

# SLIKOVNA BIOMETRIJA

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Slikovna biometrija
<b>Course title:</b>	Image based biometry
<b>Članica nosilka/UL Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	2. letnik	1. semester	izbirni
Računalništvo in informatika, druga stopnja, magistrski	Podatkovne vede (smer)	2. letnik	1. semester	izbirni
Računalništvo in informatika, druga stopnja, magistrski	Računalništvo in informatika (smer)		1. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0075165
<b>Koda učne enote na članici/UL Member course code:</b>	63554

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	10	20			105	6

**Nosilec predmeta/Lecturer:** Peter Peer

**Vrsta predmeta/Course type:** strokovni izbirni predmet/specialist elective course

**Jeziki/Languages:**

Predavanja/Lectures:	Angleščina, Slovenščina
Vaje/Tutorial:	Angleščina, Slovenščina

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

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**Prerequisites:**

### Vsebina:

Predmet temelji predvsem na postopkih računalniškega vida, ki predstavljajo izhodišče večine biometričnih sistemov. Ciljna skupina so študentje, ki jih zanimata visoko-tehnološki razvoj in raziskave, saj je veliko pristopov še v raziskovalni fazi. Glavna vsebina, ki se bo zaradi razvoja področja spreminjala:

Osnove biometrije  
Biometrične modalnosti  
Zgradba tipičnega biometričnega sistema  
Razpoznavna/verifikacija/identifikacija  
Metrike

### Content (Syllabus outline):

The course relies mostly on computer vision, as most biometrics technologies are based on it. Students interested in cutting edge technology, much of which is still in a research stage, are the intended target for the course. The main content (will evolve due to developments in the field):

Biometry basics  
Biometrical modalities  
Structure of a typical biometric system  
Recognition/verification/identification  
Metrics

<p>Pogoji za korektno primerjanje sistemov (baze, ogrodja)  Uspešnost in uporabnost sistemov  Računalniški vid kot temelj biometričnih sistemov  -----  Prstni odtis  Zajem  Ocena kvalitete slike in izboljšanje kvalitete  Procesiranje  Singularne točke, minucije, grebeni  Ujemanje  -----  Šarenica  Zajem  Izboljšanje kvalitete  Procesiranje (segmentacija, normalizacija, kodiranje)  Značilke  Ujemanje  -----  Obraz  Zajem  Podmodalnosti  Procesiranje  Značilke (pristop na osnovi izgleda, modela in/ali teksture)  Ujemanje  -----  Gibanje  Zajem  Vpliv dinamike  Procesiranje (pristop na osnovi izgleda in/ali modela)  Dinamične značilke  Ujemanje  -----  Uhelj  Zajem  Procesiranje  Značilke  Ujemanje  -----  Večbiometrični sistemi /  večmodalnost / fuzije  Ključni problemi modalnosti/sistemov (raziskovalni izzivi)</p> <p>Predavanja predstavijo pristope in razložijo njihovo delovanje. Na laboratorijskih vajah to znanje uporabimo za apliciranje na praktične probleme v Matlabu in odprtokodnih orodjih.</p>	<p>Conditions for correct comparisons of the systems (databases, frameworks)  Performance and usefulness of the systems  Computer vision as the foundation of the biometric systems  -----  Fingerprint  Acquisition  Quality assessment and quality improvement  Processing  Singular points, minutiae, ridges  Matching  -----  Iris  Acquisition  Quality improvement  Processing (segmentation, normalization, coding)  Feature points  Matching  -----  Face  Acquisition  Sub-modalities  Processing  Feature points (appearance/  model/texture-based approach)  Matching  -----  Gait  Acquisition  Influence of dynamics  Processing (appearance/  model-based approach)  Dynamic feature points  Matching  -----  Ear  Acquisition  Processing  Feature points  Matching  -----  Multi-biometric systems / multi-modality / fusions  Key problems of modalities/systems (research challenges)</p> <p>The lectures introduce the approaches and explain their operation. At tutorial the knowledge is applied to practical problems in Matlab and open source tools.</p>
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### Temeljna literatura in viri/Readings:

Anil K. Jain, Arun A. Ross, Karthik Nandakumar, *Introduction to Biometrics*, Springer, 2011 (glavna, izhodiščna literatura / primary literature)  
Ruud M. Bolle, Jonathan Connell, Sharath Pankanti, Nalini K. Ratha, Andrew W. Senior, *Guide to Biometrics*, 2003  
Vsebine bodo podprte tudi s članki iz pomembnih konferenc in revij. /  
Content will be backed also with articles from important conferences and journals.

**Cilji in kompetence:**

<p>Cilji predmeta:          Študent dobi dober pregled nad področjem biometrije in tistimi področji računalniškega vida, ki tvorijo temelje biometričnih sistemov.          Študent je seznanjen s potekom raziskovalnega dela.          Študent pridobi dobro osnovo za doktorski študij.          Pridobljene kompetence študenta:          Pozna terminologijo in principe analize identitete.          Pozna obseg biometričnih tehnologij in njihove prednosti in slabosti.          Pozna delovanje biometričnega sistema od zajema do odločitve.          Razume potek procesiranja za vsako biometrično modalnost.          Pozna nekatere omejitve delovanja biometričnih sistemov.          Kritično razmišlja o starejših in novejših modalnostih, kako se modalnosti lahko dopolnjujejo.          Pozna nekatere odprte probleme/izzive v biometriji.</p>
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**Objectives and competences:**

<p>Objectives of the course:          Student gains good overview over the biometry and with it related computer vision methods that set foundations of biometric systems.          Student gets acquainted with the flow of the research work.          Student gets good foundation for doctoral study.          Gained student competences:</p> <ul style="list-style-type: none"> <li>• Knows the terminology and principles of identity analysis.</li> <li>• Knows the scope of the biometric technologies and their (dis)advantages.</li> <li>• Knows how the system works from the acquisition to decision.</li> <li>• Understands the processing flow for each biometric modality.</li> <li>• Knows some limitations of biometric systems.</li> <li>• Is able to critically consider older and newer modalities and how they can work together.</li> <li>• Is familiar with some open problems/challenges in biometry.</li> </ul>
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**Predvideni študijski rezultati:**

<p>Po uspešno opravljenem predmetu bodo študenti zmožni:</p> <ul style="list-style-type: none"> <li>- pojasniti razvojni cikel biometričnega sistema</li> <li>- razlikovati med specifikami različnih modalnosti</li> <li>- izbrati algoritme računalniškega vida za biometrični cevovod</li> <li>- implementirati biometrični cevovod</li> <li>- ovrednotiti kvaliteto vsakega koraka v cevovodu</li> <li>- zgraditi večbiometrični sistem</li> <li>- argumentirati izbiro metrik, baz, protokolov</li> <li>- identificirati odprta raziskovalna vprašanja</li> <li>- spisati tehnično poročilo.</li> </ul>
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**Intended learning outcomes:**

<p>After successful completion of the course, students will be able to:</p> <ul style="list-style-type: none"> <li>- explain the design cycle of the biometric system</li> <li>- differentiate between specifics of different modalities</li> <li>- choose computer vision algorithms for biometric pipeline</li> <li>- implement biometric pipeline</li> <li>- evaluate the quality of each step in the pipeline</li> <li>- build multi-biometric system</li> <li>- argument the choice of metrics, databases, protocols</li> <li>- identify open research questions</li> <li>- write a technical report.</li> </ul>
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**Metode poučevanja in učenja:**

<p>Predavanja in laboratorijske vaje, individualno delo na domačih nalogah/projektu, predstavitve izdelkov.</p>
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**Learning and teaching methods:**

<p>Lectures and tutorial, individual work on assignments/project, presentations of outcomes.</p>
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**Načini ocenjevanja:****Delež/Weight****Assessment:**

Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge/projekt, predstavitve)	67,00 %	Continuing (assignments/project, presentations)
Končno preverjanje (pisni ali ustni izpit)	33,00 %	Final: (written or oral exam)
Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL).		Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana).

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

<p>EMERŠIČ, Žiga, ŠTRUC, Vitomir, PEER, Peter. Ear recognition : more than a survey. <i>Neurocomputing</i>, ISSN 0925-2312. [Print ed.], Sep. 2017, vol. 255, str. 26-39. [COBISS.SI-ID 1537395395], [JCR]</p>
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MEDEN, Blaž, MALJI, Refik Can, FABIJAN, Sebastjan, EKENEL, Hazim Kemal, ŠTRUC, Vitomir, PEER, Peter. Face deidentification with generative deep neural networks. *IET signal processing*, ISSN 1751-9675. [Print ed.], May 2017, vol. , no. , str. 1-17. [COBISS.SI-ID 1537419459], [JCR]

PEER, Peter, EMERŠIČ, Žiga, BULE, Jernej, ŽGANEC GROS, Jerneja, ŠTRUC, Vitomir. Strategies for exploiting independent cloud implementations of biometric experts in multibiometric scenarios. *Mathematical problems in engineering*, ISSN 1024-123X. [Print ed.], Mar. 2014, vol. 2014, str. 1-15. [COBISS.SI-ID 10478420], [JCR]

KOVAČ, Jure, PEER, Peter. Human skeleton model based dynamic features for walking speed invariant gait recognition. *Mathematical problems in engineering*, ISSN 1024-123X. [Print ed.], Jan. 2014, vol. 2014, str. 1-15. [COBISS.SI-ID 10477140], [JCR]

KOVAČ, Jure, PEER, Peter. Transformation based walking speed normalization for gait recognition. *Transactions on internet and information systems*, ISSN 1976-7277, Nov. 2013, vol. 7, no. 11, str. 2690-2701. <http://www.itiis.org/>. [COBISS.SI-ID 10308948], [JCR]

(Nosilec ima sicer reference iz vseh modalnosti iz vsebine.)

Celotna bibliografija je dostopna na:  
<http://splet02.izum.si/cobiss/bibliography?code=19226&sciif=on>.

# 3D ZVOK V MULTIMEDIJI

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	3D zvok v multimediji
<b>Course title:</b>	3D sound in multimedia
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	2. letnik	1. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0090466
<b>Koda učne enote na članici/UL Member course code:</b>	64M30

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			105	6

**Nosilec predmeta/Lecturer:** Jaka Sodnik

**Vrsta predmeta/Course type:** strokovni izbirni predmet/specialist elective course

<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

Opravljanje študijskih obveznosti je opredeljeno v Pravilniku o preverjanju in ocenjevanju znanja ter izpitnem redu FE.

**Prerequisites:**

As specified by internal acts of the University of Ljubljana and Faculty of Electrical Engineering.

**Vsebina:**

Vibracije in zvočno valovanje

- propagacijske lastnosti zvoka
- lastnosti medijev
- karakteristike zvočnih izvorov

2. Zaznava zvoka in psihoakustika

3. Lokalizacija zvoka

- medušesni časovni in amplitudni pojavi
- spektralna vsebina
- premiki glave in zvočnih izvorov
- razdalja in reverberacija

4. Snemanje prostorskega zvoka

- tehnike snemanja večkanalnega in prostorskega zvoka
- zajem prenosnih funkcij glave (HRTF)

5. Predvajanje prostorskega zvoka

- dvokanalni stereo

**Content (Syllabus outline):**

Vibration and sound waves

- propagation properties of sound
- characteristics of the media
- characteristics of sound sources

2. The perception of sound and psychoacoustics

3. Localization of sound

- inter-aural time and amplitude cues
- spectral content
- head movements of source movements cues
- distance and reverberation

4. Recording the surround sound

- multi-channel and surround sound recording techniques
- acquisition of head-related transfer functions (HRTF)

5. Playback of surround sound

<ul style="list-style-type: none"> <li>· večkanalni stereo in surround sistemi</li> <li>· implementacija prenosnih funkcij glave</li> <li>· uporaba digitalnih signalnih procesorjev</li> <li>· simulacija razdalje in reverberacije</li> </ul> <p>6. Zvočni uporabniški vmesniki multimedijskih naprav</p> <ul style="list-style-type: none"> <li>· govorni vmesniki</li> <li>· negovorni zvočni vmesniki</li> <li>· sonifikacija</li> <li>· zvočne ikone</li> <li>· uporabniške metafore</li> </ul> <p>7. 3D zvočni uporabniški vmesniki multimedijskih naprav</p> <ul style="list-style-type: none"> <li>· prenosljive naprave</li> <li>· virtualna okolja</li> <li>· aeronavtika</li> <li>· vozila</li> <li>· slabovidni in slepi uporabniki</li> <li>· vmesniki možgani-računalnik</li> </ul>	<ul style="list-style-type: none"> <li>· two-channel stereo</li> <li>· multichannel stereo and surround systems</li> <li>· implementation of head-related transfer functions</li> <li>· using digital signal processors</li> <li>· simulation of distance and reverberation</li> </ul> <p>6. Auditory user interfaces in multimedia devices</p> <ul style="list-style-type: none"> <li>· speech interfaces</li> <li>· non-speech interfaces</li> <li>· sonication</li> <li>· auditory icons</li> <li>· interface metaphors</li> </ul> <p>7. 3D auditory user interfaces in multimedia devices</p> <ul style="list-style-type: none"> <li>· portable devices</li> <li>· virtual Environments</li> <li>· aeronautics</li> <li>· vehicles</li> <li>· visually impaired and blind users</li> <li>· brain-computer interfaces</li> </ul>
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### Temeljna literatura in viri/Readings:

1. Sodnik J, Tomažič S: Spatial auditory human-computer interfaces, SpringerBriefs in Computer Science, september 2015.
2. Begault R. Durand: 3D Sound for Virtual Reality and Multimedia, Academic Press, Inc. UK, 1994.
3. Rumsey F: Spatial Audio (Music Technology), Elsevier, 2005.

### Cilji in kompetence:

Širši vpogled v področje 3D zvoka in njegove uporabe v sodobnih multimedijskih storitvah in napravah. Študentje naj spoznajo osnovne fizikalne značilnosti zvočnega valovanja v različnih medijih in prostorih ter sposobnosti dojetanja in lokalizacije zvoka pri ljudeh. Osvojijo tudi znanja s področja zajema in implementacije 3D zvoka ter njegove uporabe v interakciji med uporabnikom in sodobnimi multimedijskimi napravami.

### Objectives and competences:

Broader insight into 3D sound and its use in modern multimedia services and devices. Students should understand the basic physical characteristics of sound waves in different media and spaces, and the ability of perception and sound localization in humans. They also acquire the knowledge on recording and implementation techniques of 3D sound and its use in the interaction between a user and modern multimedia devices.

### Predvideni študijski rezultati:

Po uspešno opravljenem modulu naj bi bili študenti zmožni:

- opisati osnovne lastnosti in zakonitosti zvočnega valovanja v prostoru,
- razložiti mehanizme lokalizacije prostorskega zvoka pri človeku,
- razložiti tehnike snemanja 3D zvoka,
- razložiti tehnike obdelave 3D zvoka,
- razložiti tehnike generacije 3D zvoka s pomočjo digitalnega signalnega procesiranja,
- razložiti tehnike predvajanja 3D zvoka s pomočjo različnih konfiguracij zvočnikov,
- opisati kategorije in specifik različnih zvočnih uporabniških vmesnikov, ki temeljijo na uporabi 3D zvoka

### Intended learning outcomes:

After successful completion of the course, students should be able to:

- describe basic properties and principles of acoustic wave in a space,
- explain mechanisms for human sound localization,
- explain techniques for 3D sound recording,
- explain techniques for 3D sound processing,
- explain techniques for generation of 3D sound through digital signal processing,
- explain techniques for replaying 3D sound through different configurations of loud speakers
- describe different categories and specifics of auditory user interfaces based on 3D sound

### Metode poučevanja in učenja:

### Learning and teaching methods:

Predavanja, na katerih se študent seznanja s teoretičnimi osnovami, in laboratorijske vaje, kjer nekaj problemov spozna tudi praktično in jih skuša v duhu timskega dela reševati.	Lectures in which the student is acquainted with the theoretical basics and lab work where the student meets the practical problems and solves them in the team.
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Načini ocenjevanja:	Delež/Weight	Assessment:
Način: pisni izpit, ustni izpit. Ocena 5 je negativna ocena, ocene od vključno 6 do 10 so pozitivne. Pozitivna ocena pisnega izpita je pogoj za pristop k ustnemu izpitu. Prispevki k oceni:		Type: laboratory exercises, written exam, oral exam. Negative grade is 5, positive grades: from 6 to 10. Positive evaluation of written exam is a prerequisite for the oral exam. Contributions to the final grade:
pisni izpit	50,00 %	written exam
ustni izpit	50,00 %	oral examination

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

- SODNIK, Jaka, TOMAŽIČ, Sašo. Spatial auditory human-computer interfaces, SpringerBriefs in Computer Science, (objavljeno september 2015).
- JAKUS, Grega, DICKE, Christina, SODNIK, Jaka. A 2.user study of auditory, head-up and multi-modal displays in vehicles. *Applied Ergonomics*, ISSN 0003-6870. [Print ed.], Jan. 2015, vol. 46, pt. A, str. 184-192, ilustr. <http://dx.doi.org/10.1016/j.apergo.2014.08.008>, doi: 10.1016/j.apergo.2014.08.008. [COBISS.SI-ID 10729812]SODNIK, Jaka, SUŠNIK, Rudolf, ŠTULAR, Mitja, TOMAŽIČ, Sašo. Spatial sound resolution of an interpolated HRIR library. *Appl. Acoust.* [Print ed.], Nov. 2005, vol. 66, no. 11, str. 1219-1234, ilustr. [COBISS.SI-ID 4991572]
- SODNIK, Jaka, JAKUS, Grega, TOMAŽIČ, Sašo. Multiple spatial sounds in hierarchical menu navigation for visually impaired computer users. *International journal of human-computer studies*, ISSN 1071-5819, Jan.-Feb. 2011, vol. 69, no. 1/2, str. 100-112, ilustr. [COBISS.SI-ID 8085332]
- SODNIK, Jaka, DICKE, Christina, TOMAŽIČ, Sašo, BILLINGHURST, Mark. A user study of auditory versus visual interfaces for use while driving. *International journal of human-computer studies*, ISSN 1071-5819, May 2008, vol. 66, no. 5, str. 318-332, ilustr. [COBISS.SI-ID 6450004], [JCR, SNIP, WoS do 8. 7. 2015: št. citatov (TC): 14, čistih citatov (CI): 12, normirano št. čistih citatov (NC): 48, Scopus do 8. 7. 2015: št. citatov (TC): 38, čistih citatov (CI): 30, normirano št. čistih citatov (NC): 119]

Celotna bibliografija je dostopna na SICRISu:  
<http://izumbib.izum.si/bibliografije/Y20150824114353-23408.html>.

# ALGORITMI

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Algoritmi
<b>Course title:</b>	Algorithms
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	2. letnik	2. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0170985
<b>Koda učne enote na članici/UL Member course code:</b>	63508

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	20	10			105	6

**Nosilec predmeta/Lecturer:** Andrej Brodnik

**Vrsta predmeta/Course type:** strokovni izbirni predmet/specialist elective course

<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

<b>Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:</b>	<b>Prerequisites:</b>
Osnovno znanje algoritmov in podatkovnih struktur.	Basic knowledge of algorithms and data structures.

### Vsebina:

Vsebina predmeta:  
Računska zahtevnost za algoritme tipa deli in vladaj.  
Randomizirani algoritmi in verjetnostna analiza algoritmov.  
Amortizirana analiza algoritmov.  
Iskanje v večdimenzionalnih prostorih: k-d drevesa, R drevesa, lokalno občutljivo razprševanje.  
Sortiranje s predpostavkami: s štetjem, korensko urejanje, sektorsko urejanje.  
Iskanje s predpostavkami: drevesa van Emde Boats.  
Razpršene tabele: funkcije razprševanja, univerzalno razprševanje, popolno razprševanje, Bloomovi filtri.  
Hevristične metode reševanja problemov: lokalne metode.  
Metahevristike pri optimizaciji.  
Biolško navdahnjene metode: genetski algoritmi, diferencialna evolucija in metode roja.

### Content (Syllabus outline):

The topics:  
Computational complexity for divide and conquer algorithms.  
Randomized algorithms and probabilistic analysis.  
Amortized analysis of algorithms.  
Searching in multidimensional spaces: k-d trees, R-trees and locality-sensitive hashing.  
Sorting with assumptions: counting sort, radix sort, bucket sort.  
Searching with assumptions: van Emde Boats trees.  
Hash tables: hash functions, universal hashing, perfect hashing, Bloom filters.  
Heuristic programming: local methods.  
Metaheuristics for optimization.  
Biologically inspired methods: genetic algorithms, differential evolution, swarm intelligence.  
Computational geometry: line-segment properties, convex hull, closest pair of points.



<p>Računska geometrija: lastnosti daljic, konveksna ovojnica, par najbližjih točk. Večnitni in porazdeljeni algoritmi. Avtomati in gramatike. Študenti, ki na prvi stopnji še niso osvojili osnovnih algoritmov in podatkovnih struktur, bodo pod mentorstvom izvajalcev v obliki seminarjev in domačih nalog sproti obdelali še manjkajoče predznanje.</p>	<p>Multithreaded and distributed algorithms. Automata theory and grammars. Students lacking a required background from the 1st degree courses will gain needed knowledge and skills through additional preparation of seminar papers and programming assignments throughout the course. The topics will be individually selected.</p>
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### Temeljna literatura in viri/Readings:

T. H. Cormen, C.E. Leiserson, R.L. Rivest, C. Stein: *Introduction to Algorithms, 3rd edition*. MIT Press, 2009.  
K.A.Berman, J.L. Paul: *Algorithms: Sequential, Parallel, and Distributed*. Thomson, 2005.  
J. Kleinberg, E. Tardos: *Algorithm Design*. Pearson Education, 2006.

### Cilji in kompetence:

Cilj predmeta je nadgraditi znanje s področja načrtovanja in analize algoritmov in podatkovnih struktur. Študenti bodo dosegli nivo, ko znajo analizirati večino algoritmov in si razširili orodjarno znanih algoritmov in tehnik za njihov razvoj.

#### Splošne kompetence:

sposobnost kritičnega razmišljanja,  
razvoj spretnosti kritičnega, analitičnega in sintetičnega razmišljanja,  
sposobnost razumevanja in reševanja profesionalnih izzivov,  
sposobnost nadgradnje pridobljenega znanja.

#### Predmetno-specifične kompetence:

poznavanje mojstrove metode in metode Akra-Bazzi za analizo algoritmov tipa deli in vladaj,  
randomizacija algoritmov  
verjetnostna analiza algoritmov,  
amortizirana analiza algoritmov,  
poznavanje razredov formalnih jezikov in zapis regularnih izrazov ter kontekstno neodvisnih gramatik,  
poznavanje vloge predpostavk pri razvoju učinkovitih algoritmov,  
učinkovito iskanje prostorskih podatkov,  
uporaba razpršenih tabel, sestava razprševalne funkcije,  
priprava optimizacijskega problema za reševanje z lokalnimi metodami,  
uporaba meta-hevristik v lokalnih metodah:  
spremenljive okolice, vodeno lokalno iskanje, tabu preiskovanje,  
priprava problema za reševanje z biološko navdahnjenimi metodami: genetskimi algoritmi, metodo rojev, diferencialno evolucijo in kolonijo mravelj,  
uporaba tehnik računske geometrije in poznavanje učinkovitih algoritmov za konveksno ovojnico,  
analiza večnitnih algoritmov, paralelna pohitritev,  
spreminjanje enonitnih v večnitne algoritme,

### Objectives and competences:

The goal of this course is to upgrade the knowledge of the analysis of algorithms and data structures and algorithm design techniques. A level where most of the algorithms can be analysed will be reached. Students will expand their algorithm toolbox and a set of design approaches.

#### General competences:

ability of critical thinking,  
developing skills in critical, analytical and synthetic thinking,  
the ability to understand and solve professional challenges in computer and information science,  
the ability to upgrade acquired knowledge.

#### Subject-specific competences:

use of master theorem and Akra-Bazzi method for analysis of divide-and-conquer algorithms,  
randomization of algorithms,  
probabilistic analysis of algorithms,  
amortized analysis of algorithms,  
classes of formal languages, writing regular expressions and context-free grammars,  
the role of assumptions in development of efficient algorithms,  
efficient search of spatial data and low-dimensional data,  
use of hash tables, construction of hash functions,  
preprocessing problems for optimization based on local search,  
using met heuristics in local search: variable neighbour method, guided local search, tabu search,  
preprocessing problems for biology inspired methods: particle swarm optimization, differential evolution, ant colony optimization  
using techniques from computational geometry and efficiently finding convex hull,  
analysis of multithreaded algorithms, speed-up turning single threaded algorithms in multi-threaded algorithms,  
knowing distributed algorithm development.

poznavanje razvoja porazdeljenih algoritmov.	
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<b>Predvideni študijski rezultati:</b>	<b>Intended learning outcomes:</b>
<p>Po uspešnem zaključku tega predmeta bo študent:</p> <ul style="list-style-type: none"> <li>- znal opredeliti razliko med težkim in lahkim problemom ter med dobrim in slabim algoritmom,</li> <li>- razumel delovanje izbranih algoritmov in jih znal implementirati v izbranem programskem jeziku,</li> <li>- sposoben izkazati algoritmični način razmišljanja in reševanja problemov,</li> <li>- sposoben samostojno razviti nov algoritem za izbrane probleme,</li> <li>- znal raziskati problem, določiti način reševanja in poiskati ali razviti algoritem,</li> <li>- sposoben ovrednotiti kakovost algoritma za reševanje izbranega problema.</li> </ul>	<p>After the completion of the course a student will be able to:</p> <ul style="list-style-type: none"> <li>- define the difference between easy and hard problems and between good (efficient) and bad (inefficient) solutions,</li> <li>- understand the selected algorithms and implement them in a selected programming language,</li> <li>- show the algorithmic way of thinking and solving the problems,</li> <li>- independently develop algorithms for solving the selected problems,</li> <li>- research the selected problem, find an approach to solve the problem and develop an appropriate algorithm,</li> <li>- evaluate the quality of a selected algorithm.</li> </ul>

<b>Metode poučevanja in učenja:</b>	<b>Learning and teaching methods:</b>
<p>Predavanja, laboratorijske vaje in domače naloge; pomembno je sprotno oddajanje domačih nalog. Študenti s šibkim obstoječim znanjem bodo manjkajoče znanje pridobili z dodatnimi individualnimi seminarskimi nalogami in programerskimi projekti.</p>	<p>Lectures and homework; assignments are assigned regularly and shall be delivered on time. For students with low prior knowledge individual work (seminal papers and programming assignments) will be assigned.</p>

<b>Načini ocenjevanja:</b>	<b>Delež/Weight</b>	<b>Assessment:</b>
Način: pisni in ustni izpit, naloge.		Type: written and oral examination, coursework.
Sprotno preverjanje: domače naloge, seminarsko delo.	50,00 %	Continuing: homework, seminars.
Končno preverjanje: pisni in ustni izpit.	50,00 %	Final: written and oral exam.
Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL).		Grading: 6-10 pass, 5 fail (according to the Statutes of University of Ljubljana).

<b>Reference nosilca/Lecturer's references:</b>
<p>BRODNIK, Andrej, GRGUROVIČ, Marko, POŽAR, Rok. Modifications of the Floyd-Warshall algorithm with nearly quadratic expected-time. <i>Ars mathematica contemporanea</i>. 2022, vol. 22, no. 1, str. 1-22, ilustr. ISSN 1855-3966.</p> <p>BRODNIK, Andrej, MALNIČ, Aleksander, POŽAR, Rok. A subquadratic algorithm for the simultaneous conjugacy problem. <i>Journal of graph theory</i>. 2022, str. 1-8. ISSN 1097-0118.</p> <p>BRODNIK, Andrej, MALNIČ, Aleksander, POŽAR, Rok. The simultaneous conjugacy problem in the symmetric group. <i>Mathematics of computation</i>. Nov. 2021, vol. 90, no. 332, str. 2977-2995. ISSN 0025-5718.</p> <p>BRODNIK, Andrej, JEKOVEC, Matevž. Sliding suffix tree. <i>Algorithms</i>. 2018, vol. 11, no. 8, str. 1-11. ISSN 1999-4893.</p> <p>BRODNIK, Andrej, GRGUROVIČ, Marko. Parallelization of ant system for GPU under the PRAM model. <i>Computing and informatics</i>. 2018, vol. 37, no. 1, str. 229-243, graf. prikazi. ISSN 1335-9150.</p>

# AMBIENTNA INTELIGENCA

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Ambientna inteligenca
<b>Course title:</b>	Ambient intelligence
<b>Članica nosilka/UL Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik	2. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0090461
<b>Koda učne enote na članici/UL Member course code:</b>	64M26

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			105	6

**Nosilec predmeta/Lecturer:** Matej Zajc

**Vrsta predmeta/Course type:** strokovni izbirni predmet/specialist elective course

<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

<b>Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:</b>	<b>Prerequisites:</b>
Vpis v letnik.	Regular enrolment.

