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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Razpoznavanje vzorcev | | | | | | | | | | | | | | |
| **Course title:** | | | Pattern Recognition | | | | | | | | | | | | | | |
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| **Študijski program in stopnja**  **Study programme and level** | | | | | **Študijska smer**  **Study field** | | | | | | | | **Letnik**  **Academic year** | | **Semester**  **Semester** | | |
| Podiplomski magistrski študijski program druge stopnje Elektrotehnika | | | | | Avtomatika in informatika | | | | | | | | 1 | | 1 | | |
| 2nd cycle masters study programme in ELECTRICAL ENGINEERING | | | | | Control systems and computer engineering | | | | | | | | 1 | | 1 | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Obvezni-strokovni / Compulsory professional | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64203 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **45** | **0** | | | **30** | | |  | | | |  | | | **75** | |  | **6** |
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| **Nosilec predmeta / Lecturer:** | | | | | Simon Dobrišek | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | slovenščina in po potrebi angleščina / Slovene and English, if necessary | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | slovenščina in po potrebi angleščina / Slovene and English, if necessary | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisites:** | | | | | | | |
| Vpis v letnik. | | | | | | | | |  | Enrolment in the year of the course. | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| * Uvod v razpoznavanje vzorcev: osnovni pojmi in izrazoslovje, začetni zapis vzorcev, računska zapletenost algoritmov razpoznavanja, razvrstitev postopkov razpoznavanja vzorcev. * Razčlenjevanje vzorcev: postopki razčlenjevanja govornega signala in slik. * Hevristične značilke vzorcev: značilke izsekov govornega signala, značilke področij slike. * Analiza področja uporabe v vzorčnem prostoru s postopki iskanja rojev: definicija rojev in rojenja vzorcev, mere podobnosti vzorcev, predobdelava množice vzorcev, hierarhični postopek iskanja rojev. * Najboljše značilke vzorcev: mere ločljivosti razredov vzorcev, izbira in izpeljava značilk, določanje značilk z ortogonalnimi transformacijami. * Razvrščanje vzorcev s prileganjem: pravilo razvrščanja "k-najbližjih sosedov". * Razvrščanje vzorcev z odločanjem: odločitvene funkcije, načrti razvrščevalnikov vzorcev, polinomske odločitvene funkcije, postopki učenja, stroji podpornih vektorjev, verjetnostne odločitvene funkcije, učenje verjetnostnih odločitvenih funkcij. * Razvrščanje vzorcev z nevronskimi omrežji: topologija nevronskih omrežjih, vzvratno učenje, globoka nevronska omrežja, povratna nevronska omrežja. * Preizkušanje razpoznavalnika vzorcev: postopki ocenjevanja verjetnosti napačnega razpoznavanja z in brez preizkusne množice vzorcev. | | | | | | | |  | | * Introduction to pattern recognition: basic concepts and terminology, pattern representation, computational complexity of pattern-recognition algorithms, the main types of pattern-recognition methods. * Pattern segmentation: speech-signal segmentation techniques and image segmentation techniques * Heuristic features of patterns: features of speech segments, features of image segments. * Application domain analysis using clustering techniques: definition of clusters and clustering, pattern-similarity measures, pre-processing of sets of patterns, hierarchical clustering algorithm. * Optimal feature generation: class-separation measure, feature selection and feature extraction, feature generation using orthogonal transformations. * Pattern classification by pattern matching: pattern template matching, k-nearest-neighbour rule. * Decision-based pattern classification: decision functions, designs of pattern classifiers, polynomial decision functions, training algorithms, support vector machines, probabilistic decision functions, learning probabilistic decision functions. * Pattern classification by neural networks: neural network topologies, back-propagation training, deep neural networks, recurrent neural networks. * Testing pattern-recognition systems: methods for estimating the probability of the classification error with and without a test set. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. N. Pavešić: Razpoznavanje vzorcev (3. izdaja), Založba FE in FRI, 2012. 2. S. Theodoridis, K. Koutroumbas: Pattern Recognition (4. izdaja), Academic Press, 2009. 3. C. M. Bishop: Pattern Recognition and Machine Learning, Springer, 2007 | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Seznaniti študenta z osnovnimi matematičnimi in računalniškimi načeli izgradnje umetnih zaznavnih sistemov, ki so nepogrešljiv del inteligentnih sistemov v avtomatiki. | |  | | To provide students with an understanding of the basic mathematical and computational principles of constructing artificial perception systems, which are an essential part of intelligent systems in automation and control. