

UČNI NAČRT PREDMETA / COURSE SYLLABUS						
Predmet:	Strojno učenje 2					
Course title:	Machine learning 2					
Študijski program in stopnja Study programme and level	Študijska smer Study field			Letnik Academic year	Semester Semester	
Podatkovne znanosti, magistrski študijski program druge stopnje	-			Drugi	Tretji	
The second cycle masters study programme Data Sciences	-			Second	Third	
Vrsta predmeta / Course type				Obvezni / Obligatory		
Univerzitetna koda predmeta / University course code:				2-PZ-MAG-SU2-2024-01-31		
Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	-	30	-	-	90	5
Nosilec predmeta / Lecturer:				izr. prof. dr. Biljana Mileva Boshkoska		
Jeziki / Languages:	Predavanja / Lectures:	Slovenski, angleški / Slovene, English				
	Vaje / Tutorial:	Slovenski, angleški / Slovene, English				
Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:				Prerequisites:		
Pogoj za vključitev v delo je absolvirano znanje iz verjetnosti, programiranja, strojno učenje 1 . Pogoj za pristop k izpitu je ustrezno pripravljena projektna naloga s poročili ter pozitivno ocenjeno predstavitvijo projektne naloge.				Prerequisite for participation is obtained knowledge of probabilistic, programming and machine learning 1 is required. The condition for taking the exam is a properly prepared project assignment with reports and a positively assessed presentation of project work assignment.		
Vsebina:				Content (Syllabus outline):		

<ul style="list-style-type: none"> • Predmet bo v teoriji in na praktičnih primerih predstavil sledeče napredne vsebine: <ul style="list-style-type: none"> - Učenje na mnogorazsežnih podatkov - Nevronske mreže (NM) in globoko učenje: • Uvod in aplikacije NM in globokega učenja. • Učenje globokih NM: naprej povezane nevronske mreže, stohastični gradientni spust, vzvratno razširjanje napake, radialno povezane nevronske mreže. Aktivacijske in cenilne funkcije. Regularizacija, inicializacija, normalizacija. Posodabljanje parametrov. • Klasifikacija in segmentacija slik. Vizualizacija in interpretacija globokih nevronskih mrež. • Rekurentne nevronske mreže: vzvratno razširjanje napake skozi čas in podnaslavljanje slik. • Globoko spodbujevalno učenje. • Aplikacije globokega učenja: računalniški vid. 	<ul style="list-style-type: none"> • The course will cover theoretical and practical machine learning approaches: <ul style="list-style-type: none"> - Learning on high-dimensional data - Neural networks (NN) and deep learning: • Introduction and applications of deep learning. • Training NN: Feedforward NN, stochastic gradient descent, backpropagation, radial basis networks. Activation and loss functions. Regularization, initialization, normalization. Parameter updates. • Image classification and segmentation. Visualizing and interpreting deep NNs. • Recurrent Neural Networks: backpropagation through time and image captioning. • Deep Reinforcement Learning. • Applications of deep learning: computer vision.
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Temeljni literatura in viri / Readings:

- Leskovic, Jure, Rajaraman, Anand, Ullman, Jeffrey D (2020): *Mining of Massive Datasets*, Cambridge University Press. (3rd Edition).
- McKinney, Wes (2017): *Python for Data Analysis*, O'Reilly Media. (2nd Edition).
- Szeliski, Richard (2011): *Computer Vision: Algorithms and Applications*. Springer.
- Goodfellow, I., Bengio, Y., Courville, A. (2016): *Deep Learning*, MIT Press.
- Aggarwal, Charu C. (2023): *Neural Networks and Deep Learning (2nd Edition)*, Springer.
- Géron, Aurélien (2022): *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow (3rd Edition)*, O'Reilly Media, Inc..
- Mileva Boshkoska, Biljana: Prosojnice iz predavanj in vaj pri predmetu Strojno učenje 2, Moodle, FIŠ.

Cilji in kompetence:

Cilj je predstaviti osnove umetne inteligence in metod in algoritmov strojnega učenja ter uporabiti pridobljene veščine za odkrivanje znanj iz podatkov ter za reševanje klasifikacijskih in regresijskih nalog. Študenti bodo dobili teoretično znanje iz tekstovnega rudarjenja, nevronske mreže, globokega učenja in računalniškega vida in ga uporabili pri resničnih problemih iz znanstvenega in poslovnega okolja.

Učna enota prispeva k razvoju naslednjih splošnih in predmetno specifičnih kompetenc:

Splošne kompetence:

- sposobnost fleksibilne uporabe znanja v praksi;
- obvladovanje sodobnih visoko zmogljivih orodij in specifične programske opreme za obdelovanje podatkov.
- zmožnost artikulacije raziskovalnega problema in na tej podlagi sposobnost pridobivanja, selekcije, ocenjevanja in umeščanja novih informacij;
- razvoj kritične in samokritične presoje;

Predmetno-specifične kompetence:

- obvladanje raziskovalnih metod, postopkov, procesov in algoritmov na področju umetne inteligence in strojnega učenja;
- sposobnost za reševanje konkretnih raziskovalnih problemov z uporabo metod strojnega učenja ;
- razumevanje teoretičnih temeljev rudarjenja tekstovnih podatkov, globokega učenja ter računalniškega vida.