### Vsebina:

1. Uvod v ambientno inteligenco: principi; pristopi; umestitev v področje multimedije; terminologija; definicije
2. Ambient v kontekstu percepcije in kreacije multimedijskih vsebin
3. Ambientna inteligenca: vsenavzoče tehnologije v odnosu do uporabnika: aplikacija multimedijskih tehnologij v različnih pametnih okoljih; razumevanje razvoja mentalnega modela uporabnika v inteligentnih okoljih
4. Določanje konteksta: določanje kaj je relevanten kontekst za dano aktivnost; določitev potrebnih senzorjev in informacijskih virov; obdelava; komunikacija
5. Tehnologije, ki uporabniku omogočajo aktivnosti v izbranih kontekstih: vseprisotno računalništvo; vgrajeni sistemi; senzorji; IKT tehnologije

### Content (Syllabus outline):

1. Introduction to ambient intelligence: principles; related fields; terminology; definitions
2. Ambient in the context of perception and creation of multimedia content
3. Ambient intelligence: pervasive technologies in relation to user: multimedia technology applications in variety of intelligent environments; understanding user's mental model development in intelligent environments
4. Context definition: context definition for selected activity; selection of relevant sensors and information sources; processing; networking
5. Technologies enabling user's activities in selected contexts: pervasive computing; embedded systems; sensors; ICT technologies
6. User: interaction with environment; mental model development; modalities; channels

<p>6. Uporabnik: interakcija z okoljem; razvoj mentalnega modela, modalnosti, kanali</p> <p>7. Komunikacija človek-ambient: vmesniki; vhodno-izhodne naprave; zajem podatkov o uporabniku in okolici; modalnosti; personalizacija; povezljivost</p> <p>8. Prototipiranje sistemov ambientne inteligence</p> <p>9. Raziskovalno delo na izbranih aplikativnih področjih: dom; zabava; učenje; profesionalna okolja; različne skupine uporabnikov; analiza in določitev zahtev</p> <p>10. Praktično delo: načrtovanje prototipa za izbrani problem; uporaba tehnik za načrtovanje interakcije; predstavitev prototipa uporabniške interakcije s sistemom; ovrednotenje rešitve</p>	<p>7. Communication human-ambient: interfaces; input/output devices; user and ambient sensing; modalities; personalization; connectivity</p> <p>8. Prototyping of ambient intelligence systems</p> <p>9. Research activities on selected application domains: home; entertainment; learning; professional environments; analysis and requirements definition</p> <p>10. Practical work: designing a prototype for selected domain; interaction design tools; interaction prototype demonstration; assessment</p>
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### Temeljna literatura in viri/Readings:

<p>1. Benyon D. Designing User Experience: A guide to HCI, UX and interaction design. Pearson, 4th Edition, 2019.</p> <p>2. Cook, D. J., Augusto, J. C., &amp; Jakkula, V. R. (2009). Ambient intelligence: Technologies, applications, and opportunities. <i>Pervasive and mobile computing</i>, 5(4), 277-298.</p> <p>3. Cook, D. J., Augusto, J. C., &amp; Jakkula, V. R. (2009). Ambient intelligence: Technologies, applications, and opportunities. <i>Pervasive and mobile computing</i>, 5(4), 277-298.</p> <p>4. Ghajargar, M., Wiberg, M., &amp; Stolterman, E. (2018). Designing IoT systems that support reflective thinking: A relational approach. <i>International Journal of Design</i>, 12(1), 21-35.</p> <p>5. Wiberg, M. (2018). The materiality of interaction: Notes on the materials of interaction design. MIT press.</p> <p>6. Lim, Y. K., Stolterman, E., &amp; Tenenber, J. (2008). The anatomy of prototypes: Prototypes as filters, prototypes as manifestations of design ideas. <i>ACM Transactions on Computer-Human Interaction (TOCHI)</i>, 15(2), 1-27.</p>
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### Cilji in kompetence:

<p>Spoznati pomen ambientne inteligence v multimediji ter aktivno uporabljati pridobljeno znanje za razvoj samostojnih rešitev.</p> <p>Razumevanje ambientne inteligence v sodobnih multimedijskih sistemih v odnosu do uporabnika.</p> <p>Obvladovati podatkovno pot od senzorja do rezultatov ambientne inteligence.</p> <p>Poznavanje konceptov in gradnikov arhitektur ambientne inteligence. Razumevanje vloge vsenavzoče tehnologije in uporabo v sodobnih storitvah.</p>	<p><b>Objectives and competences:</b></p> <p>The goal is to understand roles of ambient intelligence in multimedia and apply acquired competences for designing solutions.</p> <p>Understanding ambient intelligence in modern multimedia systems with relation to users.</p> <p>Managing data path from sensor to resulting ambient intelligence.</p> <p>Mastering concepts and building blocks of ambient intelligence. Understanding roles of pervasive technologies and their applications in modern services.</p>
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### Predvideni študijski rezultati:

<p>Po uspešno opravljenem modulu naj bi bili študenti zmožni:</p> <p>Primerjati komunikacijsko-informacijske in multimedijske tehnologije ter njihovo uporabo v različnih pametnih okoljih.</p> <p>Aplicirati tehnologije ambientne inteligence v interakciji z uporabnikom.</p> <p>Obravnavati ergonomijo v širšem kontekstu.</p> <p>Razlikovati omejitve podajanja informacije z uporabo različnih modalnosti.</p> <p>Modelirati interakcijo uporabnika s tehnologijo.</p> <p>Prilagoditi multimedijske vsebine za različne modalnosti.</p>	<p><b>Intended learning outcomes:</b></p> <p>After successful completion of the course, students should be able to:</p> <p>Compare communication-information and multimedia technologies and their use in different smart environments.</p> <p>To apply technologies of ambient intelligence in interaction with users.</p> <p>To treat ergonomics in wider context.</p> <p>To distinguish limitations of information delivery using different modalities.</p> <p>Modelling user's interaction with the technology.</p> <p>Adapt multimedia content for different modalities.</p>
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Koristiti različne pristope načrtovanja vmesnikov in interakcije.	Utilize various approaches to interface and interaction design.
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**Metode poučevanja in učenja:**

Na predavanjih so predstavljene teoretične osnove obravnavanih poglavij skupaj s prikazom rešitev enostavnih praktičnih primerov. Študentom je na voljo študijski material s podrobno vsebino. Praktično delo poteka v okviru laboratorijskih vaj. Študent na izbrano temo pripravi samostojni projekt, ki ga tudi predstavi.

**Learning and teaching methods:**

The lectures provide a theoretical background on selected topics together with simple practical demonstrations. A complete study material is available online. Practical work is being performed in the laboratory environment. Individual projects are based on selected topics and presented by students.

**Načini ocenjevanja:**

**Delež/Weight**

**Assessment:**

Način: laboratorijske vaje, samostojni projekt, pisni izpit, ustni izpit. Ocena 5 je negativna ocena, ocene od vključno 6 do 10 so pozitivne. Pozitivna ocena laboratorijskih vaj je pogoj za pristop k izpitu. Prispevki k oceni:		Type: laboratory exercises, individual project, written exam, oral exam. Negative grade is 5, positive grades: from 6 to 10. Positive evaluation of laboratory exercises is a prerequisite for the exam. Contributions to final grade:
laboratorijske vaje in samostojni projekt	50,00 %	laboratory exercises and individual project
pisni in ustni izpit	50,00 %	written and oral exam

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

- MILEV, Ivana, PRISLAN, Lev, ZAJC, Matej. Energy portal design and evaluation for consumer active participation in energy services : seven-month field study with 234 Slovenian households. Electronics. Nov.-1 2022, iss. 21, 3452, str. 1-20, ilustr. ISSN 2079-9292.
- ZAJC, Matej, ISTENIČ, Andreja, LEBENIČNIK, Maja, GAČNIK, Mateja. Tablet game-supported speech therapy embedded in children's popular practices. Behaviour & information technology. [Print ed.]. 2018, vol. 37, no. 7, str. 693-702, ilustr. ISSN 0144-929X
- GAČNIK, Mateja, ISTENIČ STARČIČ, Andreja, ZALETELJ, Janez, ZAJC, Matej. User-centred app design for speech sound disorders interventions with tablet computers. Universal access in the information society, ISSN 1615-5289, 2017, letn. 16.
- ZAJC, Matej, ISTENIČ STARČIČ, Andreja. Potentials of the Tangible User Interface (TUI) in enhancing inclusion of people with special needs in the ICT-assisted learning and e-accessibility. Lect. notes comput. sci., 2012, str. 261-270.
- ISTENIČ STARČIČ, Andreja, COTIČ, Mara, ZAJC, Matej. Design-based research on the use of a tangible user interface for geometry teaching in an inclusive classroom. British journal of educational technology, ISSN 0007-1013, 2013, 44, 5, str. 729-744.

# BREŽIČNA SENZORSKA OMREŽJA

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Brežična senzorska omrežja
<b>Course title:</b>	Wireless Sensor networks
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	2. letnik	2. semester	izbirni
Računalništvo in informatika, druga stopnja, magistrski	Računalništvo in informatika (smer)		2. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0082617
<b>Koda učne enote na članici/UL Member course code:</b>	63511

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	10	20			105	6

**Nosilec predmeta/Lecturer:**

**Vrsta predmeta/Course type:**

<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

<b>Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:</b>	<b>Prerequisites:</b>
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### Vsebina:

- Poglavja predavanj:
1. Zgradba omrežnega priključka (senzorja)
  2. Arhitektura senzorskega omrežja
  3. Fizični nivo
  4. Protokoli v senzorskih omrežjih
  5. Prenosni nivo
  6. Poimenovanje in naslavljanje
  7. Časovna sinhronizacija
  8. Določanje pozicije v prostoru
  9. Topologija omrežja
  10. Usmerjevalni protokoli
  11. Podatkovno in vsebinsko usmerjena omrežja
  12. Omrežja LWPA
  13. Satelitska senzorska omrežja

### Content (Syllabus outline):

- Basic topics:
1. Single – node architecture
  2. Network architecture
  3. Physical layer
  4. The sensor network protocol
  5. Transport layer
  6. Naming and addressing
  7. Time synchronization
  8. Localization and positioning
  9. Network topology
  10. Routing protocols
  11. Data centric and content – based networks
  12. LPWA network
  13. Satellite-based sensor networks

### Temeljna literatura in viri/Readings:

1. Holger Karl, Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", Wiley, 2007, ISBN: 0470519231
2. Ankur Dumka, Sandip K. Chaurasiya, Arindam Biswas, and Hardwari Lal Mandoria "A Complete Guide to Wireless Sensor Networks" CRC Press 2019 Number-13: 978-1-138-57828-9
3. Walteneagus Dargie, Christian Poellabauer, Fundamentals of Wireless Sensor Networks: Theory and Practice, Wiley, 2010, ISBN: 978-0-470-99765-9

Dodatna literatura:

Abdulrahman Yarali, "Wireless sensor networks (WSN)", 2020 by Nova Science Publishers, Inc., ISBN 9781536187267

### Cilji in kompetence:

Cilj predmeta je študentom računalništva in informatike predstaviti senzorska omrežja. Poudarek je na posebnostih senzorskih omrežjih, ki se od običajnih razlikujejo po omejeni moči procesorja ter omejeni energiji za napajanje.

### Objectives and competences:

The goal of this course is to gain the main knowledge about wireless sensor networks with their special properties (different processing and power capabilities).

### Predvideni študijski rezultati:

#### Znanje in razumevanje:

Po uspešno opravljenem modulu na bi bili študenti zmožni:  
 izkazati znanje in razumevanje osnovnih principov senzorskih omrežij  
 uporabiti postopke časovne sinhronizacije,  
 določiti pozicijo senzorja v prostoru,  
 zasnovati enostavno topologijo senzorskega omrežja,  
 uporabiti ustrezen usmerjevalni protokol,  
 izbrati ustrezen transportni protokol,  
 razlikovati med podatkovno in vsebinsko usmerjenimi omrežji.

**Uporaba:** Uporaba senzorskih omrežij pri raznih pogojih uporabe (v industriji, pri zajemanju podatkov na širokem področju, v domu, ...).

**Refleksija:** Spoznavanje in razumevanje uglašenosti med teorijo in njeno aplikacijo na konkretnih primerih s področja senzorskih omrežij.

**Prenosljive spretnosti - niso vezane le na en predmet:** Reševanje drugih konceptualno sorodnih problemov s področja komunikacije in zajemanja podatkov.

### Intended learning outcomes:

#### Knowledge and understanding:

After successful completion of the course, students should be able to:  
 understand the principles of sensor networks,  
 use time synchronization techniques,  
 determine the position of the sensor in the space,  
 design a simple topology of the sensor network,  
 use an appropriate routing protocol,  
 select the appropriate transport protocol,  
 distinguish between data and content-oriented networks.

**Application:** Use of sensor networks in various scenarios (industry, general data acquisition, intelligent home,...).

**Reflection:** Learning and understanding the correlation between theory and its application to specific scenarios of sensor network use.

**Transferable skills:** Solving other conceptually related problems from the fields of communication and data acquisition.

### Metode poučevanja in učenja:

Predavanja, računske vaje z ustnimi nastopi. Poseben poudarek je na sprotnem študiju in na laboratorijskem delu pri vajah.

### Learning and teaching methods:

Lectures, numerical exercises and oral presentations. Special attention is given to active study and laboratory work.

### Načini ocenjevanja:

### Delež/Weight

### Assessment:

Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, kolokviji, projektno in seminarsko delo)	50,00 %	Continuing (homework, midterm exams, project work or seminar paper)
Končno preverjanje (pisni izpit)	50,00 %	Final (written exam)
Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL).		Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana).

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

VASYLCHENKOVA, Anastasiia, MRAZ, Miha, ZIMIC, Nikolaj, MOŠKON, Miha. Classical mechanics approach applied to analysis of genetic oscillators. *IEEE/ACM transactions on computational biology and bioinformatics*, ISSN 1545-5963. [Print ed.], May/Jun. 2017, vol. 14, no. 3, str. 721-727,

BORDON, Jure, MOŠKON, Miha, ZIMIC, Nikolaj, MRAZ, Miha. Fuzzy logic as a computational tool for quantitative modelling of biological systems with uncertain kinetic data. *IEEE/ACM transactions on computational biology and bioinformatics*, ISSN 1545-5963. [Print ed.], 2015, vol. 12, no. 5, str. 1199-120

PETRONI, Mattia, ZIMIC, Nikolaj, MRAZ, Miha, MOŠKON, Miha. Stochastic simulation algorithm for gene regulatory networks with multiple binding sites. *Journal of computational biology*, ISSN 1066-5277. [Print ed.], Mar. 2015, vol. 22, no. 3, str. 218-226,

ŠOBERL, Domen, ZIMIC, Nikolaj, LEONARDIS, Aleš, KRIVIC, Jaka, MOŠKON, Miha. Hardware implementation of FAST algorithm for mobile applications. *Journal of signal processing systems for signal, image, and video technology*, ISSN 1939-8018. [Print ed.], 2015, vol. 79, no. 3, str. 247-256,

PEČAR, Primož, MRAZ, Miha, ZIMIC, Nikolaj, JANEŽ, Miha, LEBAR BAJEC, Iztok. Solving the ternary quantum-dot cellular automata logic gate problem by means of adiabatic switching. *Japanese journal of applied physics*, ISSN 0021-4922, 2008, vol. 47, no. 6, str. 5000-5006



# DIGITALNO TRŽENJE

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Digitalno trženje
<b>Course title:</b>	Digital marketing
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik	1. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0088091
<b>Koda učne enote na članici/UL Member course code:</b>	63559

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			105	6

**Nosilec predmeta/Lecturer:** Vesna Žabkar

**Vrsta predmeta/Course type:** strokovni izbirni predmet/specialist elective course

<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

<b>Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:</b>	<b>Prerequisites:</b>
Vpis v ustrezen letnik študija.	Enrolment in the relevant year of studies.

<b>Vsebina:</b>	<b>Content (Syllabus outline):</b>
Zaradi hitrih sprememb na tem področju se bo vsebina predmeta prilagajala razvoju: 1. Uvod v digitalno trženje 2. Značilnosti in vedenje porabnikov v digitalnem trženju 3. Digitalno trženje in trženjsko raziskovanje 4. Izdelki in storitve v digitalnem trženju 5. Posebnosti oblikovanja cen v digitalnem trženju 6. Tržne poti v digitalnem trženju 7. Digitalno trženjsko komuniciranje 8. Trženjski odnosi v digitalnem trženju 9. Poslovni modeli digitalnega trženja 10. Trženjski načrt za potrebe digitalnega trženja	Due to the rapid changes the course content will accommodate the development in this area: 1. Introduction to Digital Marketing 2. The characteristics and behavior of consumers in the digital marketing 3. The digital marketing and market research 4. Products and services in digital marketing 5. Special pricing in the digital marketing 6. Marketing channels in digital marketing 7. Digital Marketing Communications 8. Marketing relationships in the digital marketing 9. Business Models of Digital Marketing 10. The marketing plan for the needs of digital marketing

<b>Temeljna literatura in viri/Readings:</b>
Chaffey, D., Ellis-Chadwick, F.: Digital Marketing: Strategy, Implementation and Practice, 5/E (2012) (www.smartinsights.com)

### **Cilji in kompetence:**

Seznani slušatelje z vplivom in možnostmi učinkovite uporabe novih tehnologij na področju trženja.

- Spodbuditi h kritičnem vrednotenju informacijskih tehnologij in vpliva na veljavna prepričanja, paradigme ter strateške, operativne in taktične okvire trženja.
- Poudariti strateški vidik in potencialno uporabo e-trženjskih orodij za spremembo trženjskih strategij.
- Spodbuditi skupinsko delo s pomočjo uporabe najnovejših informacijskih tehnologij in uporabo pridobljenega znanja pri reševanju konkretnih problemov.
- Seznaniti s konkretnimi primeri iz prakse digitalnega trženja.
- Skozi vsebino in način dela pri predmetu poudariti tudi etični vidik in pri študentih spodbuditi občutljivost za vprašanja, ki jih človeku postavljajo tehnološki dosežki.

### **Objectives and competences:**

- To acquaint students with the influence and the potential efficient use of new technologies in the field of marketing.
- To support critical evaluation of information technologies and the impact on the existing beliefs, paradigms and the strategic, operational and tactical marketing frameworks.
- To emphasize the strategic aspect and the potential use of e-marketing tools to change marketing strategies.
- To encourage teamwork through the use of new information technologies and the application of acquired knowledge to solve specific problems.
- To acquaint with concrete examples from practice of digital marketing.
- Through the content and method of work of the course to emphasize the ethical aspect and stimulate the students' sensitivity to the issues raised by technological advancement.

### **Predvideni študijski rezultati:**

Znanje in razumevanje:

- Razumevanje vpliva in možnostmi učinkovite uporabe novih tehnologij na področju trženja.
- Kritično vrednotenje informacijskih tehnologij in vpliva na veljavna prepričanja, paradigme ter strateške, operativne in taktične okvire trženja.
- Poznavanje strateškega vidika in potencialne uporabe e-trženjskih orodij za spremembo trženjskih strategij.
- Poznavanje orodij za reševanju konkretnih problemov s področja digitalnega trženja.
- Razumevanje etičnega vidika glede vprašanj, ki jih človeku postavljajo tehnološki dosežki.

### **Intended learning outcomes:**

Knowledge and understanding:

- Understanding the impact and possibilities of efficient use of new technologies in the field of marketing.
- Critical evaluation of information technologies and the impact on the existing beliefs, paradigm and the strategic, operational and tactical marketing frameworks.
- Knowledge of strategic perspective and potential use of e-marketing tools to change marketing strategies.
- Knowledge of tools for solving specific problems in the field of digital marketing.
- Understanding the ethical point of view on the issues raised by human technological achievements.

### **Metode poučevanja in učenja:**

Predavanja s sodelovanjem gostov iz prakse.  
Seminarji: Omogočajo poglobljanje znanj o digitalnem trženju. Študenti analizirajo študijske primere in razpravljajo o praktičnih trženjskih problemih. V skupinah skozi cel semester pripravljajo projekt oz. e-trženjski načrt na konkretnih primerih digitalnega trženja. Namen projekta je preverjanje razumevanja ključnih konceptov in orodij ter spodbujanje uporabe orodij za odkrivanje in reševanje poslovnih problemov. Projekt je pripravljen v pisni obliki (do 20 strani + priloge) in ustno predstavljen v okviru seminarjev (30 minut predstavitev + 15 minut diskusija).  
Primeri so obravnavani teoretično v okviru predavanj

### **Learning and teaching methods:**

Lectures: With the participation of guests from practice.  
Seminars: They allow deepening knowledge of digital marketing. Students analyze case studies and discuss practical marketing problems. In groups throughout the semester they prepare a project (e-marketing plan) based on concrete examples from digital marketing. The project aims at verifying the understanding of key concepts and tools and promoting the use of tools to detect and solve business problems. The project is prepared in writing (up to 20 pages + annexes) and defended orally in the course seminars (30 minutes presentation + 15 minutes discussion).

in praktično v okviru vaj. Skupinska priprava in zagovor seminarske naloge na eno od tem digitalnega trženja.	Examples are discussed in lectures and practical exercises. Block preparation and presentation of a seminar paper on one of the topics of digital marketing is required.
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<b>Načini ocenjevanja:</b>	<b>Delež/Weight</b>	<b>Assessment:</b>
Način (pisni izpit, ustno izpraševanje, naloge, projekt) Končno izpitno oceno tvorijo analiza študijskih primerov (do 40 točk) in projekt trženjskega načrta (do 60 točk). Sestava točk pri projektu e-trženjskega načrta: * Do 50 točk: pisna oblika strateškega trženjskega načrta * Do 10 točk: predstavitev načrta Seminar in študijski primer je treba opraviti v istem študijskem letu.		Type (examination, oral, coursework, project): The final exam grade includes the case study analysis (40 points) and project marketing plan (60 points). Composition of the points in the project e-marketing plan: * Up to 50 points: a written form of a strategic marketing plan * Up to 10 points: presentation of the plan The seminar and case study should be carried out in the same academic year.

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

ARSLANAGIĆ-KALAJDŽIĆ, Maja, ŽABKAR, Vesna. The external effect of marketing accountability in business relationships : exploring the role of customer perceived value. *Industrial marketing management*, ISSN 0019-8501. [Print ed.], Apr. 2015, vol. 46, str. 83-97, doi: 10.1016/j.indmarman.2015.03.002. [COBISS.SI-ID 22510310]

RAVNIK, Robert, SOLINA, Franc, ŽABKAR, Vesna. Modelling in-store consumer behaviour using machine learning and digital signage audience measurement data. V: DISTANTE, Cosimo (ur.), BATTIATO, Sebastiano (ur.), CAVALLARO, Andrea (ur.). *Video analytics for audience measurement : First International Workshop, VAAM 2014, Stockholm, Sweden, August 24, 2014 : revised selected papers*, (Lecture notes in computer science, ISSN 0302-9743, Image processing, computer vision, pattern recognition, and graphics, 8811). Heidelberg [etc.]: Springer, cop. 2014, str. 123-133, tabele. [COBISS.SI-ID [1536031683](#)]

BODLAJ, Mateja, COENDERS, Germà, ŽABKAR, Vesna. Responsive and proactive market orientation and innovation success under market and technological turbulence. *Journal of business economics and management*, 2012, vol. 13, no. 4, str. 666-687, doi: [10.3846/16111699.2011.620143](#). [COBISS.SI-ID [21306086](#)]

OGRAJENŠEK, Irena, ŽABKAR, Vesna. Enhancing the value of survey data on consumer satisfaction in the frame of a consumer loyalty programme : case of a Slovenian retailer. *Quality technology & quantitative management*, ISSN 1684-3703, Jun. 2010, vol. 7, no. 2, str. 133-147. [COBISS.SI-ID [19365350](#)]

ČATER, Barbara, ŽABKAR, Vesna. Antecedents and consequences of commitment in marketing research services : the client's perspective. *Industrial marketing management*, ISSN 0019-8501. [Print ed.], Oct. 2009, vol. 38, no. 7, str. 785-797, ilustr., doi: [10.1016/j.indmarman.2007.10.004](#). [COBISS.SI-ID [18541798](#)]

# INFORMACIJSKA VARNOST IN ZASEBNOST

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Informacijska varnost in zasebnost
<b>Course title:</b>	Information Security and Privacy
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik, 2. letnik	1. semester	izbirni
Računalništvo in informatika, druga stopnja, magistrski	Računalništvo in informatika (smer)		1. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0082821
<b>Koda učne enote na članici/UL Member course code:</b>	63521

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			105	6

**Nosilec predmeta/Lecturer:** Denis Trček

**Vrsta predmeta/Course type:** strokovni izbirni predmet /specialist elective course

**Jeziki/Languages:**

Predavanja/Lectures:	Angleščina, Slovenščina
Vaje/Tutorial:	Angleščina, Slovenščina

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

**Prerequisites:**

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### Vsebina:

- Uvodni pregled področja.
- Ključne organizacije in standardi (ISO, ITU-T, IETF, W3C, OASIS, OMA).
- Obvladovanje tveganj.
- Varnostni mehanizmi (simetrični in asimetrični algoritmi, enosmerne zgoščevalne funkcije, homomorfna kriptografija) in varnostne storitve (principi in praktične izvedbe overjanja, zaupnosti, celovitosti, nezatajljivosti, nadzora dostopa, beleženja in alarmiranja), infrastruktura javnih ključev (časovna normala, upravljanje imenskega prostora, operativni protokoli), post-quantno računalništvo (kvantna izmenjava ključev, Lamportova kripto-shema), problematika stranskih kanalov in protiukrepi.
- Inženirski vidiki varnostnih mehanizmov.

### Content (Syllabus outline):

- Introduction.
- Key standards and organizations (ISO, ITU-T, IETF, W3C, OASIS, OMA).
- Risk management.
- Security mechanisms (symmetric and asymmetric algorithms, strong one way hash functions, homomorphic cryptography), security services (principles and practical implementations of authentication, confidentiality, integrity, non-repudiation, access control, logging and alarming), public key infrastructure (time base, name space management, operational protocols), post-quantum computing (quantum key exchange, Lamport crypto scheme), side channels problems and countemeasures.

<ul style="list-style-type: none"> <li>• Infrastruktura za overjanje, avtorizacijo in nadzor (principi, primeri standardiziranih rešitev – RADIUS in Diameter).</li> <li>• Varovanje na fizičnem in linijskem sloju (protokoli WEP, WPA1 in WPA2 in WP3).</li> <li>• Varovanje na mrežnem, transportnem in aplikacijskem sloju, vključno z internetom stvari in računalništvom v oblaku (protokoli in aplikacije kot so IPSec, TLS, S/MIME, XMLSec, SAML, XACML, WS-*, Bitcoin in bločne verige, Passkey).</li> <li>• Formalne metode (taksonomija formalnih metod s primeri kot so metoda R. Rueppla ter SPIN / Promela).</li> <li>• Obvladovanje zasebnosti in obvladovanje zaupanja ter ugleda v storitvenih arhitekturah.</li> <li>• Nove varnostne paradigme – internet stvari in varnost v oblaku.</li> <li>• Varnostno usmerjeno programsko inženirstvo (preverjanje modelov).</li> <li>• Obvladovanje tveganj pri varovanju informacijskih sistemov, organizacijski pristopi ter obvladovanje človeškega dejavnika (varnostne politike, modeliranje človeškega dejavnika in simulacije).</li> <li>• Akreditacijski in nadzorno-revizijski postopki varnosti informacijskih sistemov (ISO 2700X, CISSP), evalvacijski postopki za zagotavljanje varnosti strojno-programskih komponent (Common Criteria) ter rešitev s področja umetne inteligence.</li> <li>• Temeljna zakonodaja (direktive EU in nacionalne implementacije).</li> <li>• Zaključki.</li> <li>• Addendum: Mini vložki s praktičnim delom, ki pokrivajo najnovejše trende.</li> </ul>	<ul style="list-style-type: none"> <li>• Engineering issues related to security mechanisms.</li> <li>• Authentication, authorization and accounting infrastructure (principles, examples of standardized solutions like RADIUS and Diameter).</li> <li>• Security of physical and data layers (example protocols are WEP, WPA, WPA2 and WPA3).</li> <li>• Security of network, transport and application layers, including internet of things and clouds (example protocols and applications included are IPSec, TLS, S/MIME, XMLSec, SAML, XACML, WS-*, Bitcoin and blockchains, Passkey).</li> <li>• Formal methods (taxonomy of formal methods with examples like R. Rueppl's method and SPIN / Promela).</li> <li>• Privacy (privacy by design) with trust management and reputation management in services oriented architectures.</li> <li>• New security paradigms – Internet of Things and cloud computing.</li> <li>• Secure programming practices and verification (model checking).</li> <li>• Risk management in information systems, organizational views and human factor views (security policies, human factor modelling and simulations).</li> <li>• Accreditation and auditing of IS related to security (ISO 2700X, CISSP), standards for technical implementations of hardware and software components (Common Criteria), and standards for security management of artificial intelligence solutions.</li> <li>• Basic legislation in the area of IS security and privacy (EU directives, national implementations).</li> <li>• Conclusions.</li> <li>• Addendum: Mini practical tasks covering the latest selected technological issues.</li> </ul>
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### Temeljna literatura in viri/Readings:

<ul style="list-style-type: none"> <li>• Stallings W., Network Security Essentials, Pearson education, 2017.</li> <li>• D. Trček, Informacijska varnost in zasebnost, kopije prosojnic, FRI UL 2023.</li> <li>• D. Trček: Information Systems Security and Privacy, Springer, New York, Heidelberg, 2006.</li> </ul>
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### Cilji in kompetence:

<p>Cilj predmeta je, da študentje aktivno osvojijo znanja varovanja omrežij in zasebnosti v sodobnih informacijskih sistemih in sicer za namen skrbništva (administracije), kot tudi namen razvoja novih rešitev. Kategorizirane kompetence:</p> <ul style="list-style-type: none"> <li>-Razvijanje sposobnosti kritičnega, analitičnega in sintetičnega razmišljanja.</li> <li>-Sposobnost definiranja, razumevanja in reševanja kreativnih profesionalnih izzivov na področju računalništva in informatike.</li> <li>-Sposobnost profesionalnega komuniciranja v materinem in tujem jeziku.</li> <li>-Sposobnost biti skladen z varnostnimi, funkcionalnimi in okoljskimi zahtevami.</li> </ul>	<h3>Objectives and competences:</h3> <p>The goal of the course is to educate students to be able to actively provide security and privacy in contemporary information systems, be it as systems administrators, or developers of new solutions. Categorized competences:</p> <ul style="list-style-type: none"> <li>- Developing skills in critical, analytical and synthetic thinking.</li> <li>- The ability to define, understand and solve creative professional challenges in computer and information science.</li> <li>- The ability of professional communication in the native language as well as a foreign language.</li> <li>- Compliance with security, functional, economic and environmental principles.</li> </ul>
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-Sposobnost razumevanja in uporabe znanja računalništva in informatike na drugih relevantnih področjih (ekonomija, organizacija, umetnost, itd.). -Praktična znanja in sposobnosti na področju strojne in programske opreme ter informacijske tehnologije za uspešno profesionalno delo.	- The ability to understand and apply computer and information science knowledge to other technical and relevant fields (economics, organisational science, fine arts, etc). -Practical knowledge and skills of computer hardware, software and information technology necessary for successful professional work in computer and information science.
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<b>Predvideni študijski rezultati:</b> Po zaključku predmeta bo študent: -poznal in razumel principe varovanja informacijskih sistemov ter zagotavljanja zasebnosti, -poznal in razumel standardne rešitve na tem področju, -sposoben operativno upravljati informacijske sisteme s stališča zagotavljanja varnosti in zasebnosti, -znan razvijati enostavnejše varnostne rešitve, -sposoben interne revizije informacijskih sistemov s stališča varnosti, -znan specificirati varnostno politiko.	<b>Intended learning outcomes:</b> After completing this course a student will: -know and be familiar with principles for providing security and privacy in information systems, -know and understand standard solutions in this area, -be able to administer security and privacy of information systems, -be able to develop simpler solutions in this domain, -be qualified for internal security and privacy auditing, -be able to define security policy.
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<b>Metode poučevanja in učenja:</b> Predavanja, vaje s projektnim delom (praktične prototipne implementacije), lastne predstavitve. Udeležba na vajah je obvezna (zahtevan procent udeležbe se določi ob začetku študijskega leta). Nosilec predmeta lahko določi obvezno udeležbo tudi na predavanjih.	<b>Learning and teaching methods:</b> Lectures, laboratory work (with practical prototype implementations), students' presentations. Attendance of laboratory work is mandatory (the exact percentage is announced at the beginning of a study year). The lecturer may impose mandatory attendance of lectures.
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<b>Načini ocenjevanja:</b>	<b>Delež/Weight</b>	<b>Assessment:</b>
50 % ocene predstavlja sprotno delo študenta v obliki preverjanj na vajah (domače naloge, kvizi, praktičen projekt)	50,00 %	50% of the final grade is obtained on the basis of on-going laboratory work (home-works, quizzes, practical project implementations and presentations).
50 % ocene pa predstavlja izpit, ki je načeloma v pisni obliki, lahko pa tudi v pisni in ustni obliki (pri čemer lahko nosilec namesto ustnega izpita uvede zagovor seminarja).	50,00 %	The other 50% is obtained on the basis of a written exam, or written and oral exam (the lecturer may decide that a coursework replaces the oral exam).
Za uspešno opravljene obveznosti pri predmetu morata biti pozitivni obe delni oceni. Pristop k pisnemu izpitu je možen le po uspešno opravljenih obveznostih pri vajah (in v primeru dodatnih zahtev, ki se nanašajo na predavanja, po izpolnitvi le-teh).		To be eligible for the written exam, a candidate must have successfully completed laboratory work, and fulfilled other obligations related to lecturing that the lecturer may have imposed. For successful completion of the course both grades have to be pos
Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL).		Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana).

