Fakulteta za industrijski inženiring
Faculty of Industrial Engineering

| UČNI NAČRT PREDMETA / COURSE SYLLABUS | |
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| **Predmet:** | Strojno učenje in umetna inteligenca |
| **Course title:** | Machine learning and artificial intelligence |

| **Študijski program**<br>**Study programme and level** | **Študijska smer**<br>**Study field** | **Letnik**<br>**Academic year** | **Semester**<br>**Semester** |
|---|---|---|---|
| **Inženiring in avtomobilska industrija** | | drugi | prvi |
| **Engineeing in automobile industry** | | second | first |

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| **Vrsta predmeta / Course type** | **Izbirni / Optional** |
| **Univerzitetna koda predmeta / University course code:** | **MAG_21011** |

| Predavanja<br>Lectures | Seminar<br>Seminar | Sem. vaje<br>Tutorial | Lab. vaje<br>Laboratory work | Teren. vaje<br>Field work | Samost. delo<br>Individ. work | ECTS |
|---|---|---|---|---|---|---|
| **45** | **/** | **/** | **45** | **/** | **150** | **8** |

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| **Nosilec predmeta / Lecturer:** | **Doc. dr. Martin Žnidaršič**<br>**Doc. dr. Bernard Ženko** |

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| **Jeziki / Languages:** | **Predavanja / Lectures:** | **slovenski / Slovenian** |
| | **Vaje/Tutorial:** | **slovenski / Slovenian** |

| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | **Prerequisits:** |
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| – Izpolnjeni predpisani pogoji za vpis v 2. letnik študija. | – Standard requirements for enrollment in second year of studies. |

Fakulteta za industrijski inženiring
Faculty of Industrial Engineering

| **Vsebina:** | **Content (Syllabus outline):** |
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| Uvod v umetno inteligenco<br>– Kaj je inteligenca?<br>– Pregled raziskav AI<br>Strojno učenje in podatkovno rudarjenje<br>– Strojno učenje, podatkovno rudarjenje in statistika<br>– Proces analize podatkov in predobdelava podatkov<br>– Razvrščanje v podskupine in asociacijska pravila<br>– Linearna regresija<br>– Če-potem pravila in odločitvena drevesa<br>– Metoda najbližjih sosedov<br>– Naivni Bayes<br>– Metoda podpornih vektorjev<br>– Umetne nevronske mreže<br>– Ansambelske metode<br>– Vrednotenje modelov<br>– Praktični izzivi pri strojnem učenju (šumni, neuravnoteženi, manjkajoči podatki)<br>– Programska orodja za strojno učenje<br>Rudarjenje besedil in spleta<br>– Predobdelava besedil in gradnja značilk<br>– Klasifikacija besedil<br>Ekspertni sistemi, odločanje in podpora pri odločanju<br>– Kvantitativne metode<br>– Kvalitativne metode<br>– Funkcije koristnosti<br>– Odločanje ob negotovosti<br>– Bayesove mreže<br>Evolucijsko računanje<br>– Preiskovanje in optimizacija<br>– Lokalna in globalna optimizacija<br>– Biološko navdahnjene metode<br>– Evolucijski algoritmi<br>– Genetski algoritmi<br>– Večkriterijska optimizacija | Introduction to artificial intelligence<br>– What is intelligence?<br>– AI research overview<br>Machine learning and data mining<br>– Machine learning, data mining and statistics<br>– Data analysis process and data preprocessing<br>– Clustering and association rules<br>– Linear regression<br>– If-then rules and decision trees<br>– Nearest neighbor methods<br>– Naive Bayes<br>– Support vector machines<br>– Artificial neural networks<br>– Ensemble methods<br>– Model evaluation<br>– Practical challenges in machine learning (noisy, unbalanced, missing data)<br>– Software tools for machine learning<br>Text and web mining<br>– Text preprocessing and feature construction<br>– Text classification<br>Expert systems, decision making and decision Support<br>– Quantitative methods<br>– Qualitative methods<br>– Utility functions<br>– Decision making under uncertainty<br>– Bayesian networks<br>Evolutionary computing<br>– Search and optimization<br>– Local and global optimization<br>– Biologically inspired methods<br>– Evolutionary algorithms<br>– Genetic algorithms<br>– Multi-criteria optimization |

**Temeljni literatura in viri / Readings:**


– S. Russell, P. Norvig. Artificial Intelligence: A Modern Approach, Third edition, Prentice Hall, 2010.
– H. Witten, F. Eibe, M. A. Hall. Data mining: Practical machine learning tools and techniques, Morgan Kaufman, 2011
– I. Kononenko in M. Kukar: Machine Learning and Data Mining: Introduction to Principles and Algorithms. Horwood, 2007.
– M. Bohanec: Odločanje in modeli. DMFA - založništvo, 1. ponatis, 2012.
– E-gradiva predmeta | E-Course material