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Znanje in razumevanje:  Po zaključku tega predmeta bo študent zmožen izkazati znanje in razumevanje:   * gradnje inteligentnih sistemov, ki temeljijo na metodah razpoznavanju vzorcev, * modeliranja določenih umskih zmožnosti človeka (zaznavanje in spoznavanje okolja, učenje), * metod luščenja značilk, rojenja, razvrščanja in razpoznavanja.   Uporaba znanja:  Pridobljeno znanje bo študent lahko uporabil pri gradnji tehniških sistemov, ki lahko z gledanjem, poslušanjem in tipanjem s simboli opisujejo okolje, ki jih obkroža. Takšni sistemi so nepogrešljiv del vsakega inteligentnega (robotskega) sistema, lahko pa jih uporabljamo tudi kot samostojne izdelke visoke tehnološke vrednosti. Študent bo zmožen kritično ovrednotiti skladnost med pridobljenim znanjem ter uporabo konceptov iz teorije razpoznavanja vzorcev v praksi.  Prenosljive spretnosti:  Študent si bo pridobil spretnosti:   * uporabe literature ter drugih virov s področja razpoznavanja vzorcev, strojnega učenja in umetne inteligence. * uporaba računalniških razvojnih orodij in okolij za programiranje (pisanje programov v enem od programskih jezikov C/C++, C#, Java, Python ali z uporabo razvojnega okolja MatLab), * reševanja problemov: analiza problema, načrtovanje algoritma, implementacija programa in testiranje programa, | | |  | Knowledge and understanding:  After completing this course the student will be able to demonstrate a knowledge and understanding of the:   * construction of intelligent systems based on pattern-recognition techniques , * modelling of certain human mental capabilities (perception, cognition, learning), * pattern-feature extraction methods, clustering, classification and recognition.   The use of knowledge:  The student will be able to use the acquired knowledge to construct technical systems that are able to symbolically describe their environment by watching, listening and sensing. Such systems are an essential part of all intelligent (robotic) systems, or are used as stand-alone products with high technological values. The student will be able to critically evaluate the consistency between the acquired knowledge and the application of the concepts of the pattern-recognition theory in practice.  Transferable skills:   * the use of literature and other resources in the fields of pattern recognition, machine learning and artificial intelligence; * the use of development tools and environments for computer programming (writing computer programs in different programming languages, such as C/C++, C#, Java, Python, or using the Matlab development environment); * problem solving: problem analysis, algorithm design, implementation and testing of a program. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| * predavanja, * laboratorijske vaje in projekti, * reševanje domačih nalog. | | |  | * lectures, * laboratory exercises and projects, * coursework. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Način: domače naloge, laboratorijske vaje, projekt, pisni izpit, ustni izpit.  Ocene od 1 do vključno 5 so negativne, ocene od vključno 6 do 10 so pozitivne.  Pozitivna ocena laboratorijskih vaj je pogoj za pristop k izpitu.  Prispevki k oceni:   * domače naloge, * laboratorijske vaje in projekt, * pisni izpit, * ustni izpit. | 10%  30%  30%  30% | | | | Type: homework, laboratory exercises, project, written exam, oral exam.  Negative grades: from 1 to 5, positive grades: from 6 to 10.  Positive evaluation of laboratory exercises is a prerequisite for the exam.  Contributions to the final grade:   * coursework, * laboratory exercises and project, * written exam, * oral examination. |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. DOBRIŠEK, Simon, ŠTRUC, Vitomir, KRIŽAJ, Janez, MIHELIČ, France. Face recognition in the wild with the probabilistic Gabor-Fisher classifier. V: 11th IEEE International Conference on Automatic Face and Gesture Recognition (FG 2015), Ljubljana, Slovenia, May 4-8, 2015. FG 2015. Danvers: IEEE, cop. 2015, b-Wild, str. 1-6. 2. GAJŠEK, Rok, MIHELIČ, France, DOBRIŠEK, Simon. Speaker state recognition using an HMM-based feature extraction method. Computer speech & language, ISSN 0885-2308, Jan. 2013, vol. 27, no. 1, str. 135-150. 3. DOBRIŠEK, Simon, GAJŠEK, Rok, MIHELIČ, France, PAVEŠIĆ, Nikola, ŠTRUC, Vitomir. Towards efficient multi-modal emotion recognition. International journal of advanced robotic systems, ISSN 1729-8814, 2013, vol. 10, no. 53, str. 1-10. 4. KRIŽAJ, Janez, ŠTRUC, Vitomir, DOBRIŠEK, Simon. Towards robust 3D face verification using Gaussian mixture models. International journal of advanced robotic systems, ISSN 1729-8814, 2012, vol. 9, no. 162, str. 1-11. 5. DOBRIŠEK, Simon, MIHELIČ, France. Time- and acoustic-mediated alignment algorithms for speech recognition evaluation. V: 12th Annual Conference of the International Speech Communication Association, August 27-31, 2011, Florence, Italy. COSI, Piero (ur.). Speech science and technology for real life: conference proceedings, (Interspeech, ISSN 1990-9772). [Grenoble]: International Speech Communication Association, cop. 2011, str. 1517-1520. | | | | | |