

UČNI NAČRT PREDMETA / COURSE SYLLABUS						
<b>Predmet:</b>		Umetna inteligenca				
<b>Course title:</b>		Artificial Intelligence				
<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 magistrski študijski program Računalništvo in matematika		ni smeri		1 in 2	drugi	
Interdisciplinary Masters study programme Computer Science and Mathematics		none		1 in 2	second	
<b>Vrsta predmeta / Course type</b>				izbirni		
<b>Univerzitetna koda predmeta / University course code:</b>				63510		
<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>		Ivan Bratko				
<b>Jeziki / Languages:</b>	<b>Predavanja / Lectures:</b>		slovenski/Slovene, angleški/English			
	<b>Vaje / Tutorial:</b>		slovenski/Slovene, angleški/English			
<b>Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:</b>				<b>Prerequisites:</b>		
<b>Vsebina:</b>				<b>Content (Syllabus outline):</b>		

<p>Pregled osnovnih metod reševanja problemov in zahtevnejše metode hevrističnega preiskovanja: prostorsko učinkovite metode, reševanje problemov v realnem času.</p> <p>Metode planiranja po principu sredstev in ciljev: robotsko planiranje, sestavljanje urnikov in planiranje opravil, princip sredstev in ciljev, delno urejeno planiranje, planirni grafi.</p> <p>Strojno učenje: pregled osnovnih metod (Bayesov klasifikator, učenje dreves in pravil), ocenjevanje verjetnosti, princip minimalne dolžina opisa (MDL), ocenjevanje uspešnosti učenja, principi poenostavljanja pravil in odločitvenih dreves, koncept naučljivosti in teoretične meje učenja.</p> <p>Nekatere druge paradigme strojnega učenja:</p> <p>induktivno logično programiranje, spodbujevano učenje, konstruktivno učenje in odkrivanje novih konceptov s funkcijsko dekompozicijo.</p> <p>Predstavitev in obravnavanje negotovega znanja: sklepanje in učenje v bayesovskih mrežah, konstrukcija mrež in predstavitev vzročnosti</p> <p>Kvalitativno sklepanje in modeliranje:</p> <p>kvantitavno in kvalitativno modeliranje, modeliranje brez števil, kvalitativna simulacija.</p> <p>Genetski algoritmi, genetsko programiranje, in druge alternativne paradigme reševanja problemov.</p>	<p>Problem solving and search: review of problem solving techniques, advanced heuristic search techniques, space efficient techniques, real-time search.</p> <p>Means-ends planning: robot planning, task planning and scheduling, means-ends planning, partial order planning, planning graphs and GRAPHPLAN.</p> <p>Machine learning: review of basic methods (Bayes and naive Bayes classifier, learning of trees and rules, handling noise, pruning of trees and rules), MDL principle, Support Vector Machines, evaluating success of learning and comparing learning algorithms, learnability and theoretical limits for learning.</p> <p>Other paradigms of machine learning: inductive logic programming, reinforcement learning, constructive learning and discovering new concepts with functional decomposition.</p> <p>Reasoning with uncertainty: reasoning and learning in Bayesian networks, construction of networks and causality.</p> <p>Qualitative reasoning and modelling: qualitative and quantitative modelling, modelling without numbers, qualitative simulation of dynamic systems.</p> <p>Genetic algorithms, genetic programming and other problem-solving paradigms.</p>
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**Temeljni literatura in viri / Readings:**

S. Russell, P. Norvig, Artificial Intelligence: A Modern Approach, 3rd edition, Prentice-Hall 2009, ISBN-013:978-0-13-604259-4.

I. Witten, E. Frank, M.A. Hall, C. Pal, Data Mining, 4th edition, Morgan Kaufmann, 2016, ISBN: 978-0128042915.

I. Bratko, Prolog Programming for Artificial Intelligence, Fourth edition, Pearson Education, Addison-Wesley 2011, ISBN: 0201403757.

### **Cilji in kompetence:**

Poglobljeno znanje o metodah in tehnikah umetne inteligence.

Sposobnost reševanja zahtevnih konkretnih praktičnih problemov z metodami umetne inteligence.

Zmožnost kompetentne uporabe metod in orodij umetne pri raziskovalnem delu, vključno s seminarskimi nalogami pri drugih predmetih in pri diplomskem delu.

