

UČNI NAČRT PREDMETA / COURSE SYLLABUS						
Predmet:		Strojno učenje				
Course title:		Machine Learning				
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:				63519		
Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45	6	24			105	6
Nosilec predmeta / Lecturer:				Igor Kononenko		
Jeziki / Languages:		Predavanja / Lectures:		slovenski/Slovene, angleški/English		
		Vaje / Tutorial:		slovenski/Slovene, angleški/English		
Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:				Prerequisites:		
Potrebno je poznavanje verjetnostenga računa, statistike, programiranja, osnov strojnega učenja in preiskovalnih algoritmov.						
Vsebina:				Content (Syllabus outline):		

<p>Predavanja:</p> <ol style="list-style-type: none"> 1. Pregled metod strojnega učenja 2. Kaj je učenje in relacija učenja z inteligenco 3. Pregled potrebnega predznanja 4. Napredne metode za ocenjevanje atributov 5. Napredne metode za ocenjevanje rezultatov in vizualizacije 6. Kombiniranje algoritmov strojnega učenja 7. Bayesovsko učenje 8. Kalibracija verjetnosti, razlaga posameznih predikcij 9. Numerične metode strojnega učenja 10. Umetne nevronske mreže: Hopfieldove nevronske mreže, RBF, globoke nevronske mreže 11. Nenadzorovano učenje: razvrščanje, povezovalna pravila, prostorsko podatkovno rudarjenje 12. Konstruktivna indukcija, zanesljivosti predikcij 13. rudarjenje besedil, matrična faktorizacija, analiza arhetipov 14. Ostali pristopi k strojnemu učenju 15. Uvod v formalno teorijo naučljivosti 	<p>Lectures:</p> <ol style="list-style-type: none"> 1. Overview of ML methods 2. What is learning and relation between learning and intelligence 3. Overview of necessary background 4. Advanced attribute evaluation measures 5. Advanced methods for estimating performance and visualization 6. Combining ML algorithms 7. Bayesian learning 8. Calibration of probabilities, Explanation of individual predictions 9. Numerical ML methods 10. Artificial neural networks: Hopfield NN, RBF, Deep NN 11. Unsupervised learning: clustering, Association rules, spatial DM 12. Constructive induction, reliability of predictions 13. Text mining, Matrix factorization, Arcehtypal analysis 14. Other approaches to ML 15. Introduction to formal learning theory
<p>Vaje:</p> <p>Na vajah bodo študenti utrjevali snov, ki so jo obravnavali na predavanjih, tako da jo bodo uporabili pri reševanju praktičnih problemov. Pri tem bodo poudarki na samostojnem delu</p>	<p>Lab. Work:</p> <p>Practical applications of the knowledge gained through lectures. The emphasis is on the autonomous work of students with the help of assistants. Students will, in small groups,</p>

<p>študentov ob pomoči asistentov. Študenti bodo v manjših skupinah samostojno reševali realen problem pod mentorstvom različnih strokovnjakov s področja strojnega učenja in odkrivanja znanj iz podatkov. Skupine bodo svoje naloge in rešitve opisale v pisnem poročilu in predstavile ostalim v obliki kratke predstavitve, ter s tem dobili oceno iz vaj.</p>	<p>independently solve real-life problems under the supervision of different experts in ML and DM. The groups will describe their solutions in written reports and present them in short presentations and through those will receive their mark from lab. work.</p>
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Temeljni literatura in viri / Readings:

<p>Igor Kononenko and Matjaž Kukar: Machine Learning and Data Mining. Horwood Publ., 2007. Dodatna/Additional: David J. Hand, Heikki Mannila, Padhraic Smyth: Principles of Data Mining. The MIT Press, 2001. Ian H. Witten, Eibe Frank: Data Mining: Practical Machine Learning Tools and Techniques. Morgan Kaufmann, 1999.</p>
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Cilji in kompetence:

<p>Cilj predmeta je predstaviti teoretične osnove in osnovne principe metod strojnega učenja, osnovne algoritme strojnega učenja in njihove uporabe v praksi za iskanje zakonitosti iz podatkov ter za učenje klasifikacijskih in regresijskih modelov. Študenti bodo teoretično znanje praktično uporabili na realnih problemih iz znanstvenega in poslovnega okolja. Študenti bodo za dani problem sposobni presoje, katero od predstavljenih tehnik uporabiti, ter sestaviti prototip rešitve. Kompetence: Kompetence iz računalništva in informatike, ki omogočajo nadaljevanje študija na 3. stopnji (doktorski študij). Zmožnost prenosa znanja na sodelavce v tehnoloških in raziskovalnih skupinah. Zmožnost razumevanja in uporabe znanja iz računalništva in informatike v ostalih tehničnih in relevantnih področjih (ekonomija, organizacijske vede itd.). Zmožnost uporabiti pridobljenega znanja za reševanje tehničnih in znanstvenih problemov v računalništvu in informatiki, zmožnost nadgrajevanja</p>