Objectives and competences:

The goal is to present the basis of artificial intelligence and machine learning methods and algorithms, and use the obtained skills for knowledge discovery from data, and for solving classification and regression tasks. Students will acquire practical knowledge of text mining, neural networks, deep learning and computer vision and will apply it to on real problems from scientific and business environment.

The learning unit contributes to the development of the following general and subject-specific competences:

General competences:

- the ability of flexible usage of knowledge in practice;
- mastering cutting edge high performance tools and corresponding software for data processing;
- the ability to articulate the research problem and correspondingly, obtain, select, evaluate and embed the new information;
- the development of a critical and self-critical assessment;

Subject-specific competences:

- mastering research methods, procedures processes and algorithms in the field of artificial intelligence and machine learning;
- Ability to solve concrete research problems using the methods of machine learning
- Understanding the theoretical foundations of text data mining, deep learning, and computer vision.

Predvideni študijski rezultati:**Intended learning outcomes:**

<p>Znanje in razumevanje:</p> <p>Študent/Študentka:</p> <ul style="list-style-type: none"> • se seznanj s teoretskimi osnovami in s praktičnimi vidiki strojnega učenja in bo lahko uporabil znanje različnih tehnik in metod strojnega učenja za analizo, sintezo in predvidevanje rešitev ter njihovih posledic za ciljne probleme. • se nauči uporabljati nekaj najaktualnejših programskih orodij. <p>Prenesljive/ključne spretnosti in drugi atributi:</p> <ul style="list-style-type: none"> • prenos znanja na različna strokovna in znanstvena področja, kjer se uporabljajo metode strojnega učenja.
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<p>Knowledge and Understanding:</p> <p>The student:</p> <ul style="list-style-type: none"> • will get acquainted with the theoretical and practical aspects of machine learning and will be able to use the knowledge of different techniques and methods from machine learning for analysis, synthesis and anticipation of solutions and their consequences for target problems • will learn to use some of the most current software tools. <p>Transferable / Key Skills and other attributes:</p> <ul style="list-style-type: none"> • transfer of knowledge to various professional and scientific fields, where machine learning methods are used.
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<p>Metode poučevanja in učenja:</p> <ul style="list-style-type: none"> • predavanja z aktivno udeležbo študentov (razlaga, diskusija, vprašanja, primeri, reševanje problemov); • vaje, kjer bodo študentje pri konkretnih problemih ponovili, utrdili in dodatno osvetlili pojme in metode, spoznane na predavanjih; • laboratorijske vaje: študentje bodo spoznali nekaj najaktualnejših programskih orodij. Vaje bodo potekale v manjših skupinah, tako da bo imel vsak študent na razpolago en računalnik.
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<p>Learning and teaching methods:</p> <ul style="list-style-type: none"> • <i>Lectures with active students participation (explanation with discussions, questions, case-studies, presentations);</i> • <i>Tutorials where students will repeat, consolidate and further highlight concepts and methods learned during lectures in specific problems;</i> • <i>laboratory work: students will learn some of the most current software tools. Exercises will take place in small groups, so each student will work on one available computer.</i>
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Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
<p>Način (pisni izpit, ustno izpraševanje, naloge, projekt):</p> <ul style="list-style-type: none"> • pisni izpit • Projektna naloga s poročili ter predstavitev naloge 	<p>50 %</p> <p>50 %</p>	<p>Type (examination, oral, coursework, project)</p> <ul style="list-style-type: none"> • Written exam • Project work with reports and presentation

<p>Reference nosilca / Lecturer's references:</p> <ul style="list-style-type: none"> • ZHAO, Guoqing, LIU, Shaofeng, LOPEZ, Carmen, LU, Haiyan, ELGUETA, Sebastian, CHEN, Huilan, MILEVA BOSHKOSKA, Biljana. Blockchain technology in agri-food value chain management : a synthesis of applications, challenges and future research directions. <i>Computers in industry</i>, ISSN 0166-3615. [Print ed.], 2019, vol. 109, str. 83-99
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- BOŠKOSKI, Pavle, DEBENJAK, Andrej, MILEVA BOSHKOSKA, Biljana. Rayleigh copula for describing impedance data - with application to condition monitoring of proton exchange membrane fuel cells. *European journal of operational research*, ISSN 0377-2217. [Print ed.], 2018, vol. 266, no. 1, str. 269-277
- GRAŠIČ, Valerij, KOS, Andrej, MILEVA BOSHKOSKA, Biljana. Classification of incoming calls for the capital city of Slovenia smart city 112 public safety system using open Internet of Things data. *International journal of distributed sensor networks*, ISSN 1550-1477. [Online ed.], 2018, vol. 14, no. 9, str. 1-12, ilustr.
- MILEVA-BOSHKOSKA, Biljana, BOHANEČ, Marko, BOŠKOSKI, Pavle, JURIČIĆ, Đani. Copula-based decision support system for quality ranking in the manufacturing of electronically commutated motors. *Journal of intelligent manufacturing*, ISSN 0956-5515, 2015, vol. 26, no. 2, str. 281-293.
- MILEVA-BOSHKOSKA, Biljana, BOŠKOSKI, Pavle, DEBENJAK, Andrej, JURIČIĆ, Đani. Dependence among complex random variables as a fuel cell condition indicator. *Journal of power sources*, ISSN 0378-7753, jun. 2015, vol. 284, str. 566-573.