

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)						
<b>Predmet:</b>		Računska zahtevnost in hevristično programiranje				
<b>Course title:</b>		Computational complexity and heuristic programming				
<b>Študijski program in stopnja</b> Study programme and level		<b>Študijska smer</b> Study field		<b>Letnik</b> Academic year	<b>Semester</b> Semester	
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika		ni smeri		3	prvi	
Interdisciplinary first cycle academic study programme Computer Science and Mathematics		none		3	first	
<b>Vrsta predmeta / Course type</b>				izbirni / elective		
<b>Univerzitetna koda predmeta / University course code:</b>				63263		
<b>Predavanja</b> Lectures	<b>Seminar</b> Seminar	<b>Vaje</b> Tutorial	<b>Klinične vaje</b> work	<b>Druge oblike študija</b>	<b>Samost. delo</b> Individ. work	<b>ECTS</b>
45	10	20			105	6
<b>Nosilec predmeta / Lecturer:</b>				prof. dr. Marko Robnik Šikonja		
<b>Jeziki / Languages:</b>		<b>Predavanja / Lectures:</b>		slovenski / Slovene		
		<b>Vaje / Tutorial:</b>		slovenski / Slovene		
<b>Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:</b>				<b>Prerequisites:</b>		
Vpis v letnik študija.				Enrolment in the programme.		
<b>Vsebina:</b>				<b>Content (Syllabus outline):</b>		

<p>Vsebina predmeta:</p> <p>Analiza rekurzivnih algoritmov: substitucijska metoda, rešitev za algoritme deli in vladaj, metoda Akra-Bazzi.</p> <p>Verjetnostna analiza: definicija, analiza stohastičnih algoritmov.</p> <p>Randomizacija algoritmov.</p> <p>Amortizirana analiza kompleksnosti algoritmov.</p> <p>Reševanje linearnih rekurzivnih enačb.</p> <p>Razreda P in NP: definicija, NP-polnost, standardni NP-polni problemi.</p> <p>Prevedljivost in reševanje NP-polnih problemov.</p> <p>Aproksimacijski algoritmi.</p> <p>Kombinatorična optimizacija, lokalno preiskovanje, simulirano ohlajanje.</p> <p>Linearno programiranje za reševanje problemov.</p> <p>Metahevrstike in stohastično preiskovanje: vodeno lokalno preiskovanje, preiskovanje s spremenljivo soseščino, tabu preiskovanje.</p> <p>Populacijske metode: genetski algoritmi, optimizacija z rojem delcev, diferencialna evolucija, umetni imunski sistemi.</p>	<p>Lecture topics:</p> <p>Analysis of recursive algorithms: substitution method, solution for divide and conquer approach, Akra-Bazzi method.</p> <p>Probabilistic analysis: definition, analysis of stochastic algorithms.</p> <p>Randomization of algorithms.</p> <p>Amortized analysis of algorithm complexity.</p> <p>Solving linear recurrences.</p> <p>Classes P and NP: definitions, NP-completeness, standard NP-complete problems.</p> <p>Reducibility and solving NP-complete problems.</p> <p>Approximation algorithms.</p> <p>Combinatorial optimization, local search.</p> <p>Linear programming for problem solving.</p> <p>Metaheuristics and stochastic search: guided local search, variable neighbourhood search, and tabu search.</p> <p>Population methods: genetic algorithms, particle swarm optimization, differential evolution, artificial immune systems.</p>
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**Temeljni literatura in viri / Readings:**

T.H. Cormen, C.E. Leiserson, R.L. Rivest, C. Stein: Introduction to Algorithms, 3rd edition. MIT Press, 2009

R. Sedgewick, P. Flajolet: An Introduction to the Analysis of Algorithms. Addison-Wesley, 1995

M. Gendreau, J.-Y. Potvin: Handbook of Metaheuristics, 2nd Edition. Springer, 2010.

Dodatna literatura je na razpolago v obliki znanstvenih člankov.

Additional literature is available in the form of scientific papers.

### **Cilji in kompetence:**

Cilj predmeta je študente seznaniti z analizo algoritmov, računsko zahtevnostjo in učinkovitim reševanjem zahtevnih problemov, ki potrebujejo posebne pristope in optimizacijske tehnike.

Splošne kompetence:

sposobnost kritičnega razmišljanja,

sposobnost definiranja, razumevanja in reševanja ustvarjalnih profesionalnih izzivov,

sposobnost prenosa znanja in pisne komunikacije v domačem in tujem jeziku.

Predmetno-specifične kompetence:

uporaba metod za analizo rekurzivnih algoritmov: substitucijska metoda, drevesna metoda.

metode za analizo algoritmov deli in vladaj: mojstrova metoda in metoda Akra-Bazzi

verjetnostna analiza algoritmov,

uporaba amortizirane analize algoritmov,

prevedba nekaterih NP-polnih problemov,

### **Objectives and competences:**

The goal of the course is the students to become acquainted with the analysis of algorithms, computational complexity and techniques for efficient solving of difficult problems, requiring optimization techniques and approximations.

General competences:

ability of critical thinking,

the ability to define, understand and solve creative professional challenges in computer and information science,

the ability of knowledge transfer and writing skills in the native language as well as a foreign language.