<b>Reference nosilca/Lecturer's references:</b> 1. TRČEK, Denis, Cultural heritage preservation by using blockchain technologies. Heritage science. Jan. 2022, vol. 10, str. 1-11, ISSN 2050-7445. <a href="https://heritagesciencejournal.springeropen.com/articles/10.1186/s40494-021-00643-9">https://heritagesciencejournal.springeropen.com/articles/10.1186/s40494-021-00643-9</a> , 2022.
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2. Trček D, Wireless sensors grouping proofs for medical care and ambient assisted-living deployment, Sensors, vol. 16, no. 1, str. 1-12, 2016.
3. HUČ, Aleks, TRČEK, Denis. Anomaly detection in IoT networks : from architectures to machine learning transparency. IEEE access. Apr. 2021, vol. 9, str. 60607-60616, ISSN 2169-3536. <https://ieeexplore.ieee.org/document/9406023>.
4. Trček D., Lightweight protocols and privacy for all-in-silicon objects, Ad hoc networks, Elsevier, ISSN 1570-8705, July 2013, vol. 11, no. 5, str. 1619-1628.
5. Trček D., Brodnik A., Hard and soft security provisioning for computationally weak pervasive computing systems in e-health, IEEE wireless communications, vol. 20, no. 4, 8 str., 2013.

Celotna bibliografija je dostopna na SICRISu:

The whole bibliography can be obtained at the below URL:

<https://bib.cobiss.net/biblioweb/eval/si/slv/evalrsr/11077>.

# INTERAKTIVNOST IN OBLIKOVANJE INFORMACIJ

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Interaktivnost in oblikovanje informacij
<b>Course title:</b>	Interaction and Information Design
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik	1. semester	obvezni

<b>Univerzitetna koda predmeta/University course code:</b>	0086901
<b>Koda učne enote na članici/UL Member course code:</b>	63527

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	20	10			105	6

<b>Nosilec predmeta/Lecturer:</b>	Franc Solina
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<b>Vrsta predmeta/Course type:</b>	strokovni izbirni predmet/specialist elective course
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<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

<b>Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:</b>	<b>Prerequisites:</b>

### Vsebina:

Pri predmetu Interaktivnost in oblikovanj informacij bodo obravnavani celostni pristopi k oblikovanju informacij in oblikovanju interaktivnosti. Poudarek bo na računskih pristopih k vidnemu sporočanju ter na razvoju interaktivnih rešitev, produktov in vmesnikov v hipermedijskih okoljih. Oblikovanje informacij in oblikovanje interaktivnosti sta kontekstualizirani kot bistveni komponenti uporabniške izkušnje, ki v velikem delu determinira uporabnost informacijske storitve ali produkta.

#### Vsebina predmeta:

Oblikovanje informacij:  
Modeli vidnega zaznavanja  
Oblikovanje vidnih sporočil  
Predstavitev informacije  
Prikaz informacije  
Prikazne tehnologije  
Navigacija in interaktivnost

### Content (Syllabus outline):

The course is dedicated to a holistic perspective on information and interaction design. Emphasis will be given to computational aspects of visual messaging and development of interactive solutions, products and interfaces in hypermedia environments. Information and interaction design are considered as principal components of user experience that determines the usability of information services and products.

#### Syllabus outline:

Information design:  
Models of visual perception  
Design of visual messages  
Presentation of information  
Display of information  
Display technologies  
Navigation and interactivity  
Interaction design:



<p>Interaktivno oblikovanje:          Uporabniška izkušnja          Konceptualni modeli interaktivnosti          Kognitivni vidik interaktivnosti          Kognitivni model uporabnika          Kolaborativni in socialni vidiki          Interaktivne tehnologije          Razvojni proces interaktivnih rešitev          Vrednotenje uporabnosti</p> <p><b>Vaje:</b>          Poudarek bo na razvoju in vrednotenju interaktivnih hipermedijskih rešitev. Študentje bodo v ustrezno opremljenem laboratoriju zasnovali in razvili več prototipov z uporabo programskih orodij za grafično procesiranje in obdelavo podatkov, ki so primerni za podporo prototipno osnovanemu razvojnemu ciklu. Poleg programskih orodij bodo pri delu uporabljani tudi senzorji, interaktivni vmesniki ter elektronske komponente. Predvideno je tudi sodelovanje podiplomskih študentov Akademije za likovno umetnost in oblikovanje.</p>	<p>User experience          Conceptual models of interactivity          Cognitive perspective on interactivity          Cognitive models of users          Collaborative and social aspects          Interaction technologies          Development process of interactive solutions          Usability assessment</p> <p><b>Laboratory work</b> centers around the development and evaluation of hypermedia solutions. Students will design and develop a series of prototypes using various software tools for fast development. Beside software tools, sensors, interactive interfaces and electronic devices are used. Collaboration with students of new media at the Academy of Fine Arts at University of Ljubljana is organized.</p>
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**Temeljna literatura in viri/Readings:**

Christian Tominski, Interaction for Visualization, Morgan & Claypool, 2015.  
 Robert Spence, Information visualization: Design for Interaction, 2007.  
 Ben Fry, Visualizing Data, O'Reilly, 2008.

**Cilji in kompetence:**

Cilj predmeta je študente naučiti oblikovanja in podajanja informacij ter oblikovanja interaktivnosti s poudarkom na razvoju uporabniško in podatkovno osredotočenih multimedijjskih programskih rešitev.

**Objectives and competences:**

To teach the design and presentation of information with emphasis on interactivity based on user and data centered multimedia software solutions.

**Predvideni študijski rezultati:**

**Znanje in razumevanje:**

Poznavanje in razumevanje teoretičnih osnov: vidnega zaznavanja, vizualizacije informacij, interaktivnosti, obogatene resničnosti.

**Uporaba:**

Snovanje in implementiranje praktičnih rešitev s področja interaktivnosti in oblikovanja informacij v inteligentnih sistemih, npr. za učenje, analizo slikovnih informacij, video nadzor, kreiranje in vzdrževanje novomedijske umetnosti.

**Refleksija:**

Spoznavanje in razumevanje vloge sodobne informacijske tehnologije v družbi nasploh, še posebej pa v umetnosti, ki nudi širok spekter možnosti za eksperimentiranje s to

**Intended learning outcomes:**

**Knowledge and understanding:** Comprehension of basic principles of:  
 visual perception  
 information visualization  
 interactivity  
 augmented reality.

**Application:**

Development of practical solutions of interactivity and information design for intelligent systems, for example for:  
 learning,  
 analysis of images  
 video surveyance,  
 creation and preservation of new media art.

**Reflection:** Wholesome comprehension of the role of modern information technology in society in general and in particular in fine arts which offers a broad spectrum of possibilities for experimentation with these technologies. Reflection about the addiction with new information technology.

<p>tehnologijo. Premislek tudi o zasvojenosti s to tehnologijo.</p> <p><b>Prenosljive spretnosti - niso vezane le na en predmet:</b> Sposobnost poglobljenega samostojnega in multidisciplinarnega raziskovanja na osnovi strokovne literature in eksperimentalnega dela. Implementacija ciljno usmerjenih praktičnih rešitev.</p>	<p><b>Transferable skills:</b> Capability to tackle independently multidisciplinary research projects with the help of literature research and experimental work. Implementation of goal directed practical solutions.</p>
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<p><b>Metode poučevanja in učenja:</b> Predavanja s podporo avdio-vizualne opreme. Laboratorijske vaje v učilnici z ustrezno strojno in programsko opremo. Delo posamezno in v skupinah. Praktično delo in vrednotenje produktov.</p>	<p><b>Learning and teaching methods:</b> Lectures using audio visual equipment. Laboratory work with special hardware and software tools. Individual and team assignments. Practical work and evaluation of products.</p>
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<b>Načini ocenjevanja:</b>	<b>Delež/Weight</b>	<b>Assessment:</b>
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, kolokviji in projektno delo)	50,00 %	Continuing (homework, midterm exams, project work)
Končno preverjanje (pisni in ustni izpit)	50,00 %	Final (written and oral exam)
Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL).		Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana).

<p><b>Reference nosilca/Lecturer's references:</b> <b>Sedem del, vezanih na vsebino predmeta:</b> F. Solina, B. Meden. Light fountain - a virtually enhanced stone sculpture. <i>Digital Creativity</i> 28 (2): 89-102, 2017. A. Jaklič, F. Solina, L. Šajn. User interface for a better eye contact in videoconferencing. <i>Displays</i> 46: 25-36, 2017. B. Batagelj, F. Solina. Preservation of an interactive computer-based art installation—a case study. <i>International journal of arts &amp; technology</i> 10 (3): 206-230, 2017. A. Jaklič, M. Erič, I. Mihajlovič, Ž. Stopinšek, F. Solina. Volumetric models from 3D point clouds: The case study of sarcophagi cargo from a 2nd/3rd century AD Roman shipwreck near Sutivan on island Brač, Croatia. <i>Journal of Archaeological Science</i> 62 (October 2015): 143-152, 2015. E. Pavlin, Ž. Elsner, T. Jagodnik, B. Batagelj, F. Solina. From illustrations to an interactive art installation. <i>Journal of Information, Communication and Ethics in Society</i> 13 (2): 130-145, 2015. B. Batagelj, F. Solina. Image-Based Biometrics in Forensic Science. <i>Revija za kriminalistiko in kriminologijo</i> 66 (3): 259-266, 2015. F. Solina. 15 seconds of fame. <i>Leonardo</i> 37 (2): 105-110, 2004. Celotna bibliografija je dostopna na SICRISu: <a href="http://sicris.izum.si/search/rsr.aspx?lang=slv&amp;id=6749">http://sicris.izum.si/search/rsr.aspx?lang=slv&amp;id=6749</a>.</p>
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# INTERDISCIPLINARNI PROJEKTI

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Interdisciplinarni projekti
<b>Course title:</b>	Interdisciplinary projects
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	2. letnik	1. semester, 2. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0088147
<b>Koda učne enote na članici/UL Member course code:</b>	64318

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30		60			90	6

**Nosilec predmeta/Lecturer:** Matevž Pesek

**Vrsta predmeta/Course type:** izbirni predmet/elective course

**Jeziki/Languages:**

Predavanja/Lectures:	Angleščina, Slovenščina
Vaje/Tutorial:	Angleščina, Slovenščina

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

Predmet je namenjen študentkam in študentom študijskih programov ne glede na stopnjo in vsebino njihovega matičnega programa.

**Prerequisites:**

Course is intended for students of study programs regardless of the level of their parent program.

**Vsebina:**

Predmet poteka v soizvajalstvu Fakultete za računalništvo in informatiko (50 %) in Fakultete za elektrotehniko (50 %) ter sodelovanju drugih fakultet - interdisciplinarnost. Pri izvajanju predmeta s strani Fakultete za elektrotehniko sodelujeta Andrej Kos in Matevž Pogačnik.

Interdisciplinarni projekti je predmet, pri katerem študenti v interdisciplinarnih skupinah rešujejo realne izzive iz industrijskega in družbenega okolja inštitucij pod mentorstvom učiteljev in strokovnjakov iz različnih področij. Princip reševanja izzivov temelji na treh konceptih, in sicer analize problematike s pristopom oblikovalskega razmišljanja (angl. Design Thinking), iskanje rešitve s pomočjo vitkega inoviranja (angl. Lean Methodology) in timskega projektne delo po principih agilnega razvoja (angl.

**Content (Syllabus outline):**

The course is co-taught by the Faculty of Computer and Information Science (50%) and the Faculty of Electrical Engineering (50%) and the cooperation of other faculties - interdisciplinarity. Lecturers from Faculty of Electrical Engineering are Andrej Kos and Matevž Pogačnik.

Interdisciplinary Projects is the course where interdisciplinary students solve real industry and community challenges in teams under the mentorship consist of teachers and experts from various backgrounds. The principle of solving complex problems is based on the three main concepts, problem analytics using Design Thinking principle, solution discovery using Lean Methodology and project team work using Agile Development

<p>Agile Development). Multidisciplinarnе skupine 3 do 5 študentov preko tedenskih srečanj z mentorji pripeljejo problem do faze koncepta (angl. Proof of Concept) ali celo do produkta z minimalno funkcionalnostjo (angl. Minimum Viable Product). Cilj predmeta je, da študenti spoznajo temelje podrobne analize problema, dejanskih želja uporabnikov in poiščejo optimalno rešitev problema. Zaključijo se z javno predstavitvijo pred mentorji in uporabniki in z izdelavo predstavitvene spletne strani predlagane rešitve.</p> <p>Teme projektnih nalog predlagajo pred začetkom izvajanja predmeta podjetja, občine, javne ali zasebne organizacije ali raziskovalne institucije. Poleg tega lahko projekte naloge predlagajo tudi študenti sami. Posamezne tematike so porazdeljene po mentorjih oziroma asistentih. Ti prihajajo iz katerekoli fakultete UL. Mentor je oseba, ki pomaga in na koncu poda delno oceno opravljenega dela. Pri tem se ne ocenjuje le izdelka, ampak tudi opravljeno delo in napredek. Druga dva dela ocene sta predstavitvena spletna stran rešitve in javna predstavitev rezultatov projektnega dela.</p> <p>Izvedba projektnе naloge poteka po naslednjih fazah:</p> <ol style="list-style-type: none"> <li>1. oblikovanje skupine študentov,</li> <li>2. podobnejša seznanitev s projektnim problemom,</li> <li>3. konzultacije z izvajalci predmeta, mentorjem iz podjetja oziroma organizacije, fakultete,</li> <li>4. razvojno kreativno skupinsko delo na rešitvi problema,</li> <li>5. predstavitve vmesnih idejnih rešitev problema na fakulteti, v podjetju oziroma organizaciji,</li> <li>6. dejanska realizacija rešitve problema (izdelava prototipa izdelka),</li> <li>7. spletna stran predstavitve rešitve,</li> <li>8. končna predstavitev rešitve projektnе naloge.</li> </ol> <p>Ocena je sestavljena iz naslednjih delov:</p> <ul style="list-style-type: none"> <li>• izvajanje projekta (redna srečanja z mentorjem),</li> <li>• zahtevnost projekta,</li> <li>• rezultat projekta,</li> <li>• predstavitev projekta in</li> <li>• predstavitvena spletna stran projekta.</li> </ul>	<p>techniques. Multidisciplinary teams of 3 to 5 students will meet with mentors weekly and should develop the Proof of Concept or even Minimum Viable Product in one semester. The course goal is that the students learn how to analyze the problem, understand the customer's needs and find the best solution for the problem. The course ends with the public presentation of the results and launch of the project web.</p> <p>Project topics can be submitted by the companies, municipalities, public or private organisations, or research institutions. The topics can be also submitted by the students themselves.</p> <p>Each topic has a mentor and assistants. These can come from any faculty of University of Ljubljana. Mentor is a person who helps and at the end of an assessment proposes the assessment of the work done. Final product as well as the work and the progress done during the process are assessed in addition to the project's web site and the final public presentation of the project results.</p> <p>Project work stages:</p> <ol style="list-style-type: none"> <li>1. formation of student groups,</li> <li>2. detailed comprehension of the project problem,</li> <li>3. consultations with the supervisor from the company or institution and the faculty,</li> <li>4. developmental and creative team work on solving the problem,</li> <li>5. presentation of interim basic solutions to the faculty and the company or institution,</li> <li>6. the actual realization of the solution to the problem (product prototype, Proof of Concept),</li> <li>7. project web site,</li> <li>8. final presentation of the project problem solution.</li> </ol> <p>The rating is made up of the following parts:</p> <ul style="list-style-type: none"> <li>• implementation of the project (regular meetings with the mentor),</li> <li>• the complexity of the project,</li> <li>• project results,</li> <li>• presentation and</li> <li>• project web site.</li> </ul>
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### Temeljna literatura in viri/Readings:

1. K. Ulrich, S. Eppinger, Product Design and Development, McGraw-Hill, 2011
2. S. Berkun, Making Things Happen: Mastering Project Management, O'Reilly Media, Revised edition, 2008
3. E. Ries, The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Viking, 2011
4. C. Heath, D. Heath, Made to Stick: Why Some Ideas Survive and Others Die, Random House, 2007
5. O. Klaff, Pitch Anything: An Innovative Method for Presenting, Persuading, and Winning the Deal, McGraw-Hill, 2011
6. J. Liedtka, T. Ogilvie, The Designing for Growth: Field Book: A Step-by-step Project Guide, 2013

### Cilji in kompetence:

### Objectives and competences:

<p>Cilj predmeta je, da se študentje usposobijo za ustvarjalno in inovativno delo v multidisciplinarnih skupinah za reševanje kompleksnih tehničnih problemov.</p> <p>Kompetence, ki jih bodo pridobili študentje, so kombiniranje in praktična uporaba posameznih že pridobljenih specifičnih strokovnih kompetenc in njihova ustrezna komplementarna uporaba v okviru skupinskega dela po sodobnih metodologijah (angl. Design Thinking, Lean Methodology, Agile Development).</p>	<p>The objective of the course is to train students to work creatively in multidisciplinary teams to solve complex project problems.</p> <p>The competences students will gain are practical application of different already acquired specific professional competencies and their complementary application within group work with the use of the state of the art methodologies (Design Thinking, Lean Methodology, Agile Development).</p>
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#### **Predvideni študijski rezultati:**

<p>Po uspešno opravljenem predmetu naj bi bili študenti zmožni:</p> <ul style="list-style-type: none"> <li>• pojasniti dinamiko dela v multidisciplinarni skupini in principe projektnega dela,</li> <li>• uporabiti različna znanja za učinkovito reševanje projektnih problemov,</li> <li>• uporabiti sodobne metodologije dela za učinkovito reševanje problemov in dela v razvojnih ekipah,</li> <li>• uporabiti pridobljena znanja za komuniciranje v interdisciplinarni skupini,</li> <li>• uporabiti pridobljena znanja za reševanje problemov v interdisciplinarni skupini,</li> <li>• izdelati javne predstavitve idej in predlaganih rešitev,</li> <li>• strukturirano predstaviti rezultate dela na javni spletni strani,</li> <li>• ovrednotiti potencial ideje ali rešitve.</li> </ul>
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#### **Intended learning outcomes:**

<p>After successful completion of the course, students should be able to:</p> <ul style="list-style-type: none"> <li>• explain work dynamics in multidisciplinary teams and principles of project work,</li> <li>• use the acquired knowledge for solving the project problems effectively,</li> <li>• use the new methodologies for solving the project problems effectively and work in R&amp;D teams,</li> <li>• use the acquired knowledge for communication within interdisciplinary team,</li> <li>• use the knowledge for solving the project problems within interdisciplinary team,</li> <li>• prepare public presentations of ideas and proposed solutions,</li> <li>• present the project results on the public web site,</li> <li>• evaluate the potential of an idea or a solution.</li> </ul>
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#### **Metode poučevanja in učenja:**

Študentje pridobijo osnovna znanja s področij digitalizacije, projektnega vodenja, oblikovanja rešitev, identifikacije priložnosti, intelektualne lastnine, timskega dela, vrste inoviranja in metodologije za so-ustvarjanje, predstavitvev.

#### **Learning and teaching methods:**

Students get a basic knowledge of digitalization, project management, solution design, opportunities identification, intellectual property, teamwork, innovation and types of innovation, methodology for co-creation, design-thinking, presentation.

#### **Načini ocenjevanja:**

#### **Delež/Weight**

#### **Assessment:**

<p>Način: ocena projektnega dela. Ocena 5 je negativna, ocene od vključno 6 do 10 so pozitivne.</p>		<p>Type: project work evaluation. Negative grade: 5, positive grades: from 6 to 10.</p>
<p>Predstavitvena spletna stran rezultatov projekta.</p>	<p>20,00 %</p>	<p>Public web site of the project.</p>
<p>Zahtevnost projekta, rezultat dela. •</p>	<p>50,00 %</p>	<p>The complexity of the project, result of the project.</p>
<p>Končna predstavitvev projektne naloge, slikovni/spletni/video predstavitveni material projektne naloge.</p>	<p>30,00 %</p>	<p>Final presentation of the project, image/web/video demo.</p>

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

1. PESEK, Matevž, VUČKO, Žiga, ŠAVLI, Peter, KAVČIČ, Alenka, MAROLT, Matija. Troubadour : a gamified e-learning platform for ear training. *IEEE access*. May 2020, vol. 8, str. 97090-97102, ilustr. ISSN 2169-3536.

2. KAVČIČ, Alenka, PESEK, Matevž, BOHAK, Ciril, MAROLT, Matija. Introducing on-site customers in agile software development projects : an alternative approach to project work in engineering education. *International journal of engineering education*. 2018, no. 2, part a, str. 482-496
3. PESEK, Matevž. *Avtolog.si - vpliv odprtih podatkov na transparentnost trga rabljenih vozil v Sloveniji : predavanje na Odprti podatki javnega sektorja in digitalno gospodarstvo, 19. april 2019, Gospodarska zbornica Slovenije, Ljubljana.*
4. PESEK, Matevž, STRLE, Gregor, GUNA, Jože, STOJMENOVA DUH, Emilija, POGAČNIK, Matevž, MAROLT, Matija. Towards a personalised and context-dependent user experience in multimedia and information systems. V: LUGMAYR, Artur (ur.), et al. *Information systems and management in media and entertainment industries*. Cham: Springer, cop. 2016. Str. 149-172, ilustr. International series on computer entertainment and media technology
5. SEDLAR, Urban, KOS, Andrej, PUSTIŠEK, Matevž, BEŠTER, Janez, POGAČNIK, Matevž, MALI, Luka, STOJMENOVA DUH, Emilija. Tackling the challenges of ICT innovation and talents for industry 4.0. The IPSI BgD transactions on internet research. [Print ed.]. Jan. 2018, vol. 14, no. 1, str. 3-7, ilustr. ISSN 1820-4503. [COBISS.SI-ID 11938388]

# ISKANJE IN EKSTRAKCIJA PODATKOV S SPLETA

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Iskanje in ekstrakcija podatkov s spleta
<b>Course title:</b>	Web information extraction and retrieval
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik	2. semester	obvezni

<b>Univerzitetna koda predmeta/University course code:</b>	0086902
<b>Koda učne enote na članici/UL Member course code:</b>	63551

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	10	20			105	6

<b>Nosilec predmeta/Lecturer:</b>	Marko Bajec
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<b>Vrsta predmeta/Course type:</b>	strokovni izbirni predmet/specialist elective course
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<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

<b>Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:</b>	<b>Prerequisites:</b>

### Vsebina:

#### Vsebina predavanj:

Predmet bo pokrival naslednje vsebine:

Poizvedovanje in iskanje po spletu  
Osnovni koncepti poizvedovanja  
Modeli poizvedovanja  
Odziv ustreznosti  
Mere za ocenjevanje točnosti poizvedb  
Predobdelava besedil in spletnih strani  
Inverzni index in njegova kompresija  
Latentno semantično indeksiranje  
Iskanje po spletu  
Meta iskanje po spletu: kombiniranje različnih načinov rangiranja

Spletno pregledovanje in indeksiranje  
Osnovni algoritem spletnega pajka  
Univerzalni spletni pajek

### Content (Syllabus outline):

#### Content of the course:

This course will cover the following topics:

Information Retrieval and Web Search  
Basic Concepts of Information Retrieval  
Information Retrieval Models  
Relevance Feedback  
Evaluation Measures  
Text and Web Page Pre-Processing  
Inverted Index and Its Compression  
Latent Semantic Indexing  
Web Search  
Meta-Search: Combining Multiple Rankings

Web Crawling  
A Basic Crawler Algorithm  
Implementation Issues  
Universal Crawlers

<p>Fokusirani spletni pajki Domenski spletni pajki</p> <p>Ekstrakcija strukturiranih podatkov Indukcija ovojnice Generiranje ovojnice na osnovi primera Samodejna izdelava ovojnice Ujemanje glede na obliko besede ali drevesne strukture Večkratna poravnava Gradnja DOM dreves Ekstrakcija glede na stran s seznamom ali več strani</p> <p>Integracija podatkov Ujemanje glede na podatkovno shemo Ujemanje glede na domeno in primere Združevanje podobnosti Ujemanje 1:m Integracija iskalnikov po spletnih straneh Izgradnja globalnega iskalnika po spletnih straneh</p> <p>Rudarjenje mnenja in analiza sentimenta Klasifikacija dokumentov po sentimentu Ugotavljanje subjektivnosti v stavkih in klasifikacija sentimenta Slovarji besed in fraz, nosilcev mnenja Aspektno orientirano rudarjenje mnenja Iskanje in ekstrakcija mnenja</p>	<p>Focused Crawlers Topical Crawlers</p> <p>Structured Data Extraction Wrapper Induction Instance-Based Wrapper Learning Automatic Wrapper Generation String Matching and Tree Matching Multiple Alignment Building DOM Trees Extraction Based on a Single List Page or Multiple Pages</p> <p>Information Integration Schema-Level Matching Domain and Instance-Level Matching Combining Similarities 1:m Match Integration of Web Query Interfaces Constructing a Unified Global Query Interface</p> <p>Opinion Mining and Sentiment Analysis Document Sentiment Classification Sentence Subjectivity and Sentiment Classification Opinion Lexicon Expansion Aspect-Based Opinion Mining Opinion Search and Retrieval</p>
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### Temeljna literatura in viri/Readings:

Bing Liu, Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data (Data-Centric Systems and Applications, Springer, August 2013)  
Ricardo Baeza-Yates, Berthier Ribeiro-Neto: Modern Information Retrieval: The Concepts and Technology behind Search, 2nd Edition, ACM Press Books, 2010

### Cilji in kompetence:

Cilj predmeta je študente naučiti, kako sprogramirati iskanje po spletu (po indeksiranem in neindeksiranem delu spleta) ter kako razviti programe za ekstrakcijo strukturiranih podatkov s statičnih in dinamičnih spletnih strani. Študentje bodo spoznali osnovne koncepte spletnega iskanja in ekstrakcije podatkov s spleta ter se naučili potrebnih tehnik, ki so za to potrebne. Po uspešno opravljeni predmetu bodo sposobni samostojnega razvoja aplikacij, ki avtomatizirajo spletno iskanje in ekstrahirajo podatke s spletnih strani, vključno z ekstrakcijo podatkov iz on-line socialnih medijev.

### Objectives and competences:

The main objective of this course is to teach students about how to develop programs for web search (including surface web and deep web search) and for extraction of structural data from both, static and dynamic web pages. Beside basic concepts of the web search and retrieval, students will learn about relevant techniques and approaches. After the course, if successful, students will be able to develop programs for automatic web search and structured data extraction from web pages (including search and extraction from on-line social media).

### Predvideni študijski rezultati:

Po uspešno zaključenem modulu bodo študenti zmožni:  
Povzeti najpomembnejše pristope in tehnike s področja iskanja in ekstrakcije podatkov s spleta

### Intended learning outcomes:

After successful completion of the module, students will be able to:  
summarize the most important approaches and techniques for searching and extracting data from the web



<p>presoditi, kateri pristopi s področja iskanja in ekstrakcije podatkov s spleta so najbolj primerni za reševanje posameznih problemov,          razviti aplikacije za zajem in analizo podatkov s spleta,          konstruirati lastne algoritme za ekstrakcijo podatkov s spleta,          pojasniti delovanje in časovno kompleksnost algoritmov iskanja po spletu,          uporabiti in integrirati različne odprto-kodne rešitve s področja iskanja in ekstrakcije podatkov s spleta</p>	<p>to select approaches and techniques that are most suitable for individual problems in web information extraction and retrieval.          to develop applications for data acquisition and analysis,          to construct new algorithms for web data search and extraction,          to explain behavior and time complexity of specific web search algorithms,          to integrate and employ different open-source solutions from the field.</p>
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<b>Metode poučevanja in učenja:</b>	<b>Learning and teaching methods:</b>
Predavanja, računske vaje z ustnimi nastopi, projektni način dela pri domačih nalogah in seminarjih.	Lectures, seminars, homeworks, oral presentations, project work.

<b>Načini ocenjevanja:</b>	<b>Delež/Weight</b>	<b>Assessment:</b>
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, kolokviji in projektno delo)	50,00 %	Continuing (homework, midterm exams, project work)
Končno preverjanje (pisni in ustni izpit)	50,00 %	Final (written and oral exam)
Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL).		Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana).

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

ŠUBELJ, Lovro, BAJEC, Marko. Group detection in complex networks : an algorithm and comparison of the state of the art. *Physica. A*, 2014

ŽITNIK, Slavko, ŠUBELJ, Lovro, LAVBIČ, Dejan, VASILECAS, Olegas, BAJEC, Marko. General context-aware data matching and merging framework. *Informatica*, 2013

LAVBIČ, Dejan, BAJEC, Marko. Employing semantic web technologies in financial instruments trading : Dejan Lavbič and Marko Bajec. *International journal of new computer architectures and their applications*, 2012

ŠUBELJ, Lovro, FURLAN, Štefan, BAJEC, Marko. An expert system for detecting automobile insurance fraud using social network analysis. *Expert systems with applications*, 2011

ŠUBELJ, Lovro, JELENC, David, ZUPANČIČ, Eva, LAVBIČ, Dejan, TRČEK, Denis, KRISPER, Marjan, BAJEC, Marko. Merging data sources based on semantics, contexts and trust. *The IPSI BgD transactions on internet research*, 2011

Celotna bibliografija je dostopna na SICRISu:  
<http://sicris.izum.si/search/rsr.aspx?lang=slv&id=9270>.

