UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Strojno učenje 1
Course title:	Machine learning 1

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Podatkovne znanosti, magistrski študijski program druge stopnje	-	Prvi	Drugi
The second cycle masters study programme Data Sciences	-	First	Second

Vrsta predmeta / Course type	Obvezni / Obligatory
Univerzitetna koda predmeta / University course code:	2-PZ-MAG-SU1-2020-06-30

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:	**Prerequisits:**
Pogoj za vključitev v delo je absolvirano znanje iz verjetnosti, programiranja, linearne algebre, podatkovnih baz in osnov algoritmov. Pogoj za pristop k izpitu je ustrezno pripravljena projektna naloga s poročili ter pozitivno ocenjeno predstavitvijo naloge.	Prerequisite for participation is obtained knowledge of probability, programming, linear algebra, databases and algorithms basics is required. The precondition for taking the exam is a properly prepared project assignment with reports and a positively assessed presentation of the assignment.
Vsebina:	**Content (Syllabus outline):**

• Uvod in pregled področja: zgodovina umetne inteligence in strojnega učenja, pregled metod in aplikacij • Učenje: definicije in načini učenja; predstavitev znanja; naravno in strojno učenje ter inteligentnost; osnovni principi strojnega učenja; nadzorovano in nenadzorovano učenje. • • Ocenjevanje in izbira učnih modelov: pristranost, razpršenost in kompleksnost učnega modela, dekompozicija pristranosti in razpršenosti, navzkrižno preverjanje, zankanje • Aditivni in drevesni modeli: posplošeni aditivni modeli, drevesne metode (regresijska in klasifikacijska drevesa) • Metoda podpornih vektorjev: klasifikator s podpornimi vektorji, metoda podpornih vektorjev, reševanje regresijskih problemov; primeri uporabe metode podpornih vektorjev • Učenje s prototipom: metoda voditeljev, k-najbližjih sosedov • Nenadzorovano učenje: povezovalna pravila, razvrščanje v skupine, SOM, glavne komponente, krivulje in površine, večrazsežnostno lestvičenje, Google PageRank algoritem • Slučajni gozdovi ter učenje z ansambli • Teorija in aplikacije linearne metode za reševanje regresijskih problemov v strojnem učenju	• Introduction and overview of the field: history of artificial intelligence and machine learning, overview of methods and applications. • Learning: definitions and ways of learning; presentation of knowledge; natural and machine learning and intelligence; basic principles of machine learning; supervised and unsupervised learning. • • • Model assessment and selection: bias, variance and model complexity, bias-variance decomposition, cross-validation, bootstrap methods • Additive and tree models: generalized additive models, tree methods (regression and classification trees) • Support vector machines: classifier with support vectors, support vector method, support vector classification and regression; real case examples • Prototype methods: the k-means method, k-nearest neighbors; real case examples • Unsupervised Learning: Association Rules, Claster analysis, Self-organising maps, Principal Components, Curves and Surfaces, Multidimensional Scaling, Google PageRank algorithm • Random forests and ensembled Learning • Theory and application of linear methods for regression in machine learning

Temeljni literatura in viri / Readings:

- Tan, Pang-Ning, Steinbach, Michael, Kumar, Vipin, Karpante, Anuj (2018). *Introduction to data mining*, Pearson Addison Wesley. (2nd Edition) (izbrana poglavja)
- McKinney, Wes (2017). *Python for Data Analysis,* O'Reilly Media. (2nd Edition).s
- Aggarwal, Charu C. (2018). *Machine Learning for Text*. Springer. (izbrana poglavja)

- Bishop, Christopher M. (2006). *Pattern Recognition and Machine Learning*. Springer. (izbrana poglavja)
- Mileva Boshkoska, Biljana. Prosojnice iz predavanj in vaj pri predmetu Strojno učenje 1, 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:

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- obvladanje raziskovalnih metod, postopkov, procesov in algoritmov na področju strojnega učenja;
- sposobnost za reševanje konkretnih raziskovalnih problemov z uporabo metod strojnega učenja ;
- razumevanje teoretičnih temeljev strojnega učenja , uporaba klasifikacijskih in regresijskih metod v praksi. .

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 machine learning;
• Ability to solve concrete research problems using the methods of machine learning
• Understanding the theoretical foundations of machine learning, in particular application of advanced classification and regression models in practice.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Študent/Študentka: • se seznani 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. Prenesljive/ključne spretnosti in drugi atributi: • prenos znanja na različna strokovna in znanstvena področja, kjer se uporabljajo metode strojnega učenja.	Knowledge and Understanding: The student: • 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. Transferable / Key Skills and other attributes: • transfer of knowledge to various professional and scientific fields, where machine learning methods are used.

Metode poučevanja in učenja:	**Learning and teaching methods:**
• 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.	• *Lectures with active students' participation* (explanation with discussions, questions, case-studies, presentations); • *Tutorials where students will repeat, consolidate and further highlight concepts and methods learned during lectures in specific problems;* • *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.*

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project)
• pisni izpit • Projektna naloga s poročili ter predstavitev naloge	50 % 50 %	• Written exam • Project work with reports and presentation

Reference nosilca / Lecturer's references:

• 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. *Computers in industry*, ISSN 0166-3615. [Print ed.], 2019, vol. 109, str. 83-99

- 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, BOHANEC, 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.