Subject-specific competences:

use of methods for analysis of recursive algorithms, substitution method, recursive-tree method,

use of methods for analysis of divide-and-conquer algorithms: master theorem and Akra-Bazzi method,

probabilistic analysis of algorithms,

poznavanje ideje aproksimacijskih tehnik,  
poznavanje hevrističnih pristopov in meta-hevristik za reševanje težkih problemov,  
uporaba populacijskih optimizacijskih metod in principov evolucijskega računanja.

use of amortized analysis of algorithms,  
reduction of some NP-complete problems,  
use of heuristic methods and metaheuristics, for solving complex problems,  
use of population techniques and principles of evolutionary computation in optimization.

### **Predvideni študijski rezultati:**

Znanje in razumevanje:

Poznavanje ozadja računalniške grafike in računalniških iger.

Uporaba:

Razvoj interaktivnih 3D vizualizacij in računalniških iger.

Refleksija:

Spoznavanje in razumevanje uglašenosti med teorijo in njeno aplikacijo na konkretnih primerih s področja računalniške grafike in iger.

Prenosljive spretnosti - niso vezane le na en

predmet:

Razvoj grafičnih vizualizacij na različnih strokovnih področjih.

### **Intended learning outcomes:**

Knowledge and understanding:

Knowledge of several techniques and methods, used for analysis of algorithms and for solving complex optimization and combinatorial problems. The ability for analysis, synthesis and anticipation of solutions and their consequences for target problems using the scientific methodology.

Application:

The use of the presented methods on target problems from scientific and business environment. The understanding and usage of tools for analysis and solving such problems. The students are able to decide which of the presented techniques should be used for a given problem, and to develop a prototype solution.

Reflection:

The recognition and understanding of the importance of basic mathematical and statistical knowledge, the relation between theory and its application in concrete examples of analysis of algorithms and heuristic programming. Autonomy, (self) criticalness, (self) reflexivity, aspiration for quality.

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<p><b>Transferable skills:</b></p> <p>The ability to receive, select and evaluate new information and a proper interpretation in a context. A self-control and ability to manage limited time when preparing, planning and implementing plans and processes. Team work, writing of reports, public presentations of the results.</p> <p>Coherent mastering of basic knowledge, gained through mandatory courses, and the ability to combine the knowledge from different fields and apply it in practice.</p>
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**Metode poučevanja in učenja:**

<p>Predavanja, naloge s pisnimi poročili in z ustnimi nastopi in predstavitvami, seminarski način dela in domače naloge, ki stimulirajo sproten študij. Študenti bodo v manjših skupinah samostojno reševali in analizirali zahtevne optimizacijske probleme. Skupine bodo svoje naloge, analize in rešitve opisale v pisnem poročilu in predstavile ostalim v obliki kratke predstavitve, ki se ocenjuje skupaj s poročilom.</p>
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**Learning and teaching methods:**

<p>Lectures, assignments with written and oral demonstrations and presentations, seminar works and home works, which stimulate continuous learning. The emphasis is on the continuous study and on autonomous work on assignments and seminars. Students form small project teams and autonomously solve assignments based on real-life problems. The teams describe their solutions in written reports and prepare short oral presentations. Written reports and oral presentations are graded.</p>
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Delež (v %) /

Weight (in %)

**Načini ocenjevanja:**

**Assessment:**

<p>Način: pisni in ustni izpit, domače naloge, predstavitev projekta, projekt.</p>		<p>Type (examination, oral, coursework, project):</p>
<p>Sprotno preverjanje: domače naloge, projektno delo.</p>	50%	<p>Continuing (homework, midterm exams, project work)</p>
<p>Končno preverjanje: pisni in ustni izpit.</p>	50%	<p>Final (written and oral exam)</p>
<p>Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)</p>		<p>Grading: 6-10 pass, 1-5 fail.</p>

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**Reference nosilca / Lecturer's references:**

ROBNIK ŠIKONJA, Marko. Data generators for learning systems based on RBF networks. IEEE transactions on neural networks and learning systems, ISSN 2162-237X. [Print ed.], May 2016, vol. 27, no. 5, str. 926-938, ilustr. , doi: . [COBISS.SI-ID 1536875203]

ROBNIK ŠIKONJA, Marko, VANHOOF, Koen. Evaluation of ordinal attributes at value level. Data mining and knowledge discovery, ISSN 1384-5810, 2007, vol. 14, no. 2, str. [225]-243, ilustr. [COBISS.SI-ID 5801556]

ROBNIK ŠIKONJA, Marko, KONONENKO, Igor. Theoretical and empirical analysis of ReliefF and RReliefF. Machine learning, ISSN 0885-6125. [Print ed.], 2003, vol. 53, str. 23-69, graf. prikazi. [COBISS.SI-ID 3813460]

ROBNIK ŠIKONJA, Marko, KONONENKO, Igor. Explaining classifications for individual instances. IEEE transactions on knowledge and data engineering, ISSN 1041-4347. [Print ed.], May 2008, vol. 20, no. 5, str. 589-600, ilustr. [COBISS.SI-ID 6528340]

ROBNIK ŠIKONJA, Marko, KONONENKO, Igor, ŠTRUMBELJ, Erik. Quality of classification explanations with PRBF. Neurocomputing, ISSN 0925-2312. [Print ed.], Nov. 2012, vol. 96, str. 37-46, graf. prikazi. [COBISS.SI-ID 9365588]