# KOMUNIKACIJA ČLOVEK RAČUNALNIK

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Komunikacija človek računalnik
<b>Course title:</b>	Human-Computer Interaction
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	2. letnik	1. semester	izbirni
Računalništvo in informatika, druga stopnja, magistrski	Računalništvo in informatika (smer)		1. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0082828
<b>Koda učne enote na članici/UL Member course code:</b>	63550

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			105	6

**Nosilec predmeta/Lecturer:** Franc Jager

**Vrsta predmeta/Course type:** strokovni izbirni predmet/specialist elective course

**Jeziki/Languages:**

Predavanja/Lectures:	Angleščina, Slovenščina
Vaje/Tutorial:	Angleščina, Slovenščina

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

**Prerequisites:**

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**Vsebina:**

**Predavanja:**

1. Sposobnosti človeka (spomin in učenje, zaznavanje, poznavanje).
2. Vrste komunikacije človek računalnik (KČR) (vhodni modeli, izhodni modeli).
3. Pravila načrtovanja za KČR (principi, navodila).
4. Vzorec model-pogled-nadzornik.
5. Glasovni vmesniki.
6. Komunikacija možgani računalnik in elektroencefalogram.
7. Načrtovanje neinvazivnega vmesnika možgani računalnik (VMR).
8. Mednarodna referenčna podatkovna baza za načrtovanje VMR (EEGMMI DS - EEG Motor Movement/Imagery DataSet).
9. Izločanje časovno prostorskih značilk.

**Content (Syllabus outline):**

**Lectures:**

1. Human capabilities (memory and learning, perception, cognition).
2. Human-Computer Interaction (HCI) types (input models, output models).
3. Design rules for HCI (principles, guidelines).
4. Model-view-controller pattern.
5. Voice interfaces.
6. Brain-computer interaction and electroencephalogram.
7. Design of non-invasive Brain-Computer Interface (BCI).
8. International reference database to design BCI (EEGMMI DS - EEG Motor Movement/Imagery DataSet).
9. Extraction of spatio-temporal features.

<p>10. Spektralna analiza (časovno frekvenčne predstavitve, parametrično modeliranje).</p> <p>11. Klasifikacija časovno prostorskih značilik.</p> <p>12. VMR s strojnim učenjem.</p> <p>13. VMR aplikacije (pomikanje kurzorja, črkovanje, komunikacija za hendikepirane).</p> <p><b>Vaje:</b></p> <p>1. Utrjevanje pri predavanjih obravnavane snovi s primeri.</p> <p>2. Predstavitev tipičnih aspektov načrtovanja aplikacij KČR.</p> <p><b>Domače naloge:</b></p> <p>Študentje izdelajo tri projekte oziroma aplikacije in vsakega od njih zagovarjajo učitelju. Te projekte lahko študentje opravljajo tudi pri vajah ob pomoči učitelja.</p>	<p>10. Spectral analysis (time-frequency representations, parametric modeling).</p> <p>11. Classification of spatio-temporal features.</p> <p>12.</p> <p>13. BCI with machine learning.</p> <p>14. BCI applications (cursor moving, spelling, communication for the disabled).</p> <p><b>Practical work:</b></p> <p>1. Strengthening of topics from lectures with examples.</p> <p>2. Representing typical aspects of design of HCI applications.</p> <p><b>Homeworks:</b></p> <p>Students derive three projects or applications and each of them has to be defended to teacher. These projects can be derived at laboratory work under teacher supervision.</p>
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### Temeljna literatura in viri/Readings:

<ol style="list-style-type: none"> <li>1. Norman K L: <i>Cyberpsychology: An Introduction to Human-Computer Interaction</i>, 2008, Cambridge.</li> <li>2. Norman D A: <i>The Design of Everyday Things</i>, 2002, Basic Books.</li> <li>3. Erickson, McDonald: <i>HCI Remixed; Essay on Work that Have Influenced the HCI Community</i>, 2008, The MIT Press.</li> <li>4. Cooper, Reimann, Cronin: <i>About Face 3; The Essentials of Interface Design</i>, 2007, Wiley Publishing, Inc.</li> <li>5. Benyon, <i>Designing Interactive Systems; A comprehensive guide to HCI and interaction design</i>, 2010, Addison Wesley.</li> <li>6. Sornmo, Laguna: <i>Biological Signal Processing in Cardiac and Neurological Applications</i>, 2005, Elsevier, Inc.</li> <li>7. Sanei, Chambers: <i>EEG Signal Processing</i>, 2007, Wiley.</li> <li>8. Stone, Jarett, Woodroffe, Minocha: <i>User Interface Design and Evaluation</i> 2005, Morgan Kaufmann.</li> <li>9. Selected articles from journals (Schalk, McFarland, Hinterberger, Birbaumer, Wolpaw: <i>BCI2000: A General-Purpose Brain-Computer Interface (BCI) System</i>, IEEE TBME, Vol. 51, No. 6, pp. 1034-1043, June 2004.; Wolpaw, McFarland: <i>Control of a two-dimensional movement signal by a noninvasive brain-computer interface in humans</i>, PNAS, Vol. 101, No 51, pp. 17849-17854, Dec. 2004.)</li> </ol>
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### Cilji in kompetence:

<p>Cilj predmeta je podati splošni vpogled v področje interakcije med človekom in računalnikom. Študentje naj razumejo širok razpon konceptov pri komunikaciji med človekom in računalnikom ter naj so sposobni uporabiti principe, navodila in tehnike načrtovanja za: načrtovanje interaktivnih aplikacij in uporabniških vmesnikov, s posebnim poudarkom na komunikaciji možgani računalnik, za njihovo analizo in evaluacijo.</p>	<p><b>Objectives and competences:</b></p> <p>The goal of the subject is to give common view into the field of interaction between human and computer. Students should understand wide range of concepts in communication between human and computer, and should be able to use principles, guidelines and designing techniques to design interactive applications and user interfaces, with special emphasis on brain computer interaction, and to analyse and evaluate them.</p>
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### Predvideni študijski rezultati:

<p>Po uspešnem zaključku tega predmeta naj bi bili študenti zmožni:</p> <ul style="list-style-type: none"> <li>- poznati osnovne koncepte komunikacije človek računalnik,</li> <li>- poznati koncepte interakcije, principe, navodila in postopke načrtovanja interaktivnih aplikacij ter uporabniških vmesnikov,</li> <li>- poznati postopke vrednotenja vmesnikov,</li> </ul>	<p><b>Intended learning outcomes:</b></p> <p>After the completion of the course, students should be able to:</p> <ul style="list-style-type: none"> <li>- know the basic concepts of human-computer interaction,</li> <li>- know the concepts of interactions, principles, guidelines and procedures of designing interactive applications and user interfaces,</li> <li>- know the procedures for evaluation the interfaces,</li> </ul>
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<ul style="list-style-type: none"> <li>- prepoznati slabo in dobro načrtane uporabniške vmesnike in interaktivne aplikacije,</li> <li>- načrtati uporabniške vmesnike in interaktivne aplikacije,</li> <li>- vrednotiti uporabniške vmesnike in interaktivne aplikacije,</li> <li>- analizirati in avtomatsko klasificirati možganske valove,</li> <li>- načrtati vmesnik možgani računalnik.</li> </ul>	<ul style="list-style-type: none"> <li>- recognize badly and well designed user interfaces and interactive applications,</li> <li>- design user interfaces and interactive applications,</li> <li>- evaluate user interfaces and interactive applications,</li> <li>- analyze and automatically classify brain waves,</li> <li>- design human-computer interface.</li> </ul>
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#### Metode poučevanja in učenja:

Predavanja, vaje z ustnimi zagovori, domače naloge. Poseben poudarek je na sprotnem študiju in na samostojnem delu pri vajah in domačih nalogah.

#### Learning and teaching methods:

Lectures, practical work with oral defences, homeworks. Special emphasis on continuous and prompt study, and independent practical work and homeworks.

#### Načini ocenjevanja:

#### Delež/Weight

#### Assessment:

Način (pisni izpit, ustno izpraševanje, naloge, projekti):		Type (written exam, oral examination, coursework, projects):
Sprotno (domače naloge, kolokviji in projektno delo)	50,00 %	Continuing (homeworks, midterm exams, project work)
Končno (pisni in ustni izpit)	50,00 %	Final: (written and oral exam)
Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL).		Grading: 6-10 pass, 5 fail (According to the rules of University of Ljubljana).

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

1. AMON, Miha, JAGER, Franc. Electrocardiogram ST-segment morphology delineation method using orthogonal transformations. *PloS one*, Vol. 11, no. 2, str. 1-18, 2016.  
<http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0148814>, doi: 10.1371/journal.pone.0148814.
2. JAGER, Franc. Two chapters in *Advanced Methods and Tools for ECG Data Analysis*, Clifford G, Azuaje F, McSharry PE (editors), Artech House, Inc., 2006.
3. JAGER, Franc, TADDEI, Alessandro, MOODY, George B., EMDIN, Michele, ANTOLIČ, Gorazd, DORN, Roman, SMRDEL, Aleš, MARCHESI, Carlo, MARK, Roger G. Long-term ST database: a reference for the development and evaluation of automated ischaemia detectors and for the study of the dynamics of myocardial ischaemia. *Med. biol. eng. Comput.*, Vol. 41, str. 172-182, 2003.
4. DORN, Roman, JAGER, Franc. Semia: semi-automatic interactive graphic editing tool to annotate ambulatory ECG records. *Comput. methods programs biomed.* Vol. 75, no. 3, str. 235-249, 2004.
5. JAGER, Franc, MOODY, George B., MARK, Roger G. Protocol to assess robustness of ST analysers : a case study. *Physiological measurement* Vol. 25, no. 3, str. 629-643, 2004.

Celotna bibliografija je dostopna na SICRISu:  
<http://sicris.izum.si/search/rsr.aspx?lang=slv&id=4815>.

# KRIPTOGRAFIJA IN RAČUNALNIŠKA VARNOST

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Kriptografija in računalniška varnost
<b>Course title:</b>	Cryptography and Computer Security
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	2. letnik	1. semester, 2. semester	izbirni
Računalništvo in informatika, druga stopnja, magistrski	Računalništvo in informatika (smer)		1. semester, 2. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0082727
<b>Koda učne enote na članici/UL Member course code:</b>	63528

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	10	20			105	6

**Nosilec predmeta/Lecturer:** Aleksandar Jurišić

**Vrsta predmeta/Course type:**

**Jeziki/Languages:**

Predavanja/Lectures:	
Vaje/Tutorial:	

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

**Prerequisites:**

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### Vsebina:

Informacijska/*računalniška varnost* opisuje vse preventivne postopke in sredstva s katerimi zagotovimo dostop do informacijskih sistemov in njihove vsebine ter preprečimo njihovo nepooblaščno uporabo. Med preventivnimi ukrepi nudi *kriptografija* največjo varnost oziroma zaščito glede na svojo prilagodljivost digitalnim medijem in s tem predstavlja osnovo informacijske družbe (cilji: zasebnost, celovitost podatkov, digitalno overjanje/podpisovanje, digitalni denar, in drugi kriptografski protokoli; obseg: matematika, računalništvo, elektrotehnika, finance, poli-tika, obramba, itd.).  
Vsebina bo med drugim zajemala naslednje teme:

- **Simetrična kriptografija**
  - Klasični tajnopisi in zgodovina kriptografije

### Content (Syllabus outline):

Information/computer security describes means to control access to information systems and their contents in order to prevent unauthorized use. Cryptography provides maximum security while at the same time preserving the flexibility of digital media. It forms the foundation of an information society, enabling privacy, data integrity, digital authentication/signatures, digital cash, and other goals. It incorporates mathematics, computer science, electrical engineering, finance, policy, defence, etc. The course will cover the following topics:

- **Symmetric cryptography**
  - Classical ciphers and history of cryptography
  - Kerckhoff principle and various attacks on cryptosystems
  - Shannon theory of information and entropy

<ul style="list-style-type: none"> <li>– Kerckhoffov princip in stopnje napadov na kriptosisteme.</li> <li>– Shannonova teorija informacij in entropija (popolna, računska in dokazljiva varnost)</li> <li>– Bločne šifre (DES/IDEA, AES in finalisti, linearna in diferenčna analiza)</li> <li>– Tokovne šifre/PRNG (RC4, LFSR in Berlekamp-Masseyjev algoritem,...),</li> <li>– Kriptoanaliza in statistične metode</li> <li>– Zgoševalne funkcije (MD/SHA, HMAC, ...) in kode za avtentikacijo (MAC), napadi s paradoksom rojstnih dni, novi napadi,...</li> <li>• <b>Kriptografija javnih ključev</b> oziroma asimetrična kriptografija <ul style="list-style-type: none"> <li>– Kriptosistemi z javnimi ključi, enosmerne funkcije in z njimi povezani problemi iz teorije števil (testiranje praštevilskega, faktorizacija števil, diskretni logaritem)</li> <li>– Digitalni podpisi (RSA, DSA, enkratni, slepi, skupinski, itd.)</li> <li>– Protokoli za dogovor o ključu (Diffie-Hellman, ElGamal, Kerberos, STS)</li> <li>– Seme za identifikacijo oseb in naprav (izziv/odgovor, ...)</li> <li>– Drugi protokoli (grb/cifra po telefonu, mentalni poker, seme za deljenje skrivnosti, kode za overjanje, časovni žigi, vizualna kriptografija, dokaz brez razkritja znanja)</li> <li>– Kvantna kriptografija</li> </ul> </li> <li>• <b>Računalniška varnost</b> <ul style="list-style-type: none"> <li>– Varnost programov (hrošči, virusi, zlonamerna koda)</li> <li>– Varnost podatkovnih baz (anonimizacija)</li> <li>– Varnost operacijskih sistemov (MS Win, Unix/Linux, liveCD)</li> <li>– Varnost mrežnih komunikacij (požarni zidovi, VPN, IPsec, SSL)</li> <li>– zasebnost v računalništvu (žetoni/pametne kartice, RFID kartice)</li> <li>– Upravljanje s ključi (certifikati, CA, PKI, X.509)</li> <li>– Učinkovite in varne implementacije kriptosistemov (napadi s stranskim kanalom in obramba pred njimi)</li> <li>– Upravljanje varnosti v praksi (varnostne politike, nadzor)</li> <li>– Patenti in standardi (ISO, IEEE, IETF)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>(perfect, computational and provable security)</li> <li>– Block ciphers (DES/IDEA, AES and finalists, linear and differential analysis)</li> <li>– Stream ciphers/PRNG (RC4, LFSR and Berlekamp-Massey algorithm, ...),</li> <li>– Cryptanalysis and statistical methods <ul style="list-style-type: none"> <li>• Hash functions (MD/SHA, HMAC, ...) and authentication codes (MAC), birthday paradox attacks, new attacks, ...</li> </ul> </li> <li>• <b>Public-key cryptography</b> (asymmetric cryptography) <ul style="list-style-type: none"> <li>– Perfect security (computational, unconditional and provable security)</li> <li>– Public-key cryptosystems, one-way functions and related problems in number theory (primality testing, integer factorization, discrete logarithm problem)</li> <li>– Digital signatures (RSA, DSA, one-time, blind, group, etc.)</li> <li>– Key agreement protocols (Diffie-Hellman, ElGamal, Kerberos, STS)</li> <li>– Identification schemes for humans and devices (challenge/response, ...)</li> <li>– Other protocols (head/tail over the phone, mental poker, secret sharing schemes, authentication schemes, timestamps, visual cryptography, zero-knowledge proofs)</li> <li>– Quantum cryptography</li> </ul> </li> <li>• <b>Computer and information security</b> <ul style="list-style-type: none"> <li>– Security of programs (bugs, viruses, malicious code)</li> <li>– Security of databases (anonymization)</li> <li>– Security of OS (MS Win, Unix/Linux, liveCD)</li> <li>– Security of network communication (firewalls, VPN, IPsec, SSL)</li> <li>– Privacy in CS (tokens/smart cards, RFID cards)</li> <li>– Key management (certificates, CA, PKI, X.509)</li> <li>– Efficient and secure implementations of cryptosystems (side channel attacks and defenses against them)</li> <li>– Real time security management (security policy, monitoring)</li> <li>– Patents and standards (ISO, IEEE, IETF)</li> </ul> </li> </ul>
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### Temeljna literatura in viri/Readings:

D. Stinson, Cryptography: Theory and Practice, 3rd Ed., Chapman and Hall/CRC, 2006.  
A. Menezes, P. van Oorschot in S. Vanstone, Handbook of Applied Cryptography, CRC Press, 1997 (peti ponatis 2001).  
C.P. Pfleeger in S.L. Pfleeger, Security in Computing, 4th Ed., Prentice Hall, 2006.

### Cilji in kompetence:

Študent se spozna z osnovami kriptografije in računalniške varnosti.

### Objectives and competences:

Introduction to cryptography and computer security.

**Predvideni študijski rezultati:**

Po uspešnem zaključku tega predmeta bo študent:

- razumel osnovne probleme računalniške varnosti in v podrobnosti delovanje najbolj znanih kriptosistemov sistemov ter bo sposoben povezovati obe področji, predlagati rešitve in implementirati oziroma vzdrževati kriptografske sisteme,
- znal uporabiti oz. bil sposoben opredeliti (definirati) problem, pravilno ovrednotiti s strokovnega vidika (tako s kriptografskega kot varnostnega) ter predlagati/ovrednotiti učinkovito rešitev,
- razumel uglasenosti med teorijo in njeno rabo na konkretnih primerih računalniške varnosti.

Predmet je osnova za številne predmete, ki preučujejo računalniške sisteme in mreže, (tele)komunikacijo, digitalno forenziko, elektronsko in mobilno poslovanje,... Med pridobljene spretnosti štejejo teoretične osnove za inženirsko reševanje različnih praktičnih problemov, ki se pojavljajo v problemih iz računalniške varnosti in kriptografije.

**Intended learning outcomes:**

After successful completion of this course the students will be able to:

- master the basic problems of computer security and the detailed structure of the most famous cryptosystems and will be capable to connect these areas, propose specific solutions and implement or maintain cryptosystems,
- apply, i.e., be able to define the problem, correctly evaluate it from a professional point of view (both cryptographic and security) and to propose/evaluate an effective solution,
- understand the connection between theory and practice applied to specific examples of computer security.

This course is a foundation for several courses that study computer systems and networks, telecommunications, digital forensics, electronic and mobile commerce, etc. Students will gain a theoretical foundation for a variety of practical problems that are encountered in the field of computer security and cryptography.

**Metode poučevanja in učenja:**

Predavanja, vaje, domače naloge, seminarji, konzultacije, laboratorijsko delo. Poseben poudarek je na sprotnem študiju in na skupinskem delu pri vajah in seminarjih. Ogledali si bomo tudi kakšen video.

**Learning and teaching methods:**

Lectures, tutorials, assignments, projects, office hours, lab work. There will be a special emphasis on real-time studies and team work (tutorials and seminars). We will occasionally watch video material related to the course.

**Načini ocenjevanja:****Delež/Weight****Assessment:**

Način (pisni izpit, ustno izpraševanje, naloge, projekt):	Delež/Weight	Assessment:
Sprotno preverjanje (domače naloge, kolokviji in projektno delo)	50,00 %	Continuing (homework, midterm exams, project work)
Končno preverjanje (pisni in ustni izpit)	50,00 %	Final (written and oral exams)
Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL).		Grading: 6-10 pass, 5 fail (according to the rules of the University of Ljubljana).

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

1. A. Jurišić and J. Vidali, [Restrictions on classical distance-regular graphs](#), *Journal of Algebraic Combinatorics* **46** (2017), 571–588.
  2. A. Jurišić and J. Vidali, [Extremal 1-codes in distance-regular graphs of diameter 3](#), *Designs Codes and Cryptography* **65** (2012), 29–47.
  3. A. Jurišić and J. Koolen, [Classification of the family AT4\(qs,q,q\)](#) of antipodal tight graphs, *J. Combin. Theory (A)* **118** (2011), 842–852.
  4. A. Jurišić, P. Terwilliger and A. Žitnik, [The Q-polynomial idempotents of a distance-regular graph](#), *J. Combin. Theory (B)* **100** (2010), 683–690.
  5. A. Jurišić, A. Munemasa and J. Tagami, [On graphs with complete multipartite mu-graphs](#), *Discrete Mathematics* **310** (2010), 1812–1819.
- Celotna bibliografija je dostopna na SICRISu: <http://sicris.izum.si/search/rsr.aspx?lang=slv&cid=6518>.

# MAGISTRSKO DELO

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Magistrsko delo
<b>Course title:</b>	Master thesis
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	2. letnik	1. semester, 2. semester	obvezni

<b>Univerzitetna koda predmeta/University course code:</b>	0153664
<b>Koda učne enote na članici/UL Member course code:</b>	6305

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
					720	24

**Nosilec predmeta/Lecturer:**

**Vrsta predmeta/Course type:**

<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

<b>Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:</b>	<b>Prerequisites:</b>
Opravljanje študijskih obveznosti je opredeljeno v Študijskih pravilih FRI.	As specified by internal acts of the University of Ljubljana and Faculty of Computer and Information Science.

<b>Vsebina:</b>	<b>Content (Syllabus outline):</b>
Predmet je namenjen pripravi in izdelavi magistrskega dela.	The course is intended for preparing and completing the master thesis.

<b>Temeljna literatura in viri/Readings:</b>
<ol style="list-style-type: none"><li>Justin Zobel, Writing for Computer Science, second edition, Springer, 2004.</li><li>D. Evans and P. Gruba, <a href="#">How to Write a Better Thesis</a>, Second edition, Melbourne University Press, Melbourne, 2002.</li><li>Herman T.: Ethics and Technology: Controversies, Questions, and Strategies for Ethical Computing, Wiley; 3 edition, 2010.</li></ol>

<b>Cilji in kompetence:</b>	<b>Objectives and competences:</b>
Cilj predmeta je spoznati širše področje in relevantno literaturo s področja teme magistrskega dela, razumeti zastavljene probleme in poiskati smiselne teoretične	The goal of the course is to obtain insight into and an overview of the wide field of the topic of the master thesis, to get acquainted with the relevant literature, understand the addressed problems and find suitable



<p>ter ustrezne programske rešitve, napisati magistrsko delo in izdelati programsko podporo.</p> <p>Splošne kompetence:</p> <ul style="list-style-type: none"> <li>- Sposobnost kritičnega, analitičnega in sintetičnega razmišljanja.</li> <li>- Sposobnost strokovne komunikacije v slovenskem in tujem jeziku.</li> <li>- Sposobnost aplikacije pridobljenega znanja pri reševanju problemov s področja računalništva in informatike; sposobnost nadgradnje znanja.</li> <li>- Obvladovanje raziskovalnih metod na področju računalništva in informatike.</li> <li>- Razvoj strokovne odgovornosti in etike</li> </ul>	<p>theoretical and programming solutions, and finally to write the thesis and produce the necessary computer support.</p> <p>General competences:</p> <ul style="list-style-type: none"> <li>- Ability of critical, analytical and synthetic thinking.</li> <li>- The ability of professional communication in the Slovenian language as well as a foreign language.</li> <li>- The ability to apply acquired knowledge for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge.</li> <li>- Proficiency in research methods in the field of computer science</li> <li>- Development of professional responsibility and ethics.</li> </ul>
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<p><b>Predvideni študijski rezultati:</b></p> <p><b>Znanje in razumevanje:</b> Študenti spoznava samostojno raziskovalno delo, spoznava literaturo in obstoječe rešitve in iščejo nove prijeme za reševanje zastavljenih problemov.</p> <p><b>Uporaba:</b> Pridobivanje znanja in izkušenj pri iskanju lastnih rešitev teoretičnih in praktičnih problemov, pri pisanju strokovnih del in predstavitvi lastnih rezultatov.</p> <p><b>Refleksija:</b> Razumevanje primernosti izbranih pristopov s področja računalništva in informatike za reševanje praktičnih primerov v poslovnih okoljih.</p> <p><b>Prenosljive spretnosti - niso vezane le na en predmet:</b> Reševanje kompleksnih problemov, razvoj kompleksnih sistemov, predstavitev rešitev v obliki zaključenega pisnega izdelka in ustne predstavitve.</p>	<p><b>Intended learning outcomes:</b></p> <p><b>Knowledge and understanding:</b> Students meet with the challenge of individual research work, are acquainted to the literature and the existing solutions and find new approaches to the posed problems.</p> <p><b>Application:</b> Knowledge and experience in individually solving theoretical and practical problems, writing technical texts and presenting obtained results and solutions.</p> <p><b>Reflection:</b> Understanding the advantages of the chosen approaches in computer and information science in solving specific practical tasks.</p> <p><b>Transferable skills:</b> Solving complex problems, designing complex systems, presenting problems and their solutions in the form of a written and oral presentation.</p>
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<p><b>Metode poučevanja in učenja:</b></p> <p>Seminarsko in samostojno delo pod vodstvom mentorja.</p>	<p><b>Learning and teaching methods:</b></p> <p>Seminar work and individual work under the advisor's guidance.</p>
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Načini ocenjevanja:	Delež/Weight	Assessment:
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (vmesna pisna in ustna poročila in predstavitve)	30,00 %	Continuing (intermediate written and oral reports)
Končno preverjanje (ocena magistrskega dela in zagovora)	70,00 %	Final (grading the written thesis and the presentation)
Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana)

<p><b>Reference nosilca/Lecturer's references:</b></p> <ol style="list-style-type: none"> <li>1. OCEPEK, Uroš, BOSNIĆ, Zoran, NANČOVSKA ŠERBEC, Irena, RUGELJ, Jože. Exploring the relation between learning style models and preferred multimedia types. Computers &amp; Education, ISSN 0360- 1315., Nov. 2013, vol. 69, str. 343- 355.</li> <li>2. BOSNIĆ, Zoran, KONONENKO, Igor. Estimation of individual prediction reliability using the local sensitivity analysis. Appl. intell. (Boston). [Print ed.], Dec. 2008, vol. 29, no. 3, p. 187- 203, ilustr.</li> <li>3. BOSNIĆ, Zoran, KONONENKO, Igor. Comparison of approaches for estimating reliability of individual regression predictions. Data knowl. eng.. [Print ed.], Dec. 2008, vol. 67, no. 3, p. 504- 516</li> </ol>
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4. ŠTRUMBELJ, Erik, BOSNIĆ, Zoran, KONONENKO, Igor, ZAKOTNIK, Branko, GRAŠIĆ- KUHAR, Cvetka. Explanation and reliability of prediction models: the case of breast cancer recurrence. Knowledge and information systems, 2010, vol. 24, no. 2, p. 305- 324
5. BOSNIĆ, Zoran, KONONENKO, Igor. Automatic selection of reliability estimates for individual regression predictions. Knowl. eng. rev., 2010, vol. 25, no. 1, p. 27- 47,

# MODUL FE - 2 PREDMETA (ŠTUDENT IZBERE MODUL FE A ALI MODUL FE B)

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b> <b>Course title:</b> <b>Članica nosilka/UL</b> <b>Member:</b>	Modul FE - 2 predmeta (študent izbere Modul FE A ali Modul FE B)
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Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	2. letnik	1. semester	izbirni

Univerzitetna koda predmeta/University course code:	0165305
Koda učne enote na članici/UL Member course code:	6403

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
90		60			210	12

Nosilec predmeta/Lecturer:

Vrsta predmeta/Course type:

Jeziki/Languages:

Predavanja/Lectures:	<input type="text"/>
Vaje/Tutorial:	<input type="text"/>

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

Vsebina:

Content (Syllabus outline):

Temeljna literatura in viri/Readings:

Cilji in kompetence:

Objectives and competences:

Predvideni študijski rezultati:

Intended learning outcomes:

Metode poučevanja in učenja:

Learning and teaching methods:

**Načini ocenjevanja:**

**Delež/Weight Assessment:**

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

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# MODUL FRI - 2 PREDMETA (ŠTUDENT IZBERE MODUL FRI A ALI MODUL FRI B)

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

**Predmet:** Modul FRI - 2 predmeta (študent izbere Modul FRI A ali Modul FRI B)  
**Course title:**  
**Članica nosilka/UL**  
**Member:**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	2. letnik	1. semester, 2. semester	izbirni

**Univerzitetna koda predmeta/University course code:** 0165307

**Koda učne enote na članici/UL Member course code:** 6303

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
90		60			210	12

**Nosilec predmeta/Lecturer:**

**Vrsta predmeta/Course type:**

**Jeziki/Languages:**

Predavanja/Lectures:

Vaje/Tutorial:

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

**Prerequisites:**

**Vsebina:**

**Content (Syllabus outline):**

**Temeljna literatura in viri/Readings:**

**Cilji in kompetence:**

**Objectives and competences:**

**Predvideni študijski rezultati:**

**Intended learning outcomes:**

**Metode poučevanja in učenja:**

**Learning and teaching methods:**

**Načini ocenjevanja:**

**Delež/Weight Assessment:**

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

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# MULTIMEDIJSKI TERMINALI

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Multimedijski terminali
<b>Course title:</b>	Multimedia Terminals
<b>Članica nosilka/UL Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	2. letnik	1. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0090463
<b>Koda učne enote na članici/UL Member course code:</b>	64M28

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			105	6

**Nosilec predmeta/Lecturer:** Matej Zajc

**Vrsta predmeta/Course type:** strokovni izbirni predmet/specialist elective course

<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

<b>Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:</b>	<b>Prerequisites:</b>
Vpis v letnik.	Regular enrolment.

### Vsebina:

1. Multimedijski terminali: vrste terminalov v multimediji, osnovne strojne in programske značilnosti, zgradba multimedijskih terminalov.  
2. Lastnosti multimedijske terminalske opreme: funkcionalnost, zmogljivost, povezljivost, kompatibilnost, modularnost, standardi.  
3. Zgradba terminalov, vhodno/izhodne enote: tehnologije prikazovalnikov, senzorji, tipkovnice, vmesniki, konvergenca terminalov, sistemska integracija.  
4. Digitalni sistemi: osnovni principi delovanja digitalnih sistemov, CPE, pomnilnik, vhodno-izhodne enote.  
5. Tehnološke zahteve različnih uporabniških vmesnikov: računsko moč, ločljivost prikazovalnikov, energetska varčnost, skladnost s standardi.  
Načrtovanje strojne in programske opreme.