Objectives and competences:

<p>The goal is to present the basics and the basic principles of machine learning (ML) methods, the basic ML algorithms and their usage in practice for knowledge discovery from data, data mining (DM) and for learning classification and regression models. Students will practically apply the theoretical knowledge on real problems from scientific and business environment. The students shall be able to decide for a given problem which of the presented techniques should be used, and to develop a prototype solution. Competences: Competences in computer and information science granting access to further study at 3rd cycle doctoral programmes. The ability to transmit knowledge to co-workers in technology and research groups. The ability to understand and apply computer and information science knowledge to other technical and relevant fields (economics, organisational science, etc), The ability to apply acquired knowledge in independent work for solving technical and</p>
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pridobljenega znanja. Zmožnost preiskovanja virov znanja in iskanja virov in kritično oceniti informacijo. Zmožnost kritičnega, analitičnega in sintetičnega razmišljanja.

scientific problems in computer and information science, the ability to upgrade acquired knowledge. The ability to search knowledge sources and to search for resources and critically evaluate information.

Developing skills in critical, analytical and synthetic thinking.

Predvideni študijski rezultati:

Z uspešno zaključenim predmetom bo študent:

- sposoben uporabe različnih tehnik in metod, ki se uporabljajo pri modeliranju podatkov s strojnim učenjem. Sposoben bo za analizo, sintezo in predvidevanje rešitev ter njihovih posledic konkretnih problemov z uporabo znanstvenih metod.

- lahko uporabil predstavljene metod na konkretnih problemih iz znanstvenega in poslovnega okolja. Poznal bo in uporabil orodja za modeliranje in podatkovno rudarjenje. Fleksibilno bo lahko uporabljal znanja v praksi. - sposoben bo povezovanja znanja z različnih področij in jih uporabljal v praksi.

- razlikoval bo med različnimi pristopi strojnega učenja, med njihovimi prednostmi in slabostmi in bo lahko izbral ustrezen pristop za reševanje konkretnega problema iz podatkovnega rudarjenja.

- s principi modelov, naučenih iz podatkov, bo lahko izboljšal uporabnost in uspešnost analiziranega sistema.

Intended learning outcomes:

With successful completion of this course the student will:

- be able to use the expertise of several techniques and methods, used for data modelling with ML, for analysis, synthesis and anticipation of solutions and their consequences for target problems using the scientific methodology.

- be able to use of the presented methods on target problems from scientific and business environment. Will understand and use the tools for modelling and data mining. (S)he will flexibly use the knowledge in practice

- be able to bind together the knowledge from different fields to apply it in practice.

- differentiate among different approaches to machine learning, their advantages and disadvantages and will be able to select the appropriate method for solving particular data mining problem

-be able, using the principles of models, learned from data, to improve the usability and the performance of the analysed system.

Metode poučevanja in učenja:

Learning and teaching methods:

Predavanja, vaje z ustnimi nastopi in predstavitvami, seminarski način dela in reševanje domačih nalog, ki spodbujajo sprotno učenje. Poseben poudarek je na sprotnem študiju in na samostojnem delu pri vajah in seminarjih.	Lectures, exercises with oral demonstrations and presentations, seminar works and solving of home-works, which stimulate online learning. The emphasis is on an online study and an independent exercises and seminars.
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Delež (v %) /

Weight (in %)

Načini ocenjevanja:

Assessment:

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

Reference nosilca / Lecturer's references:

Igor Kononenko:

- KONONENKO, Igor. Machine learning for medical diagnosis : history, state of the art and perspective. Artificial intelligence in medicine, ISSN 0933-3657. [Print ed.], 2001, vol. 23, no. 1, str. 89-109 [COBISS.SI-ID 2545236]
- 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]
- KONONENKO, Igor, KUKAR, Matjaž. Machine learning and data mining : introduction to principles and algorithms. Chichester: Horwood Publishing, cop. 2007. XIX, 454 str., ilustr. ISBN 1-904275-21-4. ISBN 978-1-904275-21-3 [COBISS.SI-ID 5961556]
- ŠTRUMBELJ, Erik, KONONENKO, Igor. An efficient explanation of individual classifications using game theory. Journal of machine learning research, ISSN 1532-4435. [Print ed.], Jan. 2010, vol. 11, no. [1], str. 1-18, ilustr. [COBISS.SI-ID 7543636]
- BOSNIĆ, Zoran, KONONENKO, Igor. Automatic selection of reliability estimates for individual regression predictions. Knowledge engineering review, ISSN 0269-8889, 2010, vol. 25, no. 1, str. 27-47, graf. prikazi. [COBISS.SI-ID 7606356]