Usposobljenost za raziskovalno delo na področju umetne inteligence.

### **Objectives and competences:**

In-depth knowledge of methods and techniques of Artificial Intelligence (AI).

Ability of solving complex practical problems with AI methods.

Competence in using methods and tools of AI in research, including projects in other courses and in the final graduation project.

Ability of conducting research in Artificial Intelligence.

### **Predvideni študijski rezultati:**

Po zaključku tega predmeta bo študent:

- Razumel napredne preiskovalne algoritme in kompromise med njihovo časovno in prostorsko zahtevnostjo ter kvaliteto dobljenih hevrističnih rešitev
- Razumel algoritme za konstruiranje paralelnih planov in metode delno urejenega planiranja kot zadoščanja omejitev
- Sposoben analizirati praktične probleme preiskovanja in planiranja v konkretnih aplikacijah
- Razumel pristop in metode spodbujevanega učenja za zaporedno verjetnostno odločanje
- Razumel pristop k strojnemu učenju na osnovi matematične logike in njegove praktične

### **Intended learning outcomes:**

After the completion of the course the student will be able to:- Understand advanced search algorithms, and trade-offs between their time and space complexity, and quality of heuristic solutions produced- Understand algorithms for constructing parallel plans, and methods for partial-order planning as constraint satisfaction- Analyse practical questions of search and planning methods when applied to concrete application problems - Understand the framework and methods of reinforcement learning for sequential probabilistic decision making - Understand the logic-based approach to machine learning, and its practical advantages and drawbacks- Understand the principles and algorithms of qualitative modelling, reasoning and simulation- Able to competently combine and apply AI methods in the implementation of applications in industry,

<p>prednosti in slabosti</p> <p>- Razumel principe in algoritme kvalitativnega sklepanja, modeliranja in simulacije</p> <p>- Sposoben kombiniranja in uporabe metod umetne inteligence v industriji, robotiki, medicini, biologiji itd. ter v znanosti</p>	<p>robotics, medicine, biology, etc., and in research</p>

**Metode poučevanja in učenja:**

**Learning and teaching methods:**

<p>Predavanja, seminarske naloge in avditorne ter laboratorijske vaje.</p>	<p>Lectures, laboratory work and projects.</p>
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Delež (v %) /

Weight (in %)

**Načini ocenjevanja:**

**Assessment:**

<p>Način (pisni izpit, ustno izpraševanje, naloge, projekt): Sprotno preverjanje (domače naloge, kolokviji in projektno delo)</p> <p>Končno preverjanje (pisni in ustni izpit)</p> <p>Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL).</p>	<p>50%</p> <p>50%</p>	<p>Type (examination, oral, coursework, project): Continuing (homework, midterm exams, project work)</p> <p>Final (written and oral exam)</p> <p>Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana).</p>
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**Reference nosilca / Lecturer's references:**

<p>Ivan Bratko:</p> <p>- BRATKO, Ivan, MUGGLETON, Stephen. Applications of inductive logic programming. Communications of the ACM, ISSN 0001-0782, 1995, vol. 38, no. 11, str. 65-70 [COBISS.SI-ID 600660]</p> <p>- ŠUC, Dorian, VLADUŠIČ, Daniel, BRATKO, Ivan. Qualitatively faithful quantitative prediction. Artificial intelligence, ISSN 0004-3702. [Print ed.], 2004, vol. 158, no. 2, str. [189]-214, ilustr</p>
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[COBISS.SI-ID 4422740]

– MOŽINA, Martin, ŽABKAR, Jure, BRATKO, Ivan. Argument based machine learning. Artificial intelligence, ISSN 0004-3702. [Print ed.], 2007, vol. 171, no. 10/15, str. 922-937 [COBISS.SI-ID 6240084]

– LUŠTREK, Mitja, GAMS, Matjaž, BRATKO, Ivan. Is real-valued minimax pathological?. Artificial intelligence, ISSN 0004-3702. [Print ed.], 2006, vol. 170, str. 620-642 [COBISS.SI-ID 19805735]

– BRATKO, Ivan. Prolog programming for artificial intelligence, (International computer science series). 3rd ed. Harlow (England) [etc.]: Addison-Wesley, 2001. XXI, 678 str., graf. prikazi. ISBN 0-201-40375-7 [COBISS.SI-ID 110104320]