### Content (Syllabus outline):

1. Multimedia terminals: overview of multimedia terminals, overview of hardware and software, architectures of multimedia terminals.  
2. Attributes of multimedia terminal equipment: functionality, performance, connectivity, compatibility, modularity, relevant standards.  
3. Architecture of terminals, input/output units: display technologies, sensors, keyboards, interfaces, convergence, system integration.  
4. Digital systems: basic principles of digital systems, CPU, memory, input-output units.  
5. User interfaces' technological requirements: computing power, display resolution, energy efficiency, standard compatibility. Designing hardware and software systems.  
6. Application design: algorithm requirements, algorithm optimisation for target architecture.

<p>6. Načrtovanje aplikacij: ocena zahtevnosti algoritmov, optimizacija algoritmov za dano arhitekturo. Izbrani primeri multimedijskih terminalov v multimedijskih sistemih.</p> <p>7. Življenjski cikel razvoja multimedijskega terminala: sistemska analiza in načrtovanje.</p> <p>8. Tehnologije za napredno interakcijo: uporabniške zahteve, uporabniško usmerjeno načrtovanje, ergonomija.</p> <p>9. Nosljivi in mobilni sistemi: karakteristike, avtonomija, povezljivost.</p> <p>10. Pametni telefoni in tablični računalniki: profesionalna in domača okolja, učenje, zabava.</p>	<p>7. Multimedia terminal life cycle: system analysis and design.</p> <p>8. Technologies for advanced interaction: user requirements, user-centered design, ergonomics.</p> <p>9. Wearable and mobile systems: characteristics, autonomy, connectivity.</p> <p>10. Smart phone and tablet computer application domains: professional and home environments, learning, entertainment.</p>
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### Temeljna literatura in viri/Readings:

<ol style="list-style-type: none"> <li>1. Tamboli A. Build Your Own IoT Platform : Develop a Flexible and Scalable Internet of Things Platform. Apress Media LLC, 2022.</li> <li>2. Benyon D. Designing User Experience: A guide to HCI, UX and interaction design. Pearson, 4th Edition, 2019.</li> <li>3. Norris D. Home Automation with Raspberry Pi. McGraw-Hill Education, 2019.</li> </ol>
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### Cilji in kompetence:

Razumevanje zgradbe in delovanja multimedijskih terminalov pri zajemu, obdelavi in prikazu. Poznavanje omejitev in zmogljivosti terminalne opreme pri načrtovanju multimedijskih storitev. Sooblikovanje načrtovanja uporabniške izkušnje in procesa načrtovanja aplikacij. Načrtovanje multimedijske opreme za različne kontekste. Tehnološko poznavanje opreme za boljše načrtovanje storitev in aplikacij.

### Objectives and competences:

Understanding architectures and functions of multimedia terminals for data acquisition, processing and visualization. Mastering limitations and performance of terminal equipment for designing multimedia services. Co-design user-experience process and application design process. Designing multimedia equipment for different contexts. Understanding technological background for better service and application design.

### Predvideni študijski rezultati:

Po uspešno opravljenem modulu naj bi bili študenti zmožni:

Analizirati zgradbo in delovanje modernih terminalov v interakciji z uporabnikom.

Razviti vmesnike za interakcijo človek-računalnik pri razvoju multimedijskih storitev.

Pripraviti proces tehnološke podpore za izbran primer.

Analizirati obstoječe produkte in načrtovanje lastnih rešitev.

Ovrednotiti ustreznost rešitev glede na podane specifikacije.

### Intended learning outcomes:

After successful completion of the course, students should be able to:

Analysing architecture and functions of modern terminal equipment in interaction with users.

Designing interfaces for human-computer interaction for multimedia services.

Facilitate the process of technology support for selected case study.

Analysing of existing products and conceptualize alternative solutions.

Evaluate solution in against to the specifications.

### Metode poučevanja in učenja:

Na predavanjih so predstavljene teoretične osnove obravnavanih poglavij skupaj s prikazom rešitev enostavnih praktičnih primerov. Študentom je na voljo študijski material s podrobno vsebino. Praktično delo poteka v okviru laboratorijskih vaj. Študent na izbrano temo pripravi samostojni projekt, ki ga tudi predstavi.

### Learning and teaching methods:

The lectures provide a theoretical background on selected topics together with simple practical demonstrations. A complete study material is available online. Practical work is being performed in the laboratory environment. Individual projects are based on selected topics and presented by students.



<b>Načini ocenjevanja:</b>	<b>Delež/Weight</b>	<b>Assessment:</b>
Način: laboratorijske vaje, samostojni projekt, pisni izpit, ustni izpit. Ocena 5 je negativna ocena, ocene od vključno 6 do 10 so pozitivne. Pozitivna ocena laboratorijskih vaj je pogoj za pristop k izpitu. Prispevki k oceni:		Type: laboratory exercises, individual project, written exam, oral exam. Negative grade is 5, positive grades: from 6 to 10. Positive evaluation of laboratory exercises is a prerequisite for the exam. Contributions to final grade:
laboratorijske vaje in samostojni projekt	50,00 %	laboratory exercises and individual project
pisni in ustni izpit	50,00 %	written and oral exam

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

<p>1. ZAJC, Matej, ISTENIČ, Andreja, LEBENIČNIK, Maja, GAČNIK, Mateja. Tablet game-supported speech therapy embedded in children's popular practices. <i>Behaviour &amp; information technology</i>. [Print ed.]. 2018, vol. 37, no. 7, str. 693-702, ilustr. ISSN 0144-929X</p> <p>2. GAČNIK, Mateja, ISTENIČ STARČIČ, Andreja, ZALETELJ, Janez, ZAJC, Matej. User-centred app design for speech sound disorders interventions with tablet computers. <i>Universal access in the information society</i>, ISSN 1615-5289, 2017, letn. 16.</p> <p>3. ISTENIČ STARČIČ, Andreja, COTIČ, Mara, and ZAJC, Matej. Design-based research on the use of a tangible user interface for geometry teaching in an inclusive classroom. <i>British journal of educational technology</i>, ISSN 0007-1013, sep. 2013, vol. 44, no. 5, str. 729-744, ilustr., doi: 10.1111/j.1467-8535.2012.01341.x.</p> <p>4. MILEV, Ivana, PRISLAN, Lev, ZAJC, Matej. Energy portal design and evaluation for consumer active participation in energy services : seven-month field study with 234 Slovenian households. <i>Electronics</i>. Nov.-1 2022, iss. 21, 3452, str. 1-20, ilustr. ISSN 2079-9292.</p>
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# NAČRTOVANJE CELOVITE UPORABNIŠKE IZKUŠNJE

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Načrtovanje celovite uporabniške izkušnje
<b>Course title:</b>	User Experience Design
<b>Članica nosilka/UL Member:</b>	UL FRI

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski (od študijskega leta 2024/2025 dalje)	Ni členitve (študijski program)	2. letnik	1. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0090464
<b>Koda učne enote na članici/UL Member course code:</b>	64M29

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			105	6

**Nosilec predmeta/Lecturer:** Matevž Pogačnik

**Vrsta predmeta/Course type:** strokovni izbirni predmet/specialist elective course

<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

Opravljanje študijskih obveznosti je opredeljeno v Pravilniku o preverjanju in ocenjevanju znanja ter izpitnem redu FE.

**Prerequisites:**

As specified by internal acts of the University of Ljubljana and the Faculty of Electrotechnical engineering.

**Vsebina:**

- Celovit pregled področja
- Metode za analizo in identifikacijo ciljnih uporabnikov in zahtev, posebnosti uporabniških skupin, modeliranje uporabnikov in oblikovanje person.
- Postopki za izdelavo informacijske arhitekture
- Pravila oblikovanja uporabniškega vmesnika
- Izdelava prototipov in vrste prototipov
- Oblikovanje interaktivnosti in modalnosti interakcij
- Odzivno oblikovanje
- Vizualno oblikovanje, oblikovalni sistem in pravila CGP
- Zagotavljanje dostopnosti storitev
- Lastnosti človeške percepcije in psihologija

**Content (Syllabus outline):**

- Comprehensive overview of the field
- Methods for analysis and identification of target users and requirements, specifics of user groups, user modeling and persona design.
- Procedures for creating information architecture
- User interface design rules
- Prototyping and types of prototypes
- Designing interactivity and modality of interactions
- Responsive design
- Visual design, design system and brand identity rules
- Ensuring the accessibility of services
- Characteristics of human perception and psychology

<ul style="list-style-type: none"> <li>• Merjenje in metodologije evalvacija uporabniške izkušnje</li> <li>• Načrtovanje uporabniške izkušnje in vmesnikov za tehnologije razširjene resničnosti (XR)</li> <li>• Načrtovanje in izdelava uporabniškega vmesnika in izkušnje v izbrani programski opremi</li> </ul>	<ul style="list-style-type: none"> <li>• Measurements and evaluation methodologies of user experience</li> <li>• User experience and interface design for extended reality (XR) technologies</li> <li>• Designing and creating the user interface and user experience using selected software</li> </ul>
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### Temeljna literatura in viri/Readings:

<ol style="list-style-type: none"> <li>1. Krug, S. »Don't Make Me Think: A Common Sense Approach to Web Usability, 3rd Edition«, New Riders, 2014, ISBN-13: 978-0321965516,</li> <li>2. William, A. and Tullis, T. »Measuring the user experience: collecting, analyzing, and presenting usability metrics«. Newnes, 2013, ISBN-13: 978-0124157811</li> <li>3. Norman, D. A. »The design of everyday things: Revised and expanded edition«. Basic books, 2013, ISBN 978-0-465-05065,</li> <li>4. Krug, S. »Rocket Surgery Made Easy: The Do-It-Yourself Guide to Finding and Fixing Usability Problems«, New Riders, 2010, ISBN-13: 978-0321657299</li> <li>5. Polaine, A; Lovlie, L; Reason, B. »Service Design: From Insight to Implementation«, Rosenfeld Media, 2013, ISBN-13:978-1-933820 – 33-0</li> </ol>
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### Cilji in kompetence:

Cilj predmeta je podati vpogled v področje uporabniške izkušnje in s tem povezanega načrtovanja uporabniških vmesnikov. Predmet obravnava koncepte in značilnosti interakcije med človekom in napravo ter postopke v procesu snovanja uporabniških vmesnikov. Skozi poznavanje orodij in evalvacijskepostopke predmet podaja znanja za izvedbo uporabniških vmesnikov na različnih napravah.

### Objectives and competences:

The goal of the subject is to give common view into the field of user experience and related user interface design. The course deals with the concepts and specifics of human - device interaction and the procedures of user interface design process. Through gained knowledge of tools and evaluation procedures the course gives knowledge for the design of user interfaces on different devices.

### Predvideni študijski rezultati:

Po uspešno opravljenem predmetu naj bi bili študenti zmožni:

- Opisati in razumeti terminologijo s področja in principov uporabniške izkušnje, uporabniško usmerjenega načrtovanja, uporabnosti in dostopnosti
- Izdelati analizo potreb trga in uporabnikov, identificirati ciljne uporabnike, raziskati uporabniške potrebe in izdelati scenarije
- Načrtovati oblikovni sistem in upoštevati pravila celostne grafične podobe
- Izdelati interaktivni prototip uporabniškega vmesnika na podlagi analize in informacijske arhitekture in upoštevanjem pravil zagotavljanja dostopnosti
- Izvesti postopke evalvacije uporabniškega vmesnika in analizirati rezultate

### Intended learning outcomes:

After successful completion of the course students should be able to:

- Describe and understand the domain terminology and principles of user experience, user centred design, usability and accessibility
- Make an analysis of market and user needs, identify target users, research user needs and create scenarios.
- Create the design system and follow the rules of the brand identity
- Create an interactive prototype of the user interface based on the analysis and the information architecture, taking into account accessibility rules
- Perform user interface evaluation procedures and analyze the results

### Metode poučevanja in učenja:

Predavanja, vaje s predstavitvami rezultatov. Poseben poudarek je na sprotne študiju in na samostojnem delu pri vajah.

### Learning and teaching methods:

Lectures, practical work with presentations of results. Special emphasis on continuous and prompt study, and independent practical work.

### Načini ocenjevanja:

### Delež/Weight Assessment:

Način: projekt, pisni izpit, ustni izpit. Ocena 5 je negativna ocena, ocene od vključno 6 do 10 so pozitivne. Pozitivna ocena laboratorijskih vaj in projekta je pogoj za pristop k izpitu. Prispevki k oceni:		Type: project, written exam, oral exam. Negative grade is 5, positive grades: from 6 to 10. Positive evaluation of laboratory exercises and of the project is a prerequisite for the exam. Contributions to final grade:
pisni izpit	40,00 %	written exam
ustni izpi	20,00 %	oral examination
projekt	40,00 %	project

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

<ol style="list-style-type: none"> <li>1. SOMRAK, Andrej, POGAČNIK, Matevž, GUNA, Jože. Suitability and comparison of questionnaires assessing virtual reality-induced symptoms and effects and user experience in virtual environments. <i>Sensors</i>. Feb.-2 2021, iss. 4, 1185, str. 1-24, ilustr. ISSN 1424-8220.</li> <li>2. BURGER, Gregor, GUNA, Jože, POGAČNIK, Matevž. Suitability of inexpensive eye-tracking device for user experience evaluations. <i>Sensors</i>. Jun. 2018, no. 6, 1822, str. 1-17, ilustr. ISSN 1424-8220.</li> <li>3. SYSOEV, Mikhail, KOS, Andrej, GUNA, Jože, POGAČNIK, Matevž. Estimation of the driving style based on the users' activity and environment influence. <i>Sensors</i>. Oct. 2017, no. 10, 2404, str. 1-15, ilustr. ISSN 1424-8220.</li> <li>4. DEBELJAK, Mojca, MATJAČIĆ, Zlatko, VIDMAR, Gaj, BEŠTER, Janez, POGAČNIK, Matevž, ZUPAN, Anton. A method for selection of appropriate assistive technology for computer acces. <i>International journal of rehabilitation research</i>, ISSN 0342-5282.</li> <li>5. STOJMENOVA DUH, Emilija, GUNA, Jože, POGAČNIK, Matevž, SODNIK, Jaka. Applications of paper and interactive prototypes in designing telecare services for older adults. <i>Journal of medical systems</i>. Apr. 2016, no. 4, art. no. 92, str. 1-7, ilustr. ISSN 0148-5598.</li> </ol>
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# NAPREDNA RAČUNALNIŠKA GRAFIKA

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Napredna računalniška grafika
<b>Course title:</b>	Advanced Computer Graphics
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	2. letnik	2. semester	izbirni
Računalništvo in informatika, druga stopnja, magistrski	Računalništvo in informatika (smer)		2. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0148094
<b>Koda učne enote na članici/UL Member course code:</b>	63553

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			105	6

**Nosilec predmeta/Lecturer:** Matija Marolt

**Vrsta predmeta/Course type:** strokovni izbirni predmet/specialist elective course

<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

<b>Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:</b>	<b>Prerequisites:</b>

Vsebina:	Content (Syllabus outline):
<b>Predavanja:</b> 3D predstavitve 1. polna telesa, CSG, B-Reps 2. vokslji, posredno upodabljanje, volumetrično upodabljanje 3. točkovne predstavitve, pretvorba v ploskovne Upodabljanje 1. osnove fotometrije in radiometrije, osvetljevanje, odsevanje 2. napredni modeli osvetljevanja in odsevanja, BRDF, podpovršinsko razprševanje 3. globalna osvetlitev: enačba upodabljanja, modeli za reševanje 4. Monte Carlo sledenje poti, Metropolis light transport, mapiranje fotonov Animacija	<b>Lectures:</b> 3D representations 1. solid bodies, CSG, B-Reps 2. voxels, indirect rendering, volumetric rendering 3. point based representations, mesh reconstruction Rendering 1. foundations of radio- and photometry, lighting, reflection 2. advanced lighting models, BRDF, subsurface scattering 3. global illumination: rendering equation, models for solutions 4. Monte Carlo path tracing, Metropolis light transport, photon mapping Animation

<ol style="list-style-type: none"> <li>1. interpolacija, kinematika</li> <li>2. zajem gibanja, urejanje gibanja, predelava gibanja</li> <li>3. dinamika: sistemi delcev in vzmeti, animacija tekočin, toga telesa, mehka telesa</li> <li>4. simulacija množic</li> <li>5. obrazna animacija</li> </ol> <p><b>Vaje:</b> Laboratorijski projekti, na katerih študenti implementirajo lastne rešitve za vizualizacijo in animacijo 3D predmetov.</p>	<ol style="list-style-type: none"> <li>1. interpolation, kinematics</li> <li>2. motion capture, editing and retargeting</li> <li>3. dynamics: particle and mass-spring systems, animation of fluids, rigid bodies, deformable models</li> <li>4. crowd simulation</li> <li>5. facial animation</li> </ol> <p><b>Laboratory:</b> Laboratory projects, where students implement their own solutions for visualization and animation of 3D models.</p>
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### Temeljna literatura in viri/Readings:

<ol style="list-style-type: none"> <li>1. Matt Phar and Greg Humphreys: <i>Physically Based Rendering: From Theory To Implementation</i>. Morgan Kaufmann, Second Edition, 2010</li> <li>2. Rick Parent: <i>Computer Animation: Algorithms and Techniques</i>. Morgan Kaufmann, 3. edition 2012.</li> <li>3. John Hughes , Andries van Dam, Morgan McGuire, David F. Sklar, James D. Foley, Steven K. Feiner, Kurt Akeley: <i>Computer Graphics: Principles and Practice</i>. Addison-Wesley Professional; 3. edition, 2013</li> </ol>
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### Cilji in kompetence:

<p>Cilj predmeta je, da študenti razumejo matematične in fizikalne aspekte in algoritme, ki so podlaga modernih pristopov v računalniški grafiki (teoretična podlaga), ter da jih znajo aplicirati v svoje programske rešitve (praksa).</p> <p>Študenti bodo pridobili naslednje kompetence: Zmožnost kritičnega, analitičnega in sintetičnega razmišljanja Zmožnost definiranja, razumevanja in reševanja ustvarjalnih profesionalnih izzivov v računalništvu in informatiki Sposobnost profesionalnega komuniciranja v materinem in tujem jeziku Sposobnost uporabe pridobljenega znanja za reševanje tehničnih in znanstvenih problemov v računalništvu; sposobnost nadgrajevanja pridobljenega znanja. Kompetence na področju računalništva in informatike, ki omogočajo nadaljevanje študija na tretji stopnji.</p>	<p><b>Objectives and competences:</b></p> <p>The objective of the course is that students gain understanding of mathematical, physical and algorithmic aspects that are the basis of modern approaches in computer graphics (theory) and that they can apply them to their own software solutions (practice).</p> <p>When completing the course, students will gain the following competences: Developing skills in critical, analytical and synthetic thinking The ability to define, understand and solve creative professional challenges in computer and information science The ability of professional communication in the native language as well as a foreign language The ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge Competences in computer and information science granting access to further study at 3rd cycle doctoral programmes</p>
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### Predvideni študijski rezultati:

<p>Po uspešnem zaključku tega predmeta bo študent:</p> <ul style="list-style-type: none"> <li>- razumel delovanj metod neposredne in posredne rekonstrukcije in upodabljanja 3D predmetov</li> <li>- poznal osnove radiometrije in fotometrije</li> <li>- razumel delovanje metod za fotorealistično upodabljanje</li> <li>- razumel in uporabljal verjetnostne metode za numerično integracijo</li> <li>- razumel in uporabljal metode za numerično reševanje navadnih diferencialnih enačb</li> </ul>	<p><b>Intended learning outcomes:</b></p> <p>After the completion of the course the student will be able to:</p> <ul style="list-style-type: none"> <li>- understand the methods for direct and indirect reconstruction and rendering of 3D objects</li> <li>- know the basics of radiometry and photometry</li> <li>- understand the methods for photorealistic rendering</li> <li>- understand and use probabilistic methods for numerical integration</li> <li>- understand and use methods for numeric solving of ordinary differential equations</li> <li>- understand the different methods for animation</li> </ul>
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- razumel delovanje različnih vrst animacijskih algoritmov - sposoben analizirati in implementirati napredne metode računalniške grafike na podlagi znanstvene literature	- analyze and implement advanced computer graphics methods based on study of scientific literature
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**Metode poučevanja in učenja:**

Predavanja s praktičnimi demonstracijami, izvajanje laboratorijskega projekta pod mentorstvom asistenta.

**Learning and teaching methods:**

Lectures with practical demonstrations, laboratory work under the supervision of assistants.

**Načini ocenjevanja:**

**Delež/Weight**

**Assessment:**

Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, in projektno delo)	50,00 %	Continuing (homework, project work)
Končno preverjanje (pisni in ustni izpit)	50,00 %	Final: (written and oral exam)
Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL).		Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana).

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

LESAR, Žiga, BOHAK, Ciril, MAROLT, Matija. Evaluation of angiogram visualization methods for fast and reliable aneurysm diagnosis. Medical imaging 2015 : image perception, observer performance, and technology assessment : 25-26 February 2015, Orlando, Florida, United States.

2. BOHAK, Ciril, SODJA, Anže, MAROLT, Matija, MITROVIĆ, Uroš, PERNUŠ, Franjo. Fast segmentation, conversion and rendering of volumetric data using GPU. IWSSIP 2014 : proceedings, (International Conference on Systems, Signals, and Image Processing (Print), ISSN 2157-8672), 2014, str. 239-242.

3. MAROLT, Matija. A connectionist approach to automatic transcription of polyphonic piano music. IEEE trans. multimedia. [Print ed.], str. 439-449, ilustr. [COBISS.SI-ID 4203860]

4. MAROLT, Matija. A mid-level representation for melody-based retrieval in audio collections. IEEE trans. multimedia. [Print ed.], Dec. 2008, vol. 10, no. 8, str. 1617-1625, ilustr. [COBISS.SI-ID 6908756]

5. PESEK, Matevž, LEONARDIS, Aleš, MAROLT, Matija. Robust real-time music transcription with a compositional hierarchical model. PloS one, ISSN 1932-6203, Jan. 2017, vol. 12, no. 1, str. 1-21

# NUMERIČNA MATEMATIKA

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Numerična matematika
<b>Course title:</b>	Numerical Mathematics
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik	1. semester, 2. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0082842
<b>Koda učne enote na članici/UL Member course code:</b>	63522

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			105	6

**Nosilec predmeta/Lecturer:** Aljaž Zalar

**Vrsta predmeta/Course type:** strokovni izbirni predmet/specialist elective course

<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

<b>Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:</b>	<b>Prerequisites:</b>

### Vsebina:

- Predavanja:**
- Uvod v numerično računanje (osnove numeričnih napak in stabilnost numeričnih algoritmov);
  - Linearna algebra: sistemi linearnih enačb (direktne in iterativne metode), lastne vrednosti matrik (inverzna in QR iteracija);
  - Interpolacija in aproksimacija (Lagrangeova in Newtonova interpolacija, metoda najmanjših kvadratov, trigonometrična aproksimacija);
  - Numerično integriranje (Newton-Cotesove formule, Rombergova metoda, Gaussove integracijske formule, ocenjevanje napake in izbira koraka, numerično računanje odvodov);
  - Reševanje navadnih diferencialnih enačb (Eulerjeva in Runge-Kutta metode, stabilnost, enačbe višjih redov, sistemi diferencialnih enačbrobni problemi), parcialne diferencialne

### Content (Syllabus outline):

- Lectures:**
- Introduction to numerical computing (numerical errors and stability of numerical algorithms);
  - Linear algebra: systems of linear equations (direct and iterative methods). Matrix eigenvalues (inverse and QR iteration);
  - Interpolation and approximation (Lagrange and Newton interpolation formulas, least squares method, trigonometric approximation);
  - Numerical integration (Newton-Cotes formulas, Romberg integration, Gauss integration formulas, error estimation and step-size selection, numerical differentiation);
  - Ordinary differential equations (Euler and Runge-Kutta methods, stability, higher order equations, systems of differential equations, boundary value problems), partial differential



<p>enačbe (metode končnih diferenc, končnih elementov in spektralne metode).</p> <p><b>Vaje:</b> Pri vajah bodo študentje s pomočjo numeričnih metod reševali različne (uporabne) probleme.</p> <p><b>Domače naloge:</b> Z domačimi nalogami bodo študentje preverjali in s samostojnim delom utrdili doseženo znanje.</p>	<p>equations (finite difference, finite element and spectral methods).</p> <p><b>Tutorials:</b> Tutorials will illustrate and/or expand concepts presented in lectures by working through (real life) example problems.</p> <p><b>Homeworks:</b> Homeworks are essential part of the course. With homeworks the students will test and upgrade their knowledge.</p>
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**Temeljna literatura in viri/Readings:**

<p>B. Orel: Osnove numerične matematike, Založba FE in FRI, Ljubljana, 1997.</p> <p>D. R. Kincaid, E. W. Cheney: Numerical Analysis, Mathematics of Scientific Computing, 3rd edition, Brooks/Cole, Pacific Grove, 2002.</p> <p>K. Atkinson, W. Han: Elementary Numerical Analysis, 3rd edition, John Wiley &amp; Sons, Inc., New Jersey, 2003.</p> <p>L. N. Trefethen, D. Bau: Numerical Linear Algebra, SIAM, Philadelphia, 1997.</p> <p>R. L. Burden, J. D. Faires, A. M. Burden: Numerical Analysis, 10th edition, Cengage Learning, Boston, 2016.</p> <p>G. H. Golub, C. F. Van Loan: Matrix Computations, 3rd edition, Johns Hopkins Univ. Press, Baltimore, 1996.</p>
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**Cilji in kompetence:**

<p>Cilj predmeta je študentom računalništva in informatike predstaviti osnovne metode numerične matematike in jih usposobiti za samostojno reševanje numeričnih problemov, ki jih bodo lahko srečali pri svojem strokovnem delu.</p>	<p><b>Objectives and competences:</b> This course explores the basic methods of numerical mathematics. Successful students be able to solve numerical problems they will encounter in their work.</p>
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**Predvideni študijski rezultati:**

<p>Študent naj bi po uspešno opravljenem predmetu:</p> <ul style="list-style-type: none"> <li>-poznal in razumel osnovne numerične metode,</li> <li>-poznal prednosti in slabosti različnih numeričnih metod,</li> <li>-znan uporabljati ustrezne numerične metode pri reševanju problemov iz strokovnega dela,</li> <li>-spoznal, da so računalniške simulacije nujna sestavina raziskovalnega dela (poleg eksperimentov in teorije),</li> <li>-imel sposobnost prenosa numeričnega pristopa k analizi problema na druga področja.</li> </ul>	<p><b>Intended learning outcomes:</b> After successfully completing the course, the students will be able to:</p> <ul style="list-style-type: none"> <li>- understand and use basic numerical methods,</li> <li>- know and understand their advantages and weaknesses,</li> <li>- use appropriate numerical methods for problem solving,</li> <li>- discover that computer simulations are a necessary ingredient of research work (besides experiments and theory),</li> <li>- transfer systematic approach to numerical problem solving to other problems.</li> </ul>
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**Metode poučevanja in učenja:**

<p>Predavanja, laboratorijske vaje in domače naloge. Poudarek na samostojnem reševanju problemov.</p>	<p><b>Learning and teaching methods:</b> Type (examination, oral, coursework, project): <b>Continuing</b> (homework, midterm exams, project work) <b>Final</b> (written and oral exam) Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana).</p>
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**Načini ocenjevanja:**

Načini ocenjevanja:	Delež/Weight	Assessment:
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, kolokviji in projektno delo)	50,00 %	Continuing (homework, midterm exams, project work)
Končno preverjanje (pisni in ustni izpit)	50,00 %	Final (written and oral exam)

Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL).

Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana).

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

1. ZALAR, Aljaž. The truncated Hamburger moment problems with gaps in the index set. *Integral equations and operator theory*. June 2021, vol. 93, iss. 3, art. 22 (36 str.).
2. BHARDWAJ, Abhishek, ZALAR, Aljaž. The tracial moment problem on quadratic varieties. *Journal of mathematical analysis and applications*. June 2021, vol. 498, no. 1, art. 124936 (39. str.).
3. KLEP, Igor, MCCULLOUGH, Scott, ŠIVIC, Klemen, ZALAR, Aljaž. There are many more positive maps than completely positive maps. *International mathematics research notices*. June 2019, vol. 2019, iss. 11, str. 3313-3375.
4. ZALAR, Aljaž. Operator Positivstellensätze for noncommutative polynomials positive on matrix convex sets. *Journal of mathematical analysis and applications*. 2017, vol. 445, iss. 1, str. 32-80.
5. CIMPRIC, Jaka, ZALAR, Aljaž. Moment problems for operator polynomials. *Journal of mathematical analysis and applications*. 2013, vol. 401, iss. 1, str. 307-316.

Celotna bibliografija je dostopna na SICRISu:

<http://www.sicris.si/search/rsr.aspx?opt=1&lang=slv&id=41702>

# OBDELAVA MULTIMEDIJSKIH VSEBIN

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Obdelava multimedijских vsebin
<b>Course title:</b>	Multimedia content processing
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik	2. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0090462
<b>Koda učne enote na članici/UL Member course code:</b>	64M27

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			75	6

**Nosilec predmeta/Lecturer:** Urban Burnik

**Vrsta predmeta/Course type:** strokovni izbirni predmet/specialist elective course

<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

<b>Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:</b>	<b>Prerequisites:</b>
Vpis v letnik predmeta.	Enrolment in the year of the course.

