIČ, Jurij, MAHJOUB, Amine, RAPINE, Christophe, ROBIČ, Borut. Two-stage flexible-choice problems under uncertainty. European journal of operational research, ISSN 0377-2217. [Print ed.], Mar. 2010, vol. 201, no. 2, str. 399-403, ilustr. [COBISS.SI-ID 7087444]

– MIHELIČ, Jurij, ROBIČ, Borut. Flexible-attribute problems. Computational optimization and applications, ISSN 0926-6003. [Print ed.], 2010, vol. 47, no. 3, str. 553-566, ilustr. [COBISS.SI-ID 7087700]

– BEZENŠEK, Mitja, ROBIČ, Borut. A survey of parallel and distributed algorithms for the Steiner tree problem. International journal of parallel programming, ISSN 0885-7458. [Print ed.], 2014, vol. 42, no. 2, str. 287-319. [COBISS.SI-ID 9891924]

– TROBEC, Roman, ŠTERK, Marjan, ROBIČ, Borut. Computational complexity and parallelization of the meshless local Petrov-Galerkin methods. Computers & Structures, ISSN 0045-7949. [Print ed.], 2009, vol. 87, no. 1/2, str. 81-90. [COBISS.SI-ID 21895463]

– ROBIČ, Borut. The foundations of computability theory. Heidelberg [etc.]: Springer, cop. 2015. XX, 331 str., ilustr. ISBN 978-3-662-44807-6. ISBN 978-3-662-44808-3. [COBISS.SI-ID 1536557251]