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| Velja od: 1. 10. 2019 | Sprejel: Senat FINI Novo mesto |

**Priporočljiva literatura / Recomended Textbooks**


- Hastie T., Tibshirani R., Friedman J.: The elements of statistical learning: Data Mining, Inference, and Prediction, Springer.
- A.E. Eiben, J. E. Smith. Introduction to Evolutionary Computing, Springer, 2015.
- T.L. Brink, R.L. Keeney, H. Raiffa: Decisions with multiple objectives–preferences and value tradeoffs, Cambridge University Press, Cambridge & New York, 1993.


| **Cilji in kompetence:** | **Objectives and competences:** |
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| **Cilji**<br>Seznaniti študente z različnimi metodami umetne inteligence in strojnega učenja ter jih naučiti samostojne uporabe metod strojnega učenja za analizo podatkov in gradnjo napovednih modelov.<br><br>**Kompetence**:<br>– poznavanje osnov različnih metod umetne inteligence in strojnega učenja;<br>– sposobnost samostojnega reševanja praktičnih problemov z metodami strojnega učenja, posebej za analizo podatkov in napovedno modeliranje;<br>– sposobnost uporabe osnovnih metod umetne inteligence in strojnega učenja za praktično delo. | **Objectives**<br>To introduce students to different methods of artificial intelligence and machine learning, and teach them to autonomously use machine learning methods to analyze data and build predictive models.<br><br>**Competencies**:<br>– basic knowledge of different methods of artificial intelligence and machine learning;<br>– ability to autonomously solve practical problems using machine learning methods, especially for data analysis and predictive modeling;<br>– ability to use basic methods of artificial intelligence and machine learning for practical work. |

| **Predvideni študijski rezultati:** | **Intended learning outcomes:** |
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| Študenti bodo<br>– obvladovali znanja o različnih metodah umetne inteligence in strojnega učenja;<br>– obvladovali samostojno reševanje problemov z uporabo metod umetne inteligence in strojnega učenja;<br>– obvladovali samostojno uporabo obravnavanih metod v sklopu načrtovanja industrijskih aplikacij. | Students will<br>– demonstrate knowledge of the various methods of artificial intelligence and machine learning;<br>– demonstrate the ability of practical problem solving with methods of artificial intelligence and machine learning;<br>– demonstrate the ability to use the methods discussed for design of industrial applications. |

| **Metode poučevanja in učenja:** | **Learning and teaching methods:** |
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| Poučevanje bo sestavljeno iz treh sklopov:<br>– Prvi sklop bodo predavanja, kjer bodo predstavljene in razložene vsebine iz učnega programa.<br>– Drugi sklop bo obsegal laboratorijske vaje, kjer bodo študenti na predavanjih obravnavane vsebine uporabili za reševanje praktičnih problemov.<br>– Tretji sklop bo obsegal samostojno delo | Teaching will consist of three parts:<br>– The first part will be lectures, which will present and explain the content of the curriculum.<br>– The second part will consist of laboratory work where students will apply the knowledge acquired at the lectures in order to solve practical problems.<br>– The third part will consist of independent work of students, during which they will also have to |

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| študentov, v okviru katerega bodo morali na koncu izdelati tudi seminarsko nalogo<br>– V primeru majhnega števila vpisanih študentov je možno selektivno poglobiti obravnavo posameznih tem glede na individualne potrebe študentov.<br><br>Predmet je oblikovan na kombinirani način študija, ki vključuje aktivnosti preko elektronskega (on-line) okolja:<br>te aktivnosti so sestavljene iz samostojnih in skupinskih aktivnosti z uporabo učnega okolja Moodle in drugih elektronskih vsebin. Praviloma vključujejo diskusije v forumih, spletne strani, ogled posnetih predavanj in vaj, preverjanje znanja, odgovori na vprašanja, iskanje po spletu (bazah) itd. | produce the seminar paper.<br>– In case of a small number of enrolled students it is possible to treat selected curriculum topics in more depth, in line with individual needs of the enrolled students.<br><br>The course is designed as blended learning that includes online activities:<br>Online activities consist of independent and group activities using the LMS Moodle and other electronic or online content. Activities usually include discussions in forums, websites, viewing of recorded lectures and tutorials, assessments, answering questions, searching the web (databases), etc. |

| **Načini ocenjevanja:** | **Delež/Weight (%)** | **Assessment:** |
|---|---|---|
| Pogoj za pristop k izpitu je uspešno opravljena seminarska naloga.<br><br>– Pisni izpit<br>– Seminarska naloga z ustnim zagovorom.<br><br>Ocenjevalna lestvica je skladna z ECTS in Pravilnikom o preverjanju in ocenjevanju znanja FINI NM. | 50 %<br>50 % | Prerequisite for taking the exam is a successfully completed seminar work.<br><br>– Written exam.<br>– Seminar paper with oral defense.<br><br>Evaluation scale in accordance with ECTS and the Rules on the Evaluation and Assessment of Knowledge FINI NM. |