### Vsebina:

Obdelava multimedijских signalov s kratko ponovitvijo posebnosti digitalne obdelave signalov, časovni in frekvenčni prostor ter osnove vzorčenja. Zajem, značilnosti in digitalni zapis zvočnih, slikovnih in video signalov;  
Tipi multimedijских signalov (tekst, stacionarna grafika, zvok, slika, video, 3d video, haptični signali). Večmodalna narava informacije;  
Sodobno pojmovanje signalov v IKT (signali uporabnika in okolja, biosignali, socialni signali, ambientni signali);  
Zaznavanje zvoka, slike in videa. Fiziologija in psihologija percepcije vsebin (razumevanje omejitev človeškega percepcijskega sistema, pojem izgubnosti v multimedijском zapisu);  
Pregled eno- in večdimenzionalnih diskretnih postopkov obdelave in transformacij, ki so najpogosteje v uporabi za obdelavo zvočnih in

### Content (Syllabus outline):

Modern concept of signals in ICT (signals related to user and the environment, bio-signals, social signals, ambient signals);  
Perception of sound, images and video. Physiology and psychology of content perception (understanding of limitations of human perception, the concept of lossy notation of multimedia content);  
Overview of single- and multi-dimensional discrete algorithms and transformations that are commonly used in processing of audio and video signals (digital filters, unitary transforms, discrete Fourier transform, discrete cosine transform, wavelet transform, eigenvalue analysis, PCA, ICA);  
Methods of coding and notation of multimedia signals (lossless compression, redundancy, packetisation, encapsulation);

<p>slikovnih signalov (digitalni filtri, unitarne transformacije, diskretna Fourierova transformacija, diskretna kosinusna transformacija, valčne transformacije, analiza lastnih vrednosti, PCA, ICA); Načini kodiranja in zapisa multimedijskih signalov (brezizgubno zgoščevanje, redundanca, paketizacija, enkapsulacija); Standardizacija in komercialni zapisi avdiovizualnih gradiv, komercialni kodeki in vsebniki (MPEG,...); Identifikacija objektov in stanj v multimedijskih sistemih za implicitno interaktivnost v komunikaciji s posredništvom elektronskih naprav; Algoritmi in postopki za sintezo in integracijo multimedijskih gradiv; Sistemi za upravljanje z multimedijskimi vsebinami; Prilagajanje gradiva avdio-video storitev lastnostim prenosnega kanala in terminalne opreme; Upravljanje s avtorskimi pravicami in nadzor dostopa do vsebin; Postopki za vrednotenje kvalitete storitev v elektronskih medijih (Kvalitativno in kvantitativno vrednotenje kvalitete in standardizacija, kvaliteta uporabniške izkušnje).</p>	<p>Standardisation and commercial notation of audio-visual materials, commercial codecs and containers (MPEG, ...); Identification of objects and states in multimedia systems for implicit interactivity in communication services involving electronic devices; Algorithms and procedures for synthesis and integration of multimedia content; Content management systems for multimedia; Content adaptation in audio-visual services to characteristics of the communication channel and terminal equipment; Digital rights management and conditional access to multimedia content; Algorithms and methods for evaluation of quality of services in electronic media (Qualitative and quantitative evaluation of quality, standardization, quality of user experience).</p>
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### Temeljna literatura in viri/Readings:

1. Saeed V. Vaseghi. Multimedia Signal Processing: Theory and Applications in Speech, Music and Communications. (Wiley) Nov 12, 2007.
2. Murat Tekalp. Digital Video Processing (2nd Edition). (Prentice Hall Signal Processing Series) Jun 28, 2015.
3. John W. Woods. Multidimensional Signal, Image, and Video Processing and Coding, Second Edition. (Elsevier) Jul 1, 2011.
4. Bose, T., Digital signal and image processing, John Wiley and Sons, 2010 (izbrana poglavja).
5. Mandal, M., Multimedia Signals and Systems, Springer, 2012.

### Cilji in kompetence:

Cilj predmeta Obdelava multimedijskih vsebin je študentu podati znanje za uporabo principov, postopkov in opreme za obdelavo in končno produkcijo multimedijskih vsebin. Predmet vsebuje področja, ki obravnavajo sodobne postopke za obdelavo modeliranje in kodiranje signalov. Študent spozna teoretične osnove delovanja postopkov za obdelavo signalov, kot tudi praktična orodja, ki te postopke uporabljajo. Študent je sposoben izbrati primeren postopek ter praktično uporabiti ustrezno orodje za napredno obdelavo in modeliranje signalov. Študent spozna teoretično osnovo postopkov za precepcijsko zasnovano kompresijo multimedijskih signalov, ki je osnova standardov ter komercialnih rešitev za kodiranje zvoka, slike in videa. Pridobljeno znanje je podlaga za učinkovito izbiro ustreznega standarda za kodiranje multimedijskih vsebin. Študent obvlada procese digitalne distribucije vsebin s kodiranjem, enkapsulacijo podatkov, zaščito vsebin ter vrednotenjem kvalitete storitev.

### Objectives and competences:

The objective of the course Multimedia content processing is to equip students with knowledge, required to use principles, procedures and software for multimedia signal processing and production. The course covers modern signal processing, modelling and encoding procedures and algorithms for multimedia content. Students are taught theoretical background of methods for signal processing, as well as their implementation within available tools. Students are capable of selection of the most convenient tool for specific problem, understanding the background and are capable to use the selected tool for efficient problem solution. Students are taught theoretical background of modern techniques for perceptual based compression of multimedia signals. Acquired knowledge is basis for efficient selection of appropriate standard for digital multimedia content encoding. Students are skilled with usage of processes for digital distribution of content with encoding, encapsulation

	of data, content protection and evaluation of quality of services.
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**Predvideni študijski rezultati:**

Po uspešno opravljenem modulu naj bi bili študenti zmožni:

- Izbrati problemu ustrezne algoritme in postopke za analizo in rekonstrukcijo digitalnih multimedijskih signalov
- izbrati in uporabiti programska orodja in okolja za obdelavo multimedijskih signalov za različne ciljne platforme in za področja uporabe
- naštetati in opisati vse pomembne modalnosti signalov v multimediji
- opisati fiziološke lastnosti zaznavanja zvoka, slike in videa iz vidika obsega podatkov, ki ga človek s svojimi čutili zmore zaznati
- opisati in uporabiti osnovne algoritme za izgubno zgoščevanje zvoka, slike in videa, in izbrati standarde za učinkovit kodni zapis multimedijskih signalov
- naštetati, opisati in uporabiti sisteme za digitalno upravljanje z avtorskimi pravicami
- naštetati in opisati in uporabiti postopke za vrednotenje kvalitete multimedijske storitve.

**Intended learning outcomes:**

After successful completion of the course, students should be able to:

- Choose for a problem appropriate algorithms and procedures for analysis and reconstruction of digital multimedia signals,
- select and use programming tools related to multimedia signal processing on a various platforms and problem-specific areas
- list and describe dominant signal modalities in multimedia services
- describe physiological perception of sound, images and video from standpoint of human communication channel capacity
- describe and use basic algorithms for lossy compression of sound, images and video, and select appropriate standard for effective coding of multimedia signals
- list, describe and use systems for digital rights management
- list, describe and use of methods for evaluation of multimedia service quality.

**Metode poučevanja in učenja:**

Na predavanjih so študentom predstavljene teoretične osnove obravnavane snovi skupaj s prikazom rešitev enostavnih praktičnih problemov. Študentom je na voljo študijski material s podrobno vsebino. Praktično delo poteka v okviru laboratorijskih vaj. Te so zasnovane v več delih, v katerih se študentje postopoma poglobljeno seznanjajo s praktičnimi problemi in orodji. Študentje v okviru predmeta samostojno izdelajo projekt. Projektno skupino sestavljata dva ali trije študentje, ki opravijo nalogo iz nabora predstavljenih nalog, kot npr.: izbira in uporaba postopka za vodno žigosanje ter analiza odpornosti le tega na napade. Ob koncu semestra študentje poročajo o končnih rezultatih s primerjavo izsledkov iz literature.

**Learning and teaching methods:**

The lectures provide a theoretical background on particular subjects together with presentation of simple practical examples. A complete study material is available to the students. Practical work is being performed in the laboratory environment, and is accomplished in steps acquainting students with practical problems and tools. Students are required to finish practical individual project. Project group consists of two or three students who accomplish the task from list of available tasks such as: selection and usage of watermarking procedure and analysis of the watermark resilience to attacks. At the end of semester, students report on their results together with comparison to the results from the literature.

**Načini ocenjevanja:**

**Delež/Weight**

**Assessment:**

Način: laboratorijske vaje, pisni izpit, ustni izpit. Ocena 5 je negativna ocena, ocene od vključno 6 do 10 so pozitivne. Pozitivna ocena laboratorijskih vaj je pogoj za pristop k izpitu. Prispevki k oceni:		Type: laboratory exercises, written exam, oral exam. Negative grade is 5, positive grades: from 6 to 10. Positive evaluation of laboratory exercises is a prerequisite for the exam. Contributions to final grade:
laboratorijske vaje	30,00 %	laboratory exercises
pisni izpit	40,00 %	written exam
ustni izpit	30,00 %	oral examination

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

VALIČ, David, MEŽA, Marko, BURNIK, Urban. Primerjava HEVC in VP9. V: ŽEMVA, Andrej (ur.), TROST, Andrej (ur.). Zbornik devetindvajsete mednarodne Elektrotehniške in računalniške konference ERK 2020, ISSN 2591-0442

BURNIK, Urban, MEŽA, Marko, ZALETELJ, Janez. Automated broadcast video quality analysis system. The IPSI BgD transactions on internet research, ISSN 1820-4503. [Print ed.], Jan. 2018, vol. 14, no. 1, str. 55-64

BURNIK, Urban. Objectives and performance of H.265/HEVC Video Coding Standard. V: MILOVANOVIĆ, Bratislav D. (ur.), et al. TELSISKS 2017 : proceedings of papers, 13 International Conference on Advanced Technologies, Systems and Services in Telecommunications (TELSISKS), Serbia, Niš, October 18-20, 2017. [S. l.]: Institute of Electrical and Electronics Engineers; Niš: Faculty of Electronic Engineering, University of Niš. cop. 2017, str. 53-56

BURNIK, Urban, ZALETELJ, Janez, KOŠIR, Andrej. Video-based learners' observed attention estimates for lecture learning gain evaluation. Multimedia tools and applications, ISSN 1380-7501, 2017, vol. , no. , str. 1-24

TKALČIČ, Marko, BURNIK, Urban, KOŠIR, Andrej. Using affective parameters in a content-based recommender system for images. User modeling and user-adapted interaction, ISSN 0924-1868, 2010, vol. 20, no. 4, str. 279-311

BURNIK, Urban, TASIČ, Jurij F. Človeško zaznavanje in objektivno vrednotenje zakasnitev multimedijskih storitev. Elektrotehniški vestnik, ISSN 0013-5852. [Slovenska tiskana izd.], 2006, letn. 73, št. 1, str. 7-12

# OBDELAVA NARAVNEGA JEZIKA

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Obdelava naravnega jezika
<b>Course title:</b>	Natural language processing
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik, 2. letnik	2. semester	izbirni
Računalništvo in informatika, druga stopnja, magistrski	Podatkovne vede (smer)	2. letnik	2. semester	izbirni
Računalništvo in informatika, druga stopnja, magistrski	Računalništvo in informatika (smer)		2. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0148113
<b>Koda učne enote na članici/UL Member course code:</b>	63555

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	10	20			105	6

**Nosilec predmeta/Lecturer:** Marko Robnik Šikonja

**Vrsta predmeta/Course type:** strokovni izbirni predmet/specialist elective course

<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

### Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Priporočamo solidno predznanje verjetnosti in statistike, programiranja, strojnega učenja in algoritmov.

### Prerequisites:

Knowledge of probability and statistics, programming, machine learning, and algorithms is recommended.

### Vsebina:

Vsebina predmeta temelji na izboru sodobnih tehnik obdelave naravnega jezika, temelječih na globokem učenju, podkrepjenih s praktično rabo. V predavanjih predstavimo glavne pristope in pojasnimo delovanje posameznih metod in njihovo teoretično ozadje. V okviru laboratorijskih vaj znanje povežemo s praktično rabo in ga utrdimo z uporabo odprtokodnih sistemov za obdelavo naravnega jezika. Študenti rešujejo naloge, ki temeljijo na realnih raziskovalnih in praktičnih problemih, pretežno v slovenskem in angleškem jeziku.

### Content (Syllabus outline):

The syllabus is based on a selection of modern deep learning based natural learning processing techniques and their practical use. The lectures introduce the main tasks and techniques, explain their operation and theoretical background. During practical sessions and seminars the gained knowledge is applied to language practical task using open source tools. Student investigate and solve assignments, based on real-world research and commercial problems form English and Slovene languages.

<ol style="list-style-type: none"> <li>1. Uvod v obdelavo naravnega jezika: motivacija, razumevanje jezika, dvoumnost, tradicionalni, statistični in nevronske pristopi.</li> <li>2. Predobdelava in normalizacija besedila: regularni izrazi, gramatike, podobnost nizov, napredne tehnike normalizacije, lematizacija.</li> <li>3. Jezikovni viri: korpusi, slovarji, tezavri, mreže in semantične zbirke podatkov, WordNet.</li> <li>4. Podobnost besedil: mere, metode gručenja, kosinusna razdalja, jezikovne mreže in grafi.</li> <li>5. Predstavitev besedil: redke in goste vložitve; jezikovni modeli; vložitve besed, stavkov in dokumentov.</li> <li>6. Globoke nevronske mreže za besedila: rekurentne nevronske mreže, konvolucijske mreže za besedila, transformerji.</li> <li>7. Nevronske vložitve: word2vec, fastText, ELMo, BERT, medjezikovne vložitve.</li> <li>8. Veliki jezikovni modeli: BERT, GPT in T5, večmodalni modeli.</li> <li>9. Plitva računska in leksikalna semantika: oblikoskladenjsko označevanje, skladenjsko razčlenjevanje, prepoznavanje imenskih entitet, označevanje semantičnih vlog.</li> <li>10. Besedni pomeni in njihovo razločevanje.</li> <li>11. Afektivna analiza: sentiment, čustva.</li> <li>12. Povzemanje besedil, odgovarjanje na vprašanja in razumevanje besedil: metode in vrednotenje.</li> <li>13. Strojno prevajanje: metode in vrednotenje</li> </ol>	<ol style="list-style-type: none"> <li>1. Introduction to natural language processing: motivation, language understanding, ambiguity, traditional, statistical, and neural approaches.</li> <li>2. Text preprocessing and normalization: regular expressions, grammars, string similarity, advanced normalization techniques, lemmatization.</li> <li>3. Language resources: corpora, dictionaries, thesauri, networks and semantic databases, WordNet.</li> <li>4. Text similarity: measures, clustering approaches, cosine distance, language networks and graphs.</li> <li>5. Text representation: sparse and dense embeddings; language models; word, sentence, and document embeddings.</li> <li>6. Deep neural networks for text: recurrent neural networks, convolutional networks for text, transformers.</li> <li>7. Neural embeddings: word2vec, fastText, ELMo, BERT, cross-lingual embeddings.</li> <li>8. Large language models: BERT, GPT, and T5, multimodal models.</li> <li>9. Shallow computational and lexical semantics: part-of-speech tagging, dependency parsing, named entity recognition, semantic role labelling.</li> <li>10. Word senses and their disambiguation.</li> <li>11. Affective computing: sentiment, emotions.</li> <li>12. Text summarization, question answering and reading comprehension: methods and evaluation.</li> <li>13. Machine translation: methods and evaluation.</li> </ol>
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**Temeljna literatura in viri/Readings:**

<p>Jurafsky, David and Martin, James H. <i>Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition</i>, 3rd edition draft. 2023.</p> <p>Jacob Eisenstein. <i>Natural Language Processing</i>, MIT press, 2019</p>
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**Cilji in kompetence:**

<p>Študenti se bodo naučili teorije in rabe osnovnih algoritmov in pristopov na področju obdelave naravnega jezika. Študenti bodo:</p> <p>razumeli pristope k analizi sintakse in semantike na področju obdelave naravnega jezika;</p> <p>razumeli pristope k povzemanju dokumentov in odgovarjanju na vprašanja;</p> <p>razumeli delovanje statističnih in nevronskih pristopov k strojnemu prevajanju,</p> <p>razumeli uporabo metod globokega učenja v obdelavi naravnega jezika</p> <p>znali uporabiti orodja za obdelavo naravnega jezika.</p>	<p><b>Objectives and competences:</b></p> <p>Upon completion of the course, students shall be able to explain and apply fundamental algorithms and techniques in the area of natural language processing. In particular, students will:</p> <p>understand approaches to syntax and semantics in NLP,</p> <p>understand approaches to summarization and question answering</p> <p>understand statistical and neural approaches to machine translation,</p> <p>understand deep learning techniques used in NLP,</p> <p>know how to apply standard natural language processing tools.</p>
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**Predvideni študijski rezultati:**

<p>Ob zaključku predmeta bodo študenti:</p> <p>razumeli pristope k analizi sintakse in semantike na področju obdelave naravnega jezika;</p> <p>znali ovrednotiti pristope k povzemanju dokumentov;</p>	<p><b>Intended learning outcomes:</b></p> <p>Upon completion of the course, students will:</p> <p>understand approaches to syntax and semantics in NLP,</p> <p>evaluate approaches to summarization</p>
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razlikovali med različnimi pristopi k strojnemu prevajanju, uporabljali in prilagajali metode strojnega učenja za obdelavo naravnega jezika uporabljali in kritično vrednotili orodja za obdelavo naravnega jezika poznali obstoječe in znali zasnovati nove jezikovne vire uporabljali različne predstavitve besedil in jih prilagajali novi okoliščinam	differentiate between different approaches to machine translation, use and adapt machine learning techniques for NLP apply and critically evaluate natural language processing tools know the existing language resources and be able to design new ones use different text representations and adapt them to new contexts
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**Metode poučevanja in učenja:**

Predavanja, laboratorijske vaje, delo v majhnih skupinah, javne predstavitve projektov

**Learning and teaching methods:**

Lectures, lab work, work in small groups, public presentations of projects.

**Načini ocenjevanja:**

**Delež/Weight**

**Assessment:**

Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, projektno delo, javne predstavitve)	50,00 %	Continuing (homework, project work, public presentations)
Končno preverjanje (pisni in ustni izpit)	50,00 %	Final: (written and oral exam)
Pri obeh delih mora študent doseči vsaj polovico možnih točk. Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL).		In both parts students must get at least half of available points. Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana).

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

1. KLEMEN, Matej, KRSNIK, Luka, ROBNIK ŠIKONJA, Marko. Enhancing deep neural networks with morphological information. *Natural language engineering*. Mar. 2023, vol. 29, iss. 2, str. 360-385
2. MIOK, Kristian, ŠKRLJ, Blaž, ZAHARIE, Daniela, ROBNIK ŠIKONJA, Marko. To BAN or not to BAN: Bayesian attention networks for reliable hate speech detection. *Cognitive computation*. Jan. 2022, vol. 14, iss. 1, str. 353-371
3. ŠKVORC, Tadej, GANTAR, Polona, ROBNIK ŠIKONJA, Marko. MICE: mining idioms with contextual embeddings. *Knowledge-based systems*. Jan. 2022, vol. 235, str. 1-11
4. ŽAGAR, Aleš, ROBNIK ŠIKONJA, Marko. Cross-lingual transfer of abstractive summarizer to less-resource language. *Journal of intelligent information systems*. Feb. 2022, vol. 58, iss. 1, str. 153-173,
5. MARTINC, Matej, POLLAK, Senja, ROBNIK ŠIKONJA, Marko. Supervised and unsupervised neural approaches to text readability. *Computational linguistics*. 2021, vol. 47, no. 1, str. 141-179

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# OBLIKOVANJE VIZUALNIH KOMUNIKACIJ

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Oblikovanje vizualnih komunikacij
<b>Course title:</b>	Visual Communication Design
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik	1. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0075707
<b>Koda učne enote na članici/UL Member course code:</b>	64M25

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			105	6

<b>Nosilec predmeta/Lecturer:</b>	Boštjan Botas Kenda
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<b>Vrsta predmeta/Course type:</b>	strokovni izbirni predmet/specialist elective course
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<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

<b>Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:</b>	<b>Prerequisites:</b>
Vpis v letnik.	Enrollment in the first academic year.

<b>Vsebina:</b>	<b>Content (Syllabus outline):</b>
Zgodovinski parametri vizualnih komunikacij, raznovrstnost, pomen in vloga medijev, oblikovalski procesi, pomen in vloga oblikovanja v družbi. Grafično-oblikovalske prvine, odnos besedilo, tipografija, ilustracija, fotografija. Izdelki vizualnih komunikacij. Piktogram, črka, znak-logotip, plakat, knjiga, spletna stran, embalaža, predstavitveni film, označevanje prostorov. Priprava predstavitvene mape projektov.	Historical parameters of visual communication, diversity, relevance and role of mass media, design processes, relevance and role of design in society. Elements of graphic design, relationships among text-typography-illustration-photography. Pictogram, letter, sign and logo, poster, book, web site, packaging, promotional clip, signage/wayfinding. Preparation of individual portfolio.

<b>Temeljna literatura in viri/Readings:</b>
1. FLUSSER Vilem, K filozofiji fotografije, ZSKZ, 2011 2. JEDLICKA Wendy: Packaging Sustainability: Tools, Systems and Strategies for Innovative Package Design, Wiley, 2008 3. BRINGHURST Robert: The Elements of Typographic Style, Hartley and Marks Publishers, 2004 4. MOŽINA Klementina: Knjižna tipografija, FF, NTF, Ljubljana, 2003 5. FRUTIGER Adrian: Signs and Symbols, Delta&Spes, 1989

6. BAUR Ruedi: Ruedi Baur Integral: Anticipating, Questioning, Inscribing, Distinguishing, Irritating, Orienting, Translating, Lars Müller Publishers, 2010  
 7. MOLLERUP Per, Wayshowing, Lars Müller Publishers, 2008  
 8. LUPTON Elen, Graphic Design: The New Basics, Princeton Architectural Press; 2008

**Cilji in kompetence:**

Osnovni cilj je pokazati znanja in veščine grafičnega oblikovanja za tiskane in digitalne medije, ki v sodobnem načinu komunikacije ne more mimo vseh segmentov družbenega ustroja.  
 Specifične kompetence:  
 - sposobnost razvijanja prenosa vsebin iz enega izrazoslovja v drugega.  
 - sposobnost samostojnega, skupinskega, projektnega in raziskovalnega dela.  
 - uporabiti metodologije dela v redakciji in spremljanje faz nastanka založniškega izdelka  
 - sposobnost uporabe temeljev fotografskega, ilustratorskega in tipografskega znanja  
 - sposobnost uporabe različnih analognih in digitalnih grafičnih orodij za pripravo sporočila  
 - sposobnost ustvarjati nove ideje  
 - sposobnost vrednotenja vidnega v skladu z likovno in oblikovalsko teorijo  
 - uporabiti metodologije oblikovanja od analize, definicije problema in ciljev, zasnove idejnega projekta, predstavitve ter izvedbe.

**Objectives and competences:**

The main objective is to show the knowledge and skills of graphic design in printed and digital media which are inevitably connected with every segment of social structure within the contemporary ways of communication.  
 Specific competences:  
 Students:  
 - are able to transform the contents of one way of communication into another (i. e. from verbal to visual, from audio to video, etc.);  
 - work individually or in groups in developing project or research work;  
 - use the methodology of editorial work and get to know the phases in creating a publishing product;  
 - learn how to use photographic, illustrative and typographical knowledge;  
 - learn how to use different analogical and digital graphic tools;  
 - are able to generate new ideas;  
 - are able to evaluate what they see in accordance with art and design theory;  
 - use the methodology of design, starting from analysis, to the definition of the problem, goals, concept phase, presentation and realization.

**Predvideni študijski rezultati:**

Znanje in razumevanje:  
 Prepoznavanje in povezovanje področij vizualnega sporočanja. Združevanje v timu z namenom povezovanja različnih strok, ki so potrebne za nastanek izdelka vidnih sporočil. Preizkusiti redakcijsko delo. Uporaba posameznih elementov vizualnega komuniciranja.

**Intended learning outcomes:**

Knowledge and understanding:  
 Students recognize and connect different fields of visual communication. Students work in teams with the aim of combining all the professions needed to produce a visual product.  
 Students experience editorial work and perceive the usage of different elements of visual communication.

**Metode poučevanja in učenja:**

Tematska predavanja in pogovori na konkretno temo. Vaje in seminarske naloge. Praktično usposabljanje v založniškem timu. Konzultacije. Izvajanje nalog in njih predstavitev- nastop pred avditorijem. Delo v timu in posamezno. Skupinski in samostojni obiski kulturnih prireditev (koncerti, razstave, predavanja gostujočih, domačih in tujih strokovnjakov).

**Learning and teaching methods:**

Class oral presentations and discussions on particular issues. Seminars and practice. Practical editorial team work. Consultations. Individual or group project work and presentation of the work. Group and individual visits to cultural events (concerts, exhibitions, lectures of visiting Slovene and foreign professors and experts).

**Načini ocenjevanja:**

Študent izdelava šest nalog in jih predstavi pred avditorijem, odgovarja na vprašanja ob komentarjih na njegovo predstavitev, se vključuje v odprto diskusijo ob predstavitev drugih nalog, pripravi končno

**Delež/Weight**

**Assessment:**

Type (examination, oral, coursework, project): Students produce six project works and present them to the auditorium, answer questions and comments on their work, take active part in open discussions on other works, work at the final (exam) project and

izpitno nalogo in jo predstavi. Ocenjevalna lestvica: 5-10 (6-10 pozitivno, 5 negativno).		present it in class. Evaluation scale from 6-10 (pass) and 5 (failed).
Ocena nalog	50,00 %	Evaluation of the project works
verbalna predstavitev	30,00 %	verbal presentation
vključevanje v diskusije	20,00 %	active part in discussions

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

<p>1. IAQUIN / vinske etikete/wine label /Compasso d'oro International Design Award finalist – Food and Nutrition/Triennale di Milano 2015</p> <p>2. BARBARA CELJSKA /dvoevrski priložnostni kovanec /Banka Slovenije-Združenje evropskih bank, 2014 /2€ occasional coin/Bank of Slovenia,2014</p> <p>3. VSI ODTENKI ZELENE / Slovenski pavilion na 12. arhitekturnem bienalu v Benetkah v Italiji, 2010 /All Shades Of Green/ Biennale di Architettura di Venezia 2010</p> <p>4. Matjaž Kmecl, Joco Žnidaršič: ZAKLADI SLOVENIJE / knjiga-monografija / Cankarjeva založba, 2009 / Najlepša slovenska knjiga /monography/ Best Slovenian Book Award 2009</p> <p>5. SNEŽNIK / poštna znamka / Pošta Slovenije, 1997 / 28 ° Premio Asiago - Najlepša svetovna okoljska znamka 1998 /postal stamp/ Post of Slovenia/28 ° Premio Asiago - Best World Stamp (field: Enviornment) 1998</p>
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# OBŠTUDIJSKA STROKOVNA DEJAVNOST I

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Obštudijska strokovna dejavnost I
<b>Course title:</b>	Computer science and society I
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	2. letnik	1. semester, 2. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0070525
<b>Koda učne enote na članici/UL Member course code:</b>	63534

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
5				40	45	3

**Nosilec predmeta/Lecturer:** Slavko Žitnik

**Vrsta predmeta/Course type:** izbirni predmet/elective course

**Jeziki/Languages:**

Predavanja/Lectures:	Angleščina, Slovenščina
Vaje/Tutorial:	Angleščina, Slovenščina

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

**Prerequisites:**

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### Vsebina:

Na uvodnih predavanjih študentom pojasnimo cilje predmeta in kako jih lahko dosežejo. Med aktivnosti, ki jih lahko štejemo kot obveznosti pri predmetu sodijo vodenje računalniškega (ali po strokovni tematiki sorodnega) krožka na osnovni ali srednji šoli, vodenje študijske skupine na fakulteti, redno obiskovanje izven kurikularnih strokovnih predavanj na fakulteti ali na drugih članicah UL, ki so povezana s predmetom ipd.

### Content (Syllabus outline):

After an introductory lecture on the necessary background of the activities involved in the course, the students' activities include classes on topics in computer and information science and lab work with students of elementary and high schools, organizing study groups of students at the 1st degree level, attending extracurricular lectures at the University of Ljubljana on subjects associated to the topics of the course.

### Temeljna literatura in viri/Readings:

**Keller Gustav, Binder Annette, Thiel Rolf Dietmar (1999).** Boljša motivacija uspešnejše učenje (translated from German); Trening učnih navad. Ljubljana: Center za psihodiagnostična sredstva.  
**Bratanič, Marija (1990),** Mikropedagogija, interakcijsko-komunikacijski aspekt odgoja, Školska knjiga, Zagreb

**Cilji in kompetence:**

**Objectives and competences:**

<p>Cilj predmeta je študentom je omogočiti in s kreditnimi točkami ovrednotiti njihovo izven kurikularno strokovno, nepridobitno delo, ki je za profesionalno profiliranje strokovnjaka na področju računalništva in informatike potrebno, pa ga učni načrt sicer ne pokriva.</p> <p>Splošne kompetence:</p> <ul style="list-style-type: none"> <li>• Sposobnost strokovnega sporazumevanja v domačem in v tujem jeziku</li> <li>• Sposobnost skupinskega dela v strokovnem okolju, vodenje manjše strokovne skupine</li> <li>• Sposobnost administrativnega vodenja procesov, povezanih z raziskovanjem, industrijo, izobraževanjem in drugimi področji</li> <li>• Sposobnost prenašanja znanja in pisanja v domačem in tujem jeziku</li> </ul> <p>Predmetno specifične kompetence:</p> <ul style="list-style-type: none"> <li>• Sposobnost celovite obdelave manjših projektov in reševanja problemov iz prakse s področja računalništva in informatike.</li> <li>• Naučiti se izbrati primerno orodje in tehnologijo za reševanje konkretnega problema</li> <li>• Razvijati sposobnosti za posredovanje znanja in popularizacijo računalniških znanj in veščin.</li> </ul> <p>Sodelovanje pri skupinskem reševanju problemov, vodenja manjše skupine, pripravo gradiv, ki so za vodenje take skupine potrebna, organizacijo in pridobivanje znanj, ki so potrebni za delo skupine, pripravo terminskega in vsebinskega načrta za delo skupine itd.</p>	<p>The object of this course is to provide a framework for awarding study credits for extracurricular non-profit activities of students related to computer and information science, providing useful experience for experts in this field that are not included in the curriculum of the study program.</p> <p>General competences:</p> <ul style="list-style-type: none"> <li>• The ability of professional communication in the native language as well as a foreign language</li> <li>• The ability of teamwork within the professional environment; management of a small professional team</li> <li>• The ability for administrative management of processes related to research, industry, education and other fields</li> <li>• The ability of knowledge transfer and writing skills in the native language as well as a foreign language.</li> </ul> <p>Subject specific competences:</p> <ul style="list-style-type: none"> <li>• Completing smaller practical projects and solve problems in the fields for computer and information science</li> <li>• Obtaining the knowhow to choose the suitable tools and technologies for a specific problem</li> <li>• Developing teaching skills and means for popularizing computer and information science topics and issues.</li> </ul> <p>Participating in group solutions, organizing and supervising the work of a smaller group including the preparation of the necessary materials, planning group work, etc.</p>
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<p><b>Predvideni študijski rezultati:</b></p> <p>Spoznavanje osnovnih zakonitosti pri posredovanju znanja in popularizaciji računalniškega področja manjši skupini predvsem mlajših članov, organizaciji njenega dela in razumevanje pomena in uporabe takih znanj pri strokovnem delu strokovnjaka na področju računalništva in informatike.</p>	<p><b>Intended learning outcomes:</b></p> <p>Basic educational principles and teaching practice in the process of introducing computer science topics to smaller groups of younger students, organization of group work, understanding the role of such competencies in the work of an expert in the field of computer and information science.</p>
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<p><b>Metode poučevanja in učenja:</b></p> <p>Predavanja, mentorski in seminarski način dela ter spremljanja dela študenta, z ustim nastopom ob zaključku semestra. Poseben poudarek je na skupinskem delu pri seminarjih.</p>	<p><b>Learning and teaching methods:</b></p> <p>Lectures, individual work with students, seminars with oral presentations with special emphasis on group work.</p>
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<b>Načini ocenjevanja:</b>	<b>Delež/Weight</b>	<b>Assessment:</b>
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, kolokviji in projektno delo)	50,00 %	Continuing (homework, midterm exams, project work)
Končno preverjanje (pisni in ustni izpit)	50,00 %	Final (written and oral exam)
Ocene: opravi z odliko, opravi ali ni opravi (v skladu s Statutom UL).		Grading: passed with excellence, passed or failed (according to the Statute of UL).