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

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| **Doc. dr. Martin Žnidaršič** je raziskovalec na Odseku za tehnologije znanja, Institut Jožef Stefan, Ljubljana. Njegove raziskave so povezane s podatkovnim rudarjenjem s poudarkom na verjetnostnem modeliranju, modeliranju ocenjevanja in analizi sentimenta ter uporabo teh metod na področjih ekologije in financ.<br><br>**Doc. dr. Bernard Ženko** je raziskovalec na Odseku za tehnologije znanja, Institut Jožef Stefan, Ljubljana. Njegove raziskave so povezane s strojnim učenjem in njegovo uporabo pri reševanju praktičnih problemov na področju znanosti o okolju in življenju. Njegovi prispevki vključujejo metode za kombiniranje več klasifikatorjev, učenje modelov v obliki pravil za napovedovanje več ciljnih spremenljivk in rekonstrukcijo dinamičnih omrežij, kot tudi aplikacije metod strojnega učenja. | **Asst. Prof. Martin Žnidaršič** is a researcher at the Department of Knowledge Technologies, Jožef Stefan Institute, Ljubljana. His main research interests are in data mining with a focus on probabilistic modelling, evaluation modelling and sentiment analysis. Applications of his work are conducted mostly in domains of ecology and finance.<br><br>**Asst. Prof. Bernard Ženko** is a researcher at the Department of Knowledge Technologies, Jožef Stefan Institute, Ljubljana. His research interests are related to machine learning and its application to practical problems from environmental and life sciences. His contributions include methods for combining multiple classifiers, learning rule-based models for predicting multi-target variables and dynamical network reconstruction, as well as applications of machine learning methods. |

Izbrane objave


- S. Džeroski in B. Ženko. Is combining classifiers with stacking better than selecting the best one? Machine learning, 2004, vol. 54, str. 255-273.
- T. Aho, B. Ženko, S. Džeroski, T. Elomaa. Multi-target regression with rule ensembles. Journal of machine learning research, 2012, vol. 13, str. 2367-2407.
- M. Debeljak, A. Poljanec, B. Ženko. Modelling forest growing stock from inventory data: a data mining approach. Ecological indicators, 2014, vol. 41, pp. 30-39.
- S. Džeroski, P. Panov, B. Ženko. Machine learning ensemble methods. In: R. A. Meyers (ed.). Encyclopedia of complexity and systems science. New York: Springer, 2009, vol. 6, pp. 5317-5325.
- J. Škraban, S. Džeroski, B. Ženko, D. Mongus, S. Gangl, M. Rupnik. Gut microbiota patterns associated with colonization of different clostridium difficile ribotypes. PloS one, 2013, vol. 8, iss. 2, pp. e58005-1-e58005-13.

- S. Džeroski, B. Ženko. Is combining classifiers with stacking better than selecting the best one?. Machine learning, 2004, vol. 54, pp. 255-273.
- T. Aho, B. Ženko, S. Džeroski, T. Elomaa. Multi-target regression with rule ensembles. Journal of machine learning research, 2012, vol. 13, pp. 2367-2407.
- M. Debeljak, A. Poljanec, B. Ženko. Modelling forest growing stock from inventory data : a data mining approach. Ecological indicators : integrating monitoring, assessment and management, 2014, vol. 41, pp. 30-39.
- M. Petkovič, M. Breskvar, S. Džeroski, D. Kocev, R. Boumghar, J. Levatić, L. Lucas, A. Osojnik, B. Ženko, N. Simidjievski. Machine learning for predicting thermal power consumption of the Mars Express spacecraft. IEEE aerospace and electronic systems magazine, 2019, vol. 34, no. 7, pp. 46-60.
- N. Simidjievski, Nikola, J. Tanevski, B. Ženko, Z. Levnajić, L. Todorovski, S. Džeroski. Decoupling approximation robustly reconstructs directed dynamical networks. New journal of physics, 2018, doi: 10.1088/1367-2630/aae941.
- T. Tušar, K.Gantar, V. Koblar, B. Ženko, B. Filipič. A study of overfitting in optimization of a manufacturing quality control procedure. Applied soft computing, 2017, vol. 59, pp. 77-87, doi: 10.1016/j.asoc.2017.05.027.
- M. Carotenuto, S. Džeroski, B. Ženko, I. Slavkov, et al. Neuroblastoma tumorigenesis is regulated through the Nm23-H1/h-Prune C-terminal interaction. Scientific reports, 2013, vol. 3, pp. 1351-1- 1351-11.
- D. Stojanova, A. Kobler, P. Ogrinc, B. Ženko, S. Džeroski. Estimating the risk of fire outbreaks in the natural environment. Data mining and knowledge discovery, 2012, vol. 24, no. 2, pp. 411-442.
- J. Škraban, S. Džeroski, B. Ženko, L. Tušar, M. Rupnik. Changes of poultry faecal microbiota associated with Clostridium difficile colonisation. Veterinary Microbiology, 2013, vol. 165, iss. 3/4, pp. 416-424.
- M. Novak, P. Zalar, B. Ženko, H-J. Schroers, S. Džeroski, N. Gunde-Cimerman. Candida and Fusarium species known as opportunistic human pathogens from customer-accessible parts of residential washing machines. Fungal biology, 2015, vol. 119, iss. 2/3, pp. 95-113.
- B. Ženko, S. Džeroski. Learning classification rules for multiple target attributes. Lecture notes in computer science, 2008, vol. 5012, pp. 454-465.
- D. Gamberger, B. Ženko, A. Mitelpunkt, N. Lavrač. Homogeneous clusters of Alzheimer's disease patient population. BioMedical engineering online, 2016, vol. 15, suppl. 1, pp. 578-1-578-34.
- I. Ravkic, M. Žnidaršič, J. Ramon and J. Davis. Graph sampling with applications to estimating the number of pattern embeddings and the parameters of a statistical relational model. Data mining and knowledge discovery, 2018, vol. 32, no. 4, str. 913-948.
- P. Tomašič, G. Papa, M. Žnidaršič, Using a genetic algorithm to produce slogans, Informatica (Ljublj.), vol. 39, no. 2, str.125-133, Jun. 2015.
- J. Kranjc, J. Smailović, V. Podpečan, M. Grčar, M. Žnidaršič, N. Lavrač, Active learning for sentiment analysis on data streams : methodology and workflow implementation in the ClowdFlows platform, Inf. process. manage., vol. 51, no. 2, str. 187-203, 2015.
- J. Smailović, M. Grčar, N. Lavrač, M. Žnidaršič, Stream-based active learning for sentiment analysis in the financial domain, Inf. sci., vol. 285, str. 181-203, nov. 2014.

- J. Smailović, M. Grčar, N. Lavrač, M. Žnidaršič, Predictive sentiment analysis of tweets: a stock market application, V: Human-computer interaction and knowledge discovery in complex, unstructured, big data : proceedings, Third International Workshop, HCI-KDD 2013, Held at SouthCHI 2013, Maribor, Slovenia, July 1-3, 2013, (Lecture notes in computer science, Lecture notes in artificial intelligence, vol. 7947), Andreas Holzinger, ur., Gabriella Pasi, ur., Berlin, Heidelberg, Springer, 2013, vol. 7947, str. 77-88, 2013.
- M. Bohanec, M. Žnidaršič, V. Rajkovič, I. Bratko, B. Zupan, DEX methodology : three decades of qualitative multi-attribute modeling, Informatica (Ljubl.), vol. 37, no. 1, str. 49-54, mar. 2013.
- M. Žnidaršič, M. Bohanec, B. Zupan, Modelling impacts of cropping systems: demands and solutions for DEX methodology, Eur. J. oper. res., vol. 189, no. 3, str. 594-608, 2008.
- M. Žnidaršič, M. Bohanec, Automatic revision of qualitative multi-attribute decision models, Fund. Computing Decis. Sci., vol. 32, no. 4, str. 315-326, 2007.
- M. Žnidaršič, M. Bohanec, B. Zupan, proDEX - a DSS tool for environmental decision-making, Environ. model. softw., vol. 21, no. 10, str. 1514-1516, 2006.
- M. Žnidaršič, A. Jakulin, S. Džeroski, C. Campichler, Automatic construction of concept hierarchies : the case of foliage-dwelliung spiders, V: Selected papers from the Fourth International Workshop on Environmental Applications of Machine Learning, September 27 - October 1, 2004, Bled, Slovenia : special issue, (Ecological modelling, vol. 191, issue 1, 2006), Sašo Džeroski, ur., Bernard Ženko, ur., Marko Debeljak, ur., Amsterdam, Elsevier, 2006, vol. 191, str. 144-158, 2006.
- M. Žnidaršič, M. Bohanec, Data-based revision of probability distributions in qualitative multi- attribute decision models, Intelligent data analysis, vol. 9, str. 159-174, 2005.
- M. Žnidaršič, M. Bohanec, I. Bratko, Categorization of numerical values for DEX hierarchical models, Informatica (Ljubl.), vol. 27, no. 4, str. 405-409, 2003.
- N. Lavrač, M. Žnidaršič, Inteligenca, človek in stroj, Emzin (Ljubl.), letn. 17, št. 3/4, str. 64-67, 2007.