### Reference nosilca/Lecturer's references:

- KLEMEN, Matej, ŽITNIK, Slavko. Neural coreference resolution for Slovene language. *Computer science and information systems*. [Print ed.]. 2022, vol. 19, iss. 2, str. 495-521, ilustr. ISSN 1820-0214. <http://www.doiserbia.nb.rs/Article.aspx?ID=1820-02142100060K#.Ya2cu9DMJPY>, DOI: [10.2298/CSIS201120060K](https://doi.org/10.2298/CSIS201120060K). [COBISS.SI-ID 87851011], [JCR, SNIP, WoS, Scopus do 26. 1. 2023: št. citatov (TC): 1, čistih citatov (CI): 1, čistih citatov na avtorja (CIAu): 0,50]
- KNEZ, Timotej, GAŠPERLIN, Domen, BAJEC, Marko, ŽITNIK, Slavko. Blockchain-based transaction manager for ontology databases. *Informatica*. [Print ed.]. 2022, vol. 33, no. 2, str. 343-364, ilustr. ISSN 0868-4952. <https://informatica.vu.lt/journal/INFORMATICA/article/1264/info>, DOI: [10.15388/22-INFOR490](https://doi.org/10.15388/22-INFOR490). [COBISS.SI-ID 112947203], [JCR, SNIP, WoS, Scopus]
- ŽITNIK, Slavko, BLAGUS, Neli, BAJEC, Marko. Target-level sentiment analysis for news articles. *Knowledge-based systems*. [Print ed.]. Aug. 2022, vol. 249, str. 1-14, ilustr. ISSN 0950-7051. <https://www.sciencedirect.com/science/article/pii/S095070512200452X?via%3DiHub>, DOI: [10.1016/j.knosys.2022.108939](https://doi.org/10.1016/j.knosys.2022.108939). [COBISS.SI-ID 106573827], [JCR, SNIP, WoS do 8. 2. 2023: št. citatov (TC): 2, čistih citatov (CI): 2, čistih citatov na avtorja (CIAu): 0,67, Scopus do 30. 1. 2023: št. citatov (TC): 4, čistih citatov (CI): 4, čistih citatov na avtorja (CIAu): 1,33]
- SMITH, Glenn Gordon, HAWORTH, Robert, ŽITNIK, Slavko. Computer science meets education : Natural Language Processing for automatic grading of open-ended questions in eBooks. *Journal of educational computing research*. [Print ed.]. Dec. 2020, vol. 58, no. 7, str. 1227-1255, ilustr. ISSN 0735-6331. <https://journals.sagepub.com/doi/10.1177/0735633120927486>, DOI: [10.1177/0735633120927486](https://doi.org/10.1177/0735633120927486). [COBISS.SI-ID 17989635], [JCR, SNIP, WoS do 26. 10. 2022: št. citatov (TC): 9, čistih citatov (CI): 9, čistih citatov na avtorja (CIAu): 3,00, Scopus do 1. 2. 2023: št. citatov (TC): 11, čistih citatov (CI): 11, čistih citatov na avtorja (CIAu): 3,67]
- KNEZ, Timotej, BAJEC, Marko, ŽITNIK, Slavko. ANGLEr : a next-generation natural language exploratory framework. V: GUIZZARDI, Renata (ur.), RALYTÉ, Jolita (ur.), FRANCH, Xavier (ur.). *Research challenges in information science : 16th International Conference, RCIS 2022, Barcelona, Spain, May 17-20, 2022 : proceedings*. Cham: Springer, cop. 2022. Str. 761-768, ilustr. Lecture notes in business information processing (Internet), 446. ISBN 978-3-031-05760-1. ISSN 1865-1356. [https://link.springer.com/chapter/10.1007/978-3-031-05760-1\\_53](https://link.springer.com/chapter/10.1007/978-3-031-05760-1_53), DOI: [10.1007/978-3-031-05760-1\\_53](https://doi.org/10.1007/978-3-031-05760-1_53). [COBISS.SI-ID 108466947], [SNIP, WoS, Scopus]

# OBŠTUDIJSKA STROKOVNA DEJAVNOST II

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Obštudijska strokovna dejavnost II
<b>Course title:</b>	Computer science and society II
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	2. letnik	1. semester, 2. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0070537
<b>Koda učne enote na članici/UL Member course code:</b>	63535

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
5				40	45	3

**Nosilec predmeta/Lecturer:** Slavko Žitnik

**Vrsta predmeta/Course type:** izbirni predmet/elective course

**Jeziki/Languages:**

Predavanja/Lectures:	Angleščina, Slovenščina
Vaje/Tutorial:	Angleščina, Slovenščina

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

	<b>Prerequisites:</b>
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### Vsebina:

Na uvodnih predavanjih študentom pojasnimo cilje predmeta in kako jih lahko dosežejo. Med aktivnosti, ki jih lahko štejemo kot obveznosti pri predmetu sodijo vodenje računalniškega (ali po strokovni tematiki sorodnega) krožka na osnovni ali srednji šoli, vodenje študijske skupine na fakulteti, redno obiskovanje izven kurikularnih strokovnih predavanj na fakulteti ali na drugih članicah UL, ki so povezana s predmetom ipd.

### Content (Syllabus outline):

After an introductory lecture on the necessary background of the activities involved in the course, the students' activities include classes on topics in computer and information science and lab work with students of elementary and high schools, organizing study groups of students at the 1st degree level, attending extracurricular lectures at the University of Ljubljana on subjects associated to the topics of the course.

### Temeljna literatura in viri/Readings:

**Keller Gustav, Binder Annette, Thiel Rolf Dietmar** (1999). Boljša motivacija uspešnejše učenje (translated from German); Trening učnih navad. Ljubljana: Center za psihodiagnostična sredstva.  
**Bratanič, Marija** (1990), Mikropedagogija, interakcijsko-komunikacijski aspekt odgoja, Školska knjiga, Zagreb

**Cilji in kompetence:**

**Objectives and competences:**



<p>Cilj predmeta je študentom je omogočiti in s kreditnimi točkami ovrednotiti njihovo izven kurikularno strokovno, nepridobitno delo, ki je za profesionalno profiliranje strokovnjaka na področju računalništva in informatike potrebno, pa ga učni načrt sicer ne pokriva.</p> <p>Splošne kompetence:</p> <ul style="list-style-type: none"> <li>• Sposobnost strokovnega sporazumevanja v domačem in v tujem jeziku</li> <li>• Sposobnost skupinskega dela v strokovnem okolju, vodenje manjše strokovne skupine</li> <li>• Sposobnost administrativnega vodenja procesov, povezanih z raziskovanjem, industrijo, izobraževanjem in drugimi področji</li> <li>• Sposobnost prenašanja znanja in pisanja v domačem in tujem jeziku</li> </ul> <p>Predmetno specifične kompetence:</p> <ul style="list-style-type: none"> <li>• Sposobnost celovite obdelave manjših projektov in reševanja problemov iz prakse s področja računalništva in informatike.</li> <li>• Naučiti se izbrati primerno orodje in tehnologijo za reševanje konkretnega problema</li> <li>• Razvijati sposobnosti za posredovanje znanja in popularizacijo računalniških znanj in veščin.</li> </ul> <p>Sodelovanje pri skupinskem reševanju problemov, vodenja manjše skupine, pripravo gradiv, ki so za vodenje take skupine potrebna, organizacijo in pridobivanje znanj, ki so potrebni za delo skupine, pripravo terminskega in vsebinskega načrta za delo skupine itd.</p>	<p>The object of this course is to provide a framework for awarding study credits for extracurricular non-profit activities of students related to computer and information science, providing useful experience for experts in this field that are not included in the curriculum of the study program.</p> <p>General competences:</p> <ul style="list-style-type: none"> <li>• The ability of professional communication in the native language as well as a foreign language</li> <li>• The ability of teamwork within the professional environment; management of a small professional team</li> <li>• The ability for administrative management of processes related to research, industry, education and other fields</li> <li>• The ability of knowledge transfer and writing skills in the native language as well as a foreign language.</li> </ul> <p>Subject specific competences:</p> <ul style="list-style-type: none"> <li>• Completing smaller practical projects and solve problems in the fields for computer and information science</li> <li>• Obtaining the knowhow to choose the suitable tools and technologies for a specific problem</li> <li>• Developing teaching skills and means for popularizing computer and information science topics and issues.</li> <li>• Participating in group solutions, organizing and supervising the work of a smaller group including the preparation of the necessary materials, planning group work, etc.</li> </ul>
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<p><b>Predvideni študijski rezultati:</b></p> <p>Spoznavanje osnovnih zakonitosti pri posredovanju znanja in popularizaciji računalniškega področja manjši skupini predvsem mlajših članov, organizaciji njenega dela in razumevanje pomena in uporabe takih znanj pri strokovnem delu strokovnjaka na področju računalništva in informatike.</p>	<p><b>Intended learning outcomes:</b></p> <p>Basic educational principles and teaching practice in the process of introducing computer science topics to smaller groups of younger students, organization of group work, understanding the role of such competencies in the work of an expert in the field of computer and information science.</p>
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<p><b>Metode poučevanja in učenja:</b></p> <p>Predavanja, mentorski in seminarski način dela ter spremljanja dela študenta, z ustim nastopom ob zaključku semestra. Poseben poudarek je na skupinskem delu pri seminarjih.</p>	<p><b>Learning and teaching methods:</b></p> <p>Lectures, individual work with students, seminars with oral presentations with special emphasis on group work.</p>
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<b>Načini ocenjevanja:</b>	<b>Delež/Weight</b>	<b>Assessment:</b>
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, kolokviji in projektno delo)	50,00 %	Continuing (homework, midterm exams, project work)
Končno preverjanje (pisni in ustni izpit)	50,00 %	Final (written and oral exam)
Ocene: opravi z odliko, opravi ali ni opravi (v skladu s Statutom UL).		Grading: passed with excellence, passed or failed (according to the Statute of UL).

### Reference nosilca/Lecturer's references:

- KLEMEN, Matej, ŽITNIK, Slavko. Neural coreference resolution for Slovene language. *Computer science and information systems*. [Print ed.]. 2022, vol. 19, iss. 2, str. 495-521, ilustr. ISSN 1820-0214. <http://www.doiserbia.nb.rs/Article.aspx?ID=1820-02142100060K#.Ya2cu9DMJPY>, DOI: [10.2298/CSIS201120060K](https://doi.org/10.2298/CSIS201120060K). [COBISS.SI-ID 87851011], [JCR, SNIP, WoS, Scopus do 26. 1. 2023: št. citatov (TC): 1, čistih citatov (CI): 1, čistih citatov na avtorja (CIAu): 0,50]
- KNEZ, Timotej, GAŠPERLIN, Domen, BAJEC, Marko, ŽITNIK, Slavko. Blockchain-based transaction manager for ontology databases. *Informatica*. [Print ed.]. 2022, vol. 33, no. 2, str. 343-364, ilustr. ISSN 0868-4952. <https://informatica.vu.lt/journal/INFORMATICA/article/1264/info>, DOI: [10.15388/22-INFOR490](https://doi.org/10.15388/22-INFOR490). [COBISS.SI-ID 112947203], [JCR, SNIP, WoS, Scopus]
- ŽITNIK, Slavko, BLAGUS, Neli, BAJEC, Marko. Target-level sentiment analysis for news articles. *Knowledge-based systems*. [Print ed.]. Aug. 2022, vol. 249, str. 1-14, ilustr. ISSN 0950-7051. <https://www.sciencedirect.com/science/article/pii/S095070512200452X?via%3DiHub>, DOI: [10.1016/j.knsys.2022.108939](https://doi.org/10.1016/j.knsys.2022.108939). [COBISS.SI-ID 106573827], [JCR, SNIP, WoS do 8. 2. 2023: št. citatov (TC): 2, čistih citatov (CI): 2, čistih citatov na avtorja (CIAu): 0,67, Scopus do 30. 1. 2023: št. citatov (TC): 4, čistih citatov (CI): 4, čistih citatov na avtorja (CIAu): 1,33]
- SMITH, Glenn Gordon, HAWORTH, Robert, ŽITNIK, Slavko. Computer science meets education : Natural Language Processing for automatic grading of open-ended questions in eBooks. *Journal of educational computing research*. [Print ed.]. Dec. 2020, vol. 58, no. 7, str. 1227-1255, ilustr. ISSN 0735-6331. <https://journals.sagepub.com/doi/10.1177/0735633120927486>, DOI: [10.1177/0735633120927486](https://doi.org/10.1177/0735633120927486). [COBISS.SI-ID 17989635], [JCR, SNIP, WoS do 26. 10. 2022: št. citatov (TC): 9, čistih citatov (CI): 9, čistih citatov na avtorja (CIAu): 3,00, Scopus do 1. 2. 2023: št. citatov (TC): 11, čistih citatov (CI): 11, čistih citatov na avtorja (CIAu): 3,67]
- KNEZ, Timotej, BAJEC, Marko, ŽITNIK, Slavko. ANGLEr : a next-generation natural language exploratory framework. V: GUIZZARDI, Renata (ur.), RALYTÉ, Jolita (ur.), FRANCH, Xavier (ur.). *Research challenges in information science : 16th International Conference, RCIS 2022, Barcelona, Spain, May 17-20, 2022 : proceedings*. Cham: Springer, cop. 2022. Str. 761-768, ilustr. Lecture notes in business information processing (Internet), 446. ISBN 978-3-031-05760-1. ISSN 1865-1356. [https://link.springer.com/chapter/10.1007/978-3-031-05760-1\\_53](https://link.springer.com/chapter/10.1007/978-3-031-05760-1_53), DOI: [10.1007/978-3-031-05760-1\\_53](https://doi.org/10.1007/978-3-031-05760-1_53). [COBISS.SI-ID 108466947], [SNIP, WoS, Scopus]

# PRENOS MULTIMEDIJSKIH SIGNALOV

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Prenos multimedijskih signalov
<b>Course title:</b>	Transmission of multimedia signals
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik	1. semester	obvezni

<b>Univerzitetna koda predmeta/University course code:</b>	0075702
<b>Koda učne enote na članici/UL Member course code:</b>	64M21

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			105	6

**Nosilec predmeta/Lecturer:** Anton Umek

**Vrsta predmeta/Course type:** obvezni predmet/compulsory course

**Jeziki/Languages:**

Predavanja/Lectures:	Angleščina, Slovenščina
Vaje/Tutorial:	Angleščina, Slovenščina

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

Vpis v letnik.	Prerequisites: Enrollment in the study year.
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Vsebina:	Content (Syllabus outline):
<p>Predavanja:</p> <ul style="list-style-type: none"><li>Digitalne komunikacije med multimedijskimi napravami: terminali, video in avdio napravami, senzorji in aktuatorji.</li><li>Digitalni multimedijski signali, informacija in podatkovni pretok</li><li>Omejitve fizikalnega komunikacijskega kanala pri prenosu električnih signalov, prenosna kapaciteta komunikacijskega kanala</li><li>Obdelava signalov za prenos po komunikacijskem kanalu:<ul style="list-style-type: none"><li>o kodiranje signalov</li><li>o digitalni modulacijski postopki</li><li>o sodostop do skupnega komunikacijskega medija</li></ul></li><li>Digitalni prenosni sistemi za povezovanje prenosnih multimedijskih naprav na kratkih razdaljah : BAN, PAN, WLAN.</li></ul>	<p>Lectures:</p> <ul style="list-style-type: none"><li>Digital communication between multimedia devices: terminals, video and audio devices, sensors and actuators.</li><li>The digital multimedia signals, information and data rate</li><li>Limitations of physical communication channel for the transmission of electrical signals, the transmission capacity of the communication channel</li><li>Signal processing for transmission over the communication channel:<ul style="list-style-type: none"><li>- signal coding</li><li>- digital modulation methods</li><li>- multiple access to a common medium</li></ul></li><li>Digital transmission systems for connecting portable multimedia devices over short distances: BAN, PAN, WLAN.</li></ul>

<ul style="list-style-type: none"> <li>• Pregled in primerjava aktualnih brezžičnih tehnologij v praksi glede na topologijo omrežij, doseg, podatkovni pretok in porabo energije.</li> </ul> <p>Vaje:</p> <ul style="list-style-type: none"> <li>• Eksperimenti z uporabo sodobnih programskih orodij za modeliranje digitalnih prenosnih sistemov.</li> <li>• Laboratorijski prikaz delovanja osnovnih gradnikov digitalnih prenosnih sistemov.</li> <li>• Meritve digitalnih signalov in lastnosti prenosnih sistemov</li> <li>• Eksperimenti z multimediskimi komunikacijskimi napravami.</li> </ul>	<ul style="list-style-type: none"> <li>• Overview and comparison of current wireless technologies in practice, depending on the network topology, range, data rate and energy consumption.</li> </ul> <p>Lab work:</p> <ul style="list-style-type: none"> <li>• Experiments by using software tools for modeling digital transmission systems.</li> <li>• Laboratory demonstration of basic building blocks in digital transmission systems.</li> <li>• Measurements of digital signals and characteristics of the transmission system</li> <li>• Experiments with multimedia communication devices.</li> </ul>
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### Temeljna literatura in viri/Readings:

1. Bhatnagar, Gaurav. Introduction to multimedia systems. Academic Press, 2002.
2. Sašo Tomažič, Digitalne komunikacije, Založba FE, 2014.
3. Andy Bateman, Digital Communications: Design for the Real World, Addison Wesley, 1999.
4. Da Silva, Mário Marques. Multimedia communications and networking. CRC Press, 2012.
5. Rao, Kamisetty Ramamohan, Zoran S. Bojkovic, and Bojan M. Bakmaz. Wireless multimedia communication systems: design, analysis, and implementation. CRC Press, 2017.

### Cilji in kompetence:

- Razumevanje omejitev pri prenosu digitalnih signalov po fizičnem prenosnem kanalu.
- Poznavanje parametrov za oceno kvalitete pri prenosu multimediskih signalov po komunikacijskem kanalu.
- Poznavanje komunikacijskih tehnologij, ki omogočajo povezljivost multimediskih naprav. Poznavanje komunikacijskih protokolov, ki omogočajo povezljivost multimediskih naprav.

### Objectives and competences:

- Understanding the restrictions on the transfer of digital signals on the physical transmission channel.
- Understanding the parameters for the evaluation of the transmission quality of multimedia signals over the communication channel.
- Knowledge on communication technologies that enable connectivity multimedia devices.
- Knowledge on communication protocols that enable inter-connectivity of multimedia devices.

### Predvideni študijski rezultati:

- Po uspešno opravljenem modulu naj bi bili študenti zmožni:
- razložiti delovanje gradnikov v verigi povezav fizičnega sloja,
  - računati podatkovne pretoke multimediskih signalov in prenosne zmogljivosti povezav,
  - analizirati lastnosti različnih prenosnih tehnologij,
  - izmeriti lastnosti multimediskih signalov in komunikacijskih povezav,
  - povezati multimediske naprave v komunikacijsko omrežje.

### Intended learning outcomes:

- After successful completion of the course, students should be able to:
- explain the functionality of the building blocks in the link chain on the physical layer,
  - calculate the data flows of multimedia signals and communication channel capacities,
  - analyze the properties of different transmission technologies,
  - measure the properties of multimedia signals and communication links,
  - interconnect multimedia devices into the communication network.

### Metode poučevanja in učenja:

Predavanja, na katerih se študent seznanja s teoretičnimi osnovami, in laboratorijske vaje, kjer nekaj problemov spozna tudi praktično in jih skuša v duhu timskega dela reševati.

### Learning and teaching methods:

Lectures in which the student is acquainted with the theoretical basics and lab work where the student meets the practical problems and solves them in the team.

### Načini ocenjevanja:

### Delež/Weight Assessment:

Način: laboratorijske vaje, pisni izpit, ustni izpit. Ocena 5 je negativna ocena, ocene od vključno 6 do 10 so pozitivne. Opravljene laboratorijske vaje so pogoj za pristop k izpitu. Prispevki k oceni:		Type: laboratory exercises, written exam, oral exam. Negative grade is 5, positive grades: from 6 to 10. Completed laboratory exercises are prerequisite for the exam. Contributions to final grade:
pisni izpit	50,00 %	written exam
ustni izpit	50,00 %	oral examination

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

<ol style="list-style-type: none"> <li>1. UMEK, Anton. Theoretical and available transmission capacity of UTP. V: TENCON 2001. Piscataway: IEEE. cop. 2001, str. 698-702, ilustr.</li> <li>2. UMEK, Anton, ŠTULAR, Mitja, TOMAŽIČ, Sašo. Multiple access techniques. V: FURHT, Borivoje (ur.). Encyclopedia of wireless and mobile communications. Boca Raton; New York: Taylor &amp; Francis Group: Auerbach Publications. cop. 2008, vol. 2, str. 900-910, ilustr.</li> <li>3. UMEK, Anton, TOMAŽIČ, Sašo, KOS, Anton. Wearable training system with real-time biofeedback and gesture user interface. Personal and ubiquitous computing, ISSN 1617-4909, Oct. 2015, vol. 19, no. 7, str. 989-998, ilustr.</li> <li>4. UMEK, Anton, KOS, Anton. The role of high performance computing and communication for real-time biofeedback in sport. Mathematical problems in engineering, ISSN 1024-123X. [Print ed.], 2016, vol. 2016, str. 1-12, ilustr.</li> <li>5. KOS, Anton, MILUTINOVIĆ, Veljko, UMEK, Anton. Challenges in wireless communication for connected sensors and wearable devices used in sport biofeedback applications. FGCS, ISSN 0167-739X. [Print ed.], 2018, vol. , no. , str. 1-11, ilustr.</li> </ol>
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# PRENOS MULTIMEDIJSKIH VSEBIN

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Prenos multimedijskih vsebin
<b>Course title:</b>	Multimedia Content Transfer
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik	2. semester	obvezni

<b>Univerzitetna koda predmeta/University course code:</b>	0075703
<b>Koda učne enote na članici/UL Member course code:</b>	64M23

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			105	6

**Nosilec predmeta/Lecturer:** Anton Kos

**Vrsta predmeta/Course type:** obvezni predmet/compulsory course

**Jeziki/Languages:**

Predavanja/Lectures:	Angleščina, Slovenščina
Vaje/Tutorial:	Angleščina, Slovenščina

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

Vpis v letnik.	Enrollment in the study year.
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Vsebina:	Content (Syllabus outline):
<p>Predmet podaja znanja, ki so potrebna za razumevanje elementov, tehnik in principov prenosa multimedijskih vsebin. Študente seznanja z osnovnimi karakteristikami in zahtevami multimedijskega prometa ter pojasni in utemelji kriterije izbire ustreznega prenosnega sistema za posamezne tipe multimedijskih vsebin.</p> <ul style="list-style-type: none"><li>Definicija multimedijskih pretokov.</li><li>Prenos multimedijskih vsebin od izvora do ponora.</li><li>Omrežja in protokoli za prenos multimedijskih vsebin.</li><li>Zaseganje in deljenje virov prenosnega omrežja.</li><li>Tehnike posredovanja multimedijskih pretokov.</li><li>Lastnosti in značilnosti prometnih karakteristik multimedijskih pretokov.</li><li>Mehanizmi za prenos multimedijskih vsebin v operaterskih in ne-operaterskih okoljih</li></ul>	<p>The course provides the knowledge necessary for understanding the elements, techniques, and principles of transfer of multimedia content. Students are acquainted with the basic characteristics and requirements of multimedia traffic and with the selection criteria of the transmission system for individual types of multimedia content.</p> <ul style="list-style-type: none"><li>Definition of multimedia content and flows.</li><li>Transfer of multimedia content from the source to the destination.</li><li>Networks and protocols for the transfer of multimedia content.</li><li>Transfer network resource access and sharing.</li><li>Forwarding of multimedia data.</li><li>Properties and characteristic of multimedia traffic.</li><li>Mechanisms for the multimedia content transfer in the operator and user environments</li></ul>

<ul style="list-style-type: none"> <li>• Tehnike upravljanja multimedijskega prometa: teorija čakalnih vrst, prometni inženiring.</li> <li>• Prenosne zahteve multimedijskih storitev in pretokov ter načini njihovega prenosa: tipi storitev, najpomembnejši prenosni parametri, interaktivnost in prenos v realnem času.</li> <li>• Problemi pri prenosu multimedijskih vsebin in zagotavljanja ustreznih prenosnih pogojev.</li> <li>• Zagotavljanje kakovosti storitve: definicije, osnovni principi, standardi, parametri, mere.</li> <li>• Načrtovanje in izbira prenosnega sistema.</li> </ul>	<ul style="list-style-type: none"> <li>• Techniques of multimedia traffic engineering.</li> <li>• Transfer demands of multimedia flows and methods of its transfer: the most important transfer parameters, interactivity, real real-time transfer.</li> <li>• Problems with multimedia content transfer and the assurance of adequate transfer conditions.</li> <li>• Quality of service assurance: definitions, fundamental principles, standards, parameters, measures.</li> <li>• Planning and selection of the transfer system.</li> </ul>
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### Temeljna literatura in viri/Readings:

<ol style="list-style-type: none"> <li>1. Marques da Silva, Multimedia Communications and Networking, CRC Press, ISBN 978-1-4398-7484-4</li> <li>2. Andleigh, Thakrar, Multimedia Systems Design, Prentice Hall, 654 str., ISBN 0-13-089095-2</li> <li>3. Andrew S. Tanenbaum, Computer networks, Prentice Hall, 891 str., ISBN 0-13-038488-7</li> <li>4. Shrinavas Vegesna, IP Quality of Service, Cisco Press, 343 str., ISBN 1-57870-116-3</li> </ol>
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### Cilji in kompetence:

<p>Glavni cilj predmeta je podati celostno sliko procesa prenosa multimedijskih vsebin.</p> <p>Kompetence, ki jih bodo študenti pridobili:</p> <ul style="list-style-type: none"> <li>• Razumevanje postopka tvorbe in lastnosti prometa multimedijskih vsebin, soodvisnosti elementov prenosnega sistema in principov zagotavljanja ustreznih prenosnih pogojev.</li> <li>• Razumevanje vloge prenosnega sistema, povezovanje teorije in praktičnih problemov, sposobnost ovrednotenja ustreznosti izdelanih rešitev.</li> <li>• Razumevanje mehanizmov prenosa multimedijskih vsebin in storitev v operaterskih in neoperaterskih sistemih kot so IPTV, radiodifuzija ter v okviru spletnih in mobilnih multimedijskih storitev.</li> <li>• Samostojno delo na področju prenosa multimedijskih vsebin in upravljanju njihovega prometa.</li> </ul>
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### Objectives and competences:

<p>The main objective of the course is to provide a comprehensive overview of the process of multimedia content transfer.</p> <p>Competencies that students will gain include:</p> <ul style="list-style-type: none"> <li>• Understanding the process of multimedia content creation, the characteristics of the multimedia traffic, the interdependence of the elements of the transmission system and the principles for providing proper transmission conditions.</li> <li>• Understanding the role of the transmission system, linking the theory with the practical issues; the ability for the evaluation of the designed solutions.</li> <li>• Understanding the mechanisms of multimedia content and service transfer in the operator and non-operator systems such as IPTV, broadcasting and online and mobile multimedia services.</li> <li>• Individual work on multimedia content transfer and traffic management.</li> </ul>
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### Predvideni študijski rezultati:

<p>Po uspešno opravljenem modulu naj bi bili študenti zmožni:</p> <ul style="list-style-type: none"> <li>• razumeti osnove vseh prvin prenosa multimedijskih vsebin,</li> <li>• pojasniti osnovne prometne karakteristike multimedijskih pretokov,</li> <li>• opisati osnovne elemente prenosnega sistema,</li> <li>• analizirati lastnosti, parametre in delovanje prenosnega sistema,</li> <li>• uporabiti osnovne principe za zagotavljanje ustreznih pogojev pri prenosu multimedijskih vsebin,</li> <li>• izbrati primeren prenosni sistem za prenos multimedijskih vsebin z želeno stopnjo kakovosti storitve.</li> </ul>
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### Intended learning outcomes:

<p>After successful completion of the course, students should be able to:</p> <ul style="list-style-type: none"> <li>• understand the fundamentals of multimedia content transfer,</li> <li>• explain the fundamental traffic characteristics of multimedia flows,</li> <li>• describe the basic elements of transfer system,</li> <li>• analyse properties, parameters, and operation of the transfer system,</li> <li>• implement fundamental principles for the assurance of adequate conditions for multimedia content transfer,</li> <li>• selection of appropriate transfer systems for multimedia content transfer with the desired level of quality of service.</li> </ul>
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**Metode poučevanja in učenja:**

Predavanja, na katerih se študent seznani s teoretičnimi osnovami, in laboratorijske vaje, kjer nekaj problemov spozna tudi praktično in jih skuša v duhu timskega dela reševati.

**Learning and teaching methods:**

Lectures in which the student is acquainted with the theoretical basics and lab work where the student meets the practical problems and solves them in the team.

**Načini ocenjevanja:****Delež/Weight****Assessment:**

Način: laboratorijske vaje, pisni izpit, ustni izpit. Ocena 5 je negativna ocena, ocene od vključno 6 do 10 so pozitivne. Opravljene laboratorijske vaje so pogoj za pristop k izpitu.		Type: laboratory exercises, written exam, oral exam. Negative grade is 5, positive grades: from 6 to 10. Completed laboratory exercises are prerequisite for the exam.
Prispevki k oceni: pisni izpit	50,00 %	Contributions to final grade: written exam
ustni izpit	50,00 %	oral examination

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

1. KOS, Anton. Prenos multimedijских vsebin : skripta. Ljubljana: LKN, 2013.
2. KOS, Anton. Zagotavljanje različnih stopenj kakovosti storitev v omrežjih s paketnim prenosom podatkov : doktorska disertacija. Ljubljana: [A. Kos], 2006. 197 str.
3. KOS, Anton, VERLIČ, Robert, TOMAŽIČ, Sašo. Kakovost storitve v paketnih omrežjih = Quality of service in packet networks. Elektrotehniški vestnik, ISSN 0013-5852. [Slovenska tiskana izd.], 2004, letn. 71, št. 3, str. 103-108.
4. KOS, Anton, TOMAŽIČ, Sašo. Multimedia traffic on existing LANs. Proceedings of the International Workshop on Intelligent Communications and Multimedia Terminals, [Ljubljana, Slovenia, November 19-21, 1998]. [Ljubljana: Faculty of Electrical Engineering. 1998], str. 95-98.
5. KOS, Anton, TOMAŽIČ, Sašo. A simulator for a general packet network device - simulating a new scheduler. EUROSIM 2007 : proceedings of the 6th EUROSIM Congress on Modelling and Simulation, 9-13 September 2007, Ljubljana, Slovenia. Vol. 2, Full papers, 6th EUROSIM Congress on Modelling and Simulation, Ljubljana, Slovenia, 9-13 September, 2007. Vienna: ARGESIM. cop. 2007, str. 1-7, ilustr.
6. KOS, Anton, MILUTINOVIĆ, Veljko, UMEK, Anton. Challenges in wireless communication for connected sensors and wearable devices used in sport biofeedback applications. Future generation computer systems. [Print ed.]. Mar. 2019, vol. 92, str. 582-592.
7. HERNÁNDEZ CASILLAS, Andrea, TOMAŽIČ, Sašo, KOS, Anton. Reliable communication protocol for wireless biofeedback systems in sport. The IPSI BGD Transactions on Advanced Research. Jan. 2020, vol. 16, no. 1, str. 1-4.



# RAČUNALNIŠKA ZVOČNA PRODUKCIJA

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Računalniška zvočna produkcija
<b>Course title:</b>	Computer based sound production
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	2. letnik	1. semester	izbirni
Računalništvo in informatika, druga stopnja, magistrski	Računalništvo in informatika (smer)		1. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0082596
<b>Koda učne enote na članici/UL Member course code:</b>	63523

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			105	6

**Nosilec predmeta/Lecturer:** Denis Trček

**Vrsta predmeta/Course type:** strokovni izbirni predmet/specialist elective course

<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

**Prerequisites:**

### Vsebina:

- Uvod in zgodovinski pregled področja.
- Temelji zvoka in računalniške zvočne produkcije:
  - o fizikalni (amplituda, frekvenca, faza, interferenca, resonanca, hitrost, moč, preostale značilnosti valovanj);
  - o matematični (Fourierova teorija, teorem o vzorčenju, konvolucija, korelacija, Hilbertov transform, Gaborjev zvočni kvant in transform, itd.);
  - o fiziološki in psihoakustika (slušna percepcija in frekvenčni razpon, posredna percepcija prek drugih anatomskih struktur, pomen harmonskih komponent zvoka, lokalizacija, maskiranje, kritični pasovi, učinki okolja, rezultati zadnjih nevroznanstvenih raziskav na tem področju).

### Content (Syllabus outline):

- Introduction and overview of the field.
- Basics of sound and computer based production:
  - o physics (amplitude, frequency, phase, speed, interference, resonance, power, other wave phenomena);
  - o mathematics (Fourier theory, sampling theory, convolution, correlation, Hilbert transform, Gabor's acoustic quant and transform, etc.);
  - o physiology and psychoacoustics (aural perception, frequency range, indirect perception by various anatomical structures, the role of harmonics, localization, masking, critical bands, environmental effects, latest neuroscience research results in this domain).

<ul style="list-style-type: none"> <li>Elektronski in omrežni vidiki procesiranja: analogni in digitalni signal, (kvantizacijski) šum, pasovna širina medija in naprave, ojačitev in slabenje, analogno digitalna in digitalno analogna pretvorba, popačenja, filtriranje, vrste mikrofонов in postopki zajemanja zvoka.</li> <li>Generatorji zvoka: sintetizatorji (aditivna sinteza, odštevalna sinteza, frekvenčno modularna sinteza...), vzorčevalniki.</li> <li>Računalniško snemanje zvoka: zajem kodiranega zvoka (sekvencerji), zajem vzorčenega zvoka (direct-to-disc recording).</li> <li>Standardne studiojske komponente: mešalniki, limiterji, kompresorji, reverberatorji, odstranjevalci šuma, korektorji višine, ekvilizatorji.</li> <li>Protokoli in algoritmi v zvočni produkciji: MIDI, IEC-60958 (AES / EBU), S/PDIF, AC-3, E-AC-3.</li> <li>Sinhronizacijski mehanizmi: MTC, SMPTE, integracija z video produkcijo, računalniškimi igrami in filmom.</li> <li>Programski standardi: vmesniki (VST / Steinberg, DirectX / MS), formati zapisov (Wav, MP3, Ogg), vzorčeni zvoki (SoundFont).</li> <li>Sodobna zvočna reprodukcija (omrežni tokovniki, protokoli RTP, RTCP in RTSP), napredna 2D ter 3D produkcija (sistemi 5.1, 7.1, Dolby Atmos).</li> <li>Profesionalna orodja in njih uporaba (Steinberg-Yamaha, Twelve Tone Systems – Roland - BandLab, odprtokodne rešitve).</li> <li>Zadnji trendi - prodor umetne inteligence in strojnega učenja v zvočno produkcijo (konkretne aplikacije v zvočni produkciji).</li> </ul> <p>Addendum: Mini vložki s praktičnim delom, ki pokrivajo najnovejše trende ali specifične vidike, ki niso pokriti na vajah.</p>	<ul style="list-style-type: none"> <li>Electronic and network principles of sound processing: analog and digital signal, (quantization) noise, medium / device bandwidth, amplification and attenuation, analog to digital, and digital to analog conversion, distortion, filtering, types of microphones, signals capturing processes.</li> <li>Sound generators: synthesizers (additive synthesis, subtractive and frequency modulation synthesis...), samplers.</li> <li>Computer based recording: capturing of coded sound (sequencers), capturing of sampled sounds (with direct-to-disc recording).</li> <li>Standard studio components: mixing consoles, limiters, compressors, reverbs, noise reducers, pitch correction tools, equalizers.</li> <li>Protocols and algorithms in computer-based production: MIDI, IEC-60958 (AES / EBU), S/PDIF, AC-3, E-AC-3.</li> <li>Synchronization mechanisms: MTC, SMPTE, video, computer games and movies integration.</li> <li>Programming standards: interfaces (VST / Steinberg, DirectX / MS), formats (wav, MP3, Ogg), sampled sounds (SoundFont).</li> <li>Contemporary sound reproduction (network streaming technology, protocols RTP, RTCP, RTSP), advanced 2D and 3D production (systems 5.1, 7.1, Dolby Atmos).</li> <li>Professional tools and their application (Steinberg-Yamaha, Twelve Tone Systems – Roland - BandLab, open-source solutions).</li> <li>Latest trends – artificial intelligence and machine learning in sound production (concrete applications of ML in computer sound production).</li> </ul> <p>Addendum: Mini practical tasks covering the latest technological issues or specific issues not covered at laboratory works.</p>
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### Temeljna literatura in viri/Readings:

- D. Trček: Računalniška zvočna produkcija, kopije prosojnic, FRI UL, 2023 / 2024.
- Loy G., Musimathics, The MIT Press, MIT, Cambridge, 2006.
- V učnem načrtu omenjeni standardi.

### Cilji in kompetence:

Cilj predmeta je, da študentje tehničnih in umetniških profilov pridobijo in osvojijo znanja na področju računalniške zvočne produkcije tako za čisto tehnično, kot tudi kreativno aplikacijo v produkcijskih okoljih.

Splošne kompetence:  
Sposobnost definiranja, razumevanja in reševanja kreativnih profesionalnih izzivov na področju računalništva in informatike.  
Sposobnost profesionalnega komuniciranja v materinem in tujem jeziku.

### Objectives and competences:

The goal of the course is to educate students (with technological and fine-arts background) for using computers in sound production be it for purely technical, or creative application scenarios and production environments.

General competences:  
The ability to define, understand and solve creative professional challenges in computer and information science.  
The ability of professional communication in the native language as well as a foreign language.  
The ability to understand and apply computer and information science knowledge to other technical and

<p>Sposobnost razumevanja in uporabe znanja računalništva in informatike na drugih relevantnih področjih (ekonomija, organizacija, umetnost, itd.). Predmetno specifične kompetence: Praktična znanja in sposobnosti na področju strojne in programske opreme ter informacijske tehnologije za uspešno profesionalno delo.</p>	<p>relevant fields (economics, organisational science, fine arts, etc). Subject specific competences: Practical knowledge and skills of computer hardware, software and information technology necessary for successful professional work in computer and information science.</p>
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#### **Predvideni študijski rezultati:**

Po zaključku predmeta bo študent:

- poznal inženirske principe računalniške zvočne produkcije;
- poznal in razumel fiziološke zakonitosti percepcije zvoka;
- znan uporabljati omenjene principe v produkcijskem okolju;
- sposoben razvoja enostavnejših tehnoloških rešitev na tem področju;
- uporabe pridobljenih znanj tudi na področjih kreativnega ustvarjanja (umetnost);
- poznal problematiko zaščite in varovanja intelektualne lastine.

#### **Intended learning outcomes:**

After completion of the course a student will:

- be familiar with the engineering principles of computer sound production;
- know and understand physiological laws of sound perception;
- be able to implement these principles in production environments;
- be able to develop basic technological solutions in this area;
- know how to use the acquired knowledge in creative ways (fine arts);
- be familiar with intellectual property protection.

#### **Metode poučevanja in učenja:**

Predavanja, vaje s projektnim delom (praktične prototipne implementacije), lastne predstavitve. Udeležba na vajah je obvezna (zahtevan procent udeležbe se določi ob začetku študijskega leta). Nosilec predmeta lahko določi obvezno udeležbo tudi na predavanjih.

#### **Learning and teaching methods:**

Lectures, laboratory work (with practical prototype implementations), students' presentations. Attendance of laboratory work is mandatory (the exact percentage is announced at the beginning of a study year). The lecturer may impose mandatory attendance of lectures.

#### **Načini ocenjevanja:**

#### **Delež/Weight**

#### **Assessment:**

50 % ocene predstavlja sprotno delo študenta v obliki preverjanj na vajah (domače naloge, kvizi, praktičen projekt),	50,00 %	50% of the final grade is obtained on the basis of on-going laboratory work (home-works, quizzes, practical project implementations and presentations).
50 % ocene pa predstavlja izpit, ki je načeloma v pisni obliki, lahko pa tudi v pisni in ustni obliki (pri čemer lahko nosilec namesto ustnega izpita uvede seminar).	50,00 %	The other 50% is obtained on the basis of a written exam, or written and oral exam (the lecturer may decide that a coursework replaces the oral exam).
Za uspešno opravljene obveznosti pri predmetu morata biti pozitivni obe delni oceni. Pristop k pisnemu izpitu je možen le po uspešno opravljenih obveznostih pri vajah (in v primeru dodatnih zahtev, ki se nanašajo na predavanja, po izpolnitvi le-teh).		To be eligible for the written exam, a candidate must have successfully completed laboratory work, and fulfilled other obligations related to lecturing that the lecturer may have imposed. For successful completion of the course both grades have to be positive.
Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL).		Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana).

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

1. Trček D., Cruxes for visual domain sonification in digital arts, Digital creativity, 2021, vol. 32, no. 4, str. 293-306, Taylor & Francis, DOI: 10.1080/14626268.2021.2002913.

2. Trček D., TRČEK, Gašper. sonicLamination - from a concept to artistic binding of visual and sound domains by using advanced technology. International journal of arts and technology, 2019, vol. 11, no. 2, str. 219-229, ISSN 1754-8853.
  3. Trček D., Parallel spaces, London, Peoplesound.com, 2001, CD (ca 40 min).
  4. Trček D., glasba in glasbena produkcija na TRČEK PEČAK, Tamara. Ajkec med freskami. Ljubljana: Narodna galerija, 2002. 1 videokaseta (VHS, PAL) (ca 30 min), barve, zvok. ISBN 961-6029-56-8. [COBISS.SI-ID 121147392]
  5. Trček D., glasba in glasbena produkcija na TRČEK PEČAK, Tamara. Ajkec pri restavradorjih. Ljubljana: Televizija Slovenija: Narodna galerija, 2004/2005. 1 videokaseta (VHS, PAL), barve, zvok. [COBISS.SI-ID 513451903]
- Celotna bibliografija je dostopna na SICRISu: <https://bib.cobiss.net/biblioweb/eval/si/slv/evalrsr/11077>.

# RAČUNALNIŠKE STORITVE V OBLAKU

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Računalniške storitve v oblaku
<b>Course title:</b>	Cloud Computing
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	2. letnik	1. semester	izbirni
Računalništvo in informatika, druga stopnja, magistrski	Računalništvo in informatika (smer)		1. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0082823
<b>Koda učne enote na članici/UL Member course code:</b>	63541

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	20	10			105	6

**Nosilec predmeta/Lecturer:** Branko Matjaž Jurič

**Vrsta predmeta/Course type:** strokovni izbirni predmet /specialist elective course

**Jeziki/Languages:**

Predavanja/Lectures:	Angleščina, Slovenščina
Vaje/Tutorial:	Angleščina, Slovenščina

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

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**Prerequisites:**

### Vsebina:

Razvoj aplikacij, ki se izvajajo na strežnikih  
Definicija računalništva v oblaku: kaj je računalništvo v oblaku, namen, vloga in pomen, cilji  
Izzivi: upravljanje infrastrukture, arhitektura aplikacij za oblak, shranjevanje podatkov, varnost, ostali vidiki  
Lastnosti: samo oskrba na zahtevo, elastičnost in skalabilnost, dostop v obliki storitev, nadzor storitev, souporaba virov (pooling), itd.  
Storitveni modeli: IaaS (Infrastruktura kor storitev), PaaS (Platforma kot storitev), SaaS (Aplikacije kot storitve), XaaS  
Podrobni pregled IaaS (Infrastruktura kor storitev)

- Pregled konceptov, arhitekturni vidik
- Privatni oblak, javni oblak, hibridni oblak, virtualni oblak

### Content (Syllabus outline):

Developing applications for the server-side  
Definition of cloud computing: what is cloud computing, purpose, role and importance, objectives  
Challenges: Infrastructure Management, Application Architecture for cloud, data storage, security, other aspects  
Features: on demand self-provisioning, elasticity and scalability, access in the form of services, monitoring, sharing of resources (pooling), etc..  
Service models: IaaS (Infrastructure-as-a-Service), PaaS (Platform-as-a-Service), SaaS (Software-as-a-Service), XaaS  
Detailed overview of IaaS:

- Overview of concepts, architectural perspective
- Private cloud, public cloud, hybrid cloud, virtual cloud

<ul style="list-style-type: none"> <li>• Spoznavanje in primerjava najpomembnejših IaaS tehnologij</li> </ul> <p>Podrobni pregled PaaS (Platforma kot storitev)</p> <ul style="list-style-type: none"> <li>• Pregled konceptov, arhitekturni vidik</li> <li>• Spremembe v razvojnih modelih: Trajno stanje: distribuirani datotečni sistemi, nestrukturirane shrambe, NoSQL baze, SQL baze v oblaku; Poslovna logika: spletne storitve, REST storitve, ostale tehnologije; Izvajalno okolje</li> <li>• Spoznavanje in primerjava najpomembnejših PaaS tehnologij: Java EE, Azure, Google App Engine, itd.</li> </ul> <p>Podrobni pregled SaaS (Aplikacije kot storitve)</p> <ul style="list-style-type: none"> <li>• Pregled konceptov, arhitekturni vidik</li> <li>• Model dostopa, koncept razvoja</li> <li>• Poslovni model, storitve v oblaku (lokacijske, dostava podatkov, bogatenje podatkov, integracijske storitve, poslovna inteligenca, itd.)</li> </ul> <p>Namestitveni modeli</p> <ul style="list-style-type: none"> <li>• Zasebni, javni, hibridni, skupni oblak</li> <li>• Na lokaciji, pri ponudniku, hibridni model, pregled ponudnikov</li> </ul> <p>Migracija v oblak</p> <p>Nadzor, upravljanje, SLA in QoS</p> <p><b>Praktični del:</b></p> <ul style="list-style-type: none"> <li>• Vzpostavitev lastnega računalniškega oblaka</li> <li>• Razvoj aplikacij za oblak</li> </ul> <p>o Tehnološki vidiki</p> <p>o Vsebinsko-poslovni vidiki</p> <ul style="list-style-type: none"> <li>• Razvoj inovativnih aplikacij, ki delujejo v oblaku</li> <li>• Konfiguriranje hibridnega računalniškega oblaka</li> <li>• Spoznavanje najpomembnejših javnih oblakov: Amazon, Google App Engine, Azure, OpenStack, itd.</li> <li>• Študija prenosljivost oblačnih rešitev med ponudniki</li> <li>• Razvoj specifičnih razširitev za oblak</li> </ul>	<ul style="list-style-type: none"> <li>• Getting to know and compare the most important IaaS technologies</li> </ul> <p>Detailed overview of PaaS:</p> <ul style="list-style-type: none"> <li>• Overview of concepts, architectural perspective</li> <li>• Changes in development models: data persistence: distributed file systems, unstructured storage, NoSQL database, SQL database in the cloud; Business tier: Web services, REST services, other technology runtime environment</li> <li>• Understanding and comparison of major PaaS technologies: Java EE, Azure, Google App Engine, etc.</li> </ul> <p>Detailed overview of SaaS:</p> <ul style="list-style-type: none"> <li>• Overview of concepts, architectural perspective</li> <li>• Access Models, Development Concepts</li> <li>• Business models, Cloud Services (location, data delivery, data enrichment, integration services, business intelligence, etc.).</li> </ul> <p>Deployment models</p> <ul style="list-style-type: none"> <li>• Private, public, hybrid, shared cloud</li> <li>• On premises, remote, hybrid model, overview of providers</li> </ul> <p>Migration to the cloud</p> <p>Control, management, SLA and QoS</p> <p><b>Practical part:</b></p> <ul style="list-style-type: none"> <li>• Deploying, setting up and configuring your own Cloud</li> <li>• Developing applications for the cloud</li> </ul> <p>o Technological aspects</p> <p>o Content and business aspects</p> <ul style="list-style-type: none"> <li>• Development of innovative applications that run in the cloud</li> <li>• Configuring a hybrid cloud</li> <li>• Getting to know the most important public clouds: Amazon, Google App Engine, Azure, OpenStack, etc.</li> <li>• Portability study between cloud solution providers</li> <li>• Development of cloud-specific extensions</li> </ul>
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### Temeljna literatura in viri/Readings:

1. Barrie Sosinsky, Cloud Computing Bible, Wiley; 2011.
2. George Reese, Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, O'Reilly Media; 2009.
3. David S. Linthicum, Cloud Computing and SOA Convergence in Your Enterprise, Addison-Wesley Professional, 2009.
4. John Rhoton, Risto Haukioja, Cloud Computing Architected: Solution Design Handbook, Recursive Press, 2011.
5. Matjaz B. Juric et al., Do more with SOA Integration, Packt Publishing, 2011.

### Cilji in kompetence:

Cilj predmeta je osvojiti poglobljene znanje in poznavanje področja računalništva v oblaku in vseh nivojev storitvene usmerjenosti (XaaS), osvojiti znanje s področja infrastrukture, platforme in aplikacij v obliki storitev, spoznati načrtovalske

### Objectives and competences:

The course objective is to provide an in-depth knowledge and understanding of the scope of cloud computing and all levels of service orientation (XaaS), provide knowledge of infrastructure, platforms, and applications in the form of services, get familiar with design patterns, architectural models and best

<p>vzorci, arhitekturne modele in dobre prakse ter razumeti pomen inovativnih aplikacij v oblaku.</p> <p><b>Kompetence:</b> Študentje bodo sposobni vzpostaviti infrastrukturo za delovanje privatnih, hibridnih in zasebnih oblakov, načrtovati in implementirati arhitekturo platforme PaaS, načrtovati in implementirati aplikacije, ki se izvajajo na PaaS, razumeti specifične oblačnih arhitektur in infrastruktur. Usposobljeni bodo za razvoj SaaS aplikacij na najpomembnejših PaaS/IaaS. Razumeli bodo pomen inovacij v oblaku.</p>	<p>practices and understand the importance of innovative applications in the cloud.</p> <p><b>Competences:</b> Students will be able to deploy the infrastructure for the operation of private, hybrid and private clouds, to design and implement PaaS platform architecture, design and implement applications that are implemented on PaaS, understand the specifics of cloud architectures and infrastructures. Students will be trained to develop SaaS applications on most important PaaS / IaaS platforms and understand the importance of innovation in the cloud.</p>
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<p><b>Predvideni študijski rezultati:</b></p> <p>Po uspešnem zaključku predmeta bo študent:</p> <ul style="list-style-type: none"> <li>- razvijal programske rešitve za delovanje v oblaku</li> <li>- poznal lastnosti javnih in zasebnih oblakov</li> <li>- razumel infrastrukture in arhitekture računalniških oblakov</li> <li>- razumel cloud-native arhitekturo in jo uporabil pri razvoju</li> <li>- obvladal razvoj mikrostoritev</li> <li>- razumel in uporabljal vzorce za razvoj mikrostoritev</li> <li>- uporabil vsebnike in orkestracijo vsebnikov</li> <li>- sposoben razvoja SaaS aplikacij</li> </ul>	<p><b>Intended learning outcomes:</b></p> <p>After successful completion of the course a student will be able to:</p> <ul style="list-style-type: none"> <li>- Develop cloud-based software solutions</li> <li>- Understand the characteristic public and private clouds</li> <li>- Understand the infrastructures and architecture of computer clouds</li> <li>- Understand the cloud-native architecture and use it in the development</li> <li>- master the development of microservices</li> <li>- understand and use patterns for the development of microservices</li> <li>- use containers and orchestration of containers</li> <li>- capable of developing SaaS applications</li> </ul>
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<p><b>Metode poučevanja in učenja:</b></p> <p>Predavanja, računalniške vaje, projektni način dela pri seminarjih.</p>	<p><b>Learning and teaching methods:</b></p> <p>Lectures, computer-based workshops, project work, seminars.</p>
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<b>Načini ocenjevanja:</b>	<b>Delež/Weight</b>	<b>Assessment:</b>
Način (pisni izpit, naloge, projekt):		Type (examination, coursework, project):
Sprotno preverjanje (vaje, kolokviji in projektno delo)	50,00 %	Continuing (workshops, midterm exams, project work)
Končno preverjanje (pisni in ustni izpit)	50,00 %	Final (written and oral exam)
Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL).		Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana).

<p><b>Reference nosilca/Lecturer's references:</b></p> <ul style="list-style-type: none"> <li>• JURIČ, Matjaž B. WSDL and BPEL extensions for event driven architecture. <i>Inf. softw. technol.</i> [Print ed.], 2010, vol. 52, iss. 10, str. 1023-1043</li> <li>• JURIČ, Matjaž B., ŠAŠA, Ana, BRUMEN, Boštjan, ROZMAN, Ivan. WSDL and UDDI extensions for version support in web services. <i>J. syst. softw.</i> [Print ed.], 2009, vol. 82, iss. 8, str. 1326-1343</li> <li>• JURIČ, Matjaž B., ŠAŠA, Ana, ROZMAN, Ivan. WS-BPEL extensions for versioning. <i>Inf. softw. technol.</i> [Print ed.], 2009, vol. 51, iss. 8, str. 1261-12</li> <li>• JURIČ, Matjaž B., PANT, Kapil. <i>Business process driven SOA using BPMN and BPEL: from business process modeling to orchestration and service oriented architecture</i>. Birmingham; Mumbai: Packt Publishing, cop. 2008. V, 311 str., ilustr. ISBN 978-1-84719-146-5</li> <li>• JURIČ, Matjaž B., MATHEW, Benny, SARANG, Poornachandra G., <i>Business process execution language for web services: an architect and developer's guide to orchestrating web services using BPEL4WS</i>. Birmingham: Packt Publishing, 2006. X, 353 str., ilustr. ISBN 1-904811-81-7.</li> </ul>
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- JURIČ, Matjaž B., LOGANATHAN, Ramesh, SARANG, Poornachandra G., JENNINGS, Frank. *SOA approach to integration: XML, web services, ESB, and BPEL in real-world SOA projects*. Birmingham; Mumbai: Packt Publishing, cop. 2007. VIII, 366 str., ilustr. ISBN 978-1-904811-17-6



# SENZORSKI SISTEMI IN MULTIMEDIJA

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Senzorski sistemi in multimedija
<b>Course title:</b>	Sensor systems and multimedia
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik	1. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0075708
<b>Koda učne enote na članici/UL Member course code:</b>	64M24

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			75	6

**Nosilec predmeta/Lecturer:** Sara Stančin

**Vrsta predmeta/Course type:** izbirni predmet/elective course

**Jeziki/Languages:**

Predavanja/Lectures:	Slovenščina
Vaje/Tutorial:	Slovenščina

<b>Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:</b>	<b>Prerequisites:</b>
Vpis v letnik predmeta.	Enrolment in the year of the course.

### Vsebina:

Povezane senzorske naprave in sistemi; Senzorska omrežja; Pridobivanje, zajem, prenos in združevanje multimedijjskih vsebin; Osnove metod obdelave; Optimizacija za delovanje v realnem času; Primeri uporabe; Senzorji i senzorski sistemi v medicini; Senzorji in senzorski sistemi v energetiki; Odzivna okolja; Senzorski sistemi za zdravje, ugodje in zabavo; Nosljivi senzorski sistemi; Pametna in povezana okolja (domovi, vozila, mesta); Zasebnost in varovanje podatkov.

### Content (Syllabus outline):

Connected sensors and sensor systems; Sensor networks; Obtaining, capturing, transmitting and merging multimedia content; Fundamentals of processing methods; Optimization for real-time operations; Application examples; Sensors and sensor systems in medicine; Sensors and sensor systems in energetics; Responsive environments; Wearable sensor systems; Sensor systems for health, comfort and entertainment; Smart and connected environments (homes, vehicles, cities); Data security and privacy.

### Temeljna literatura in viri/Readings:

1. Fahmy H.M.A. *Wireless Sensor Networks, Concepts, Applications, Experimentation and Analysis*. Springer International Publishing AG., 2016.
2. Azim M.M.A., Jiang X. *Wireless Sensor Multimedia Networks: Architectures, Protocols and Applications*. CRC Press, Taylor and Francis Group, Boca Raton, U.S., 2015.
3. Yang G.Z. *Body Sensor Networks*, 2nd ed. Springer-Verlag London, United Kingdom, 2014.

4. Rao K.R., Bojkovic Z.S., Bakmaz B. M. *Wireless Multimedia Communication Systems*. CRC Press, Taylor and Francis Group, Boca Raton, U.S., 2014.

5. Hercog D. *Telekomunikacijska omrežja*. Pasadena, Ljubljana, Slovenija, 2013.

### **Cilji in kompetence:**

Cilj predmeta je študentom podati splošen vpogled v multimedijske senzorske sisteme, ki je potreben za bodoče inženirje multimedije. Cilje je predstaviti senzorske in senzorske sisteme kot tehnološko osnovo za pridobivanje podatkov o uporabniku in okolici. Snov je zanimiva za vse študente multimedije z željo po razvoju kompetenc, ki vključujejo učinkovito uporabo multimedijskih senzorskih sistemov in omogočanje interakcije z uporabnikom in okolico.

### **Objectives and competences:**

The objective of the course is to provide students with a general insight into the topic of sensors and multimedia sensor systems, required for future multimedia engineers. The course aims to present sensors and sensor systems as a technological basis for obtaining information about the user and the environment. The content is of interest for all students of multimedia having the desire to develop competences, which include efficient use of multimedia sensor systems and enabling user-environment interaction.

### **Predvideni študijski rezultati:**

Študentje opredelijo osnove načrtovanja, delovanja in uporabe multimedijskih senzorskih sistemov. Povežejo teoretična znanja s praktičnimi izzivi o principih zajema, prenosa, obdelave in združevanja multimedijskih vsebin. Naučijo se uporabljati multimedijske senzorske sisteme za spremljanje uporabnika in okolice. Poiščejo ustrezne načine uporabe multimedijskih senzorskih sistemov za različne končne aplikacije. Sestavijo in osposobijo senzorske sisteme za delovanje v realnem času. Ocenijo ustreznost delovanja sestavljenih sistemov. Presojajo različne koncepte, ki so tipični za sodobne senzorske sisteme, vključno s prenosom, obdelavo, optimizacijo in zagotavljanjem varnosti in zasebnosti.

### **Intended learning outcomes:**

Students define the basics of design, operation and use of multimedia sensor systems. They associate the obtained theoretical knowledge with practical challenges and principles of capturing, transmitting, processing and merging multimedia content. They learn to use multimedia sensor systems to track and monitor the user and the environment. They find suitable ways to use multimedia sensor systems for various applications. They develop multimedia sensor systems for real-time operation. They test the performance of different multimedia sensor systems. They evaluate different concepts that are typical of sensor systems, including transmission, processing, optimization, security and privacy.

### **Metode poučevanja in učenja:**

Na predavanjih predstavimo teoretične osnove obravnavane vsebine. Teoretični diskurz sproti podrobno dopolnjujemo s predstavitvijo različnih praktičnih rešitev. Spodbudimo kritično analizo in oceno predstavljenih rešitev. Na koncu obravnave vsakega sklopa predstavimo tudi praktični učni primer, ki se mu študentje nato detaljno posvetijo v sklopu laboratorijskih vaj. Študentom je na voljo študijski material s podrobno vsebino. Praktično delo poteka v okviru laboratorijskih vaj. V prvem delu se študentje postopoma seznanijo z uporabljanimi senzorji in programskim okoljem in kodo, ki jo imajo na voljo. Študentje nato pristopijo k sestavljanju končne rešitve za predpisan problem. Študentje delajo v skupini, ki šteje največ tri študente. Med izvajanjem vaj pa se študentje konzultirajo z asistentom. V drugem delu vaj študente spodbudimo k praktični uporabi pridobljenega znanja za reševanje konkretnega izbranega problema v obliki projektne

### **Learning and teaching methods:**

The lectures provide a theoretical background of the discussed chapters. The theoretical discourse is continuously updated with the presentation of various practical solutions. A critical analysis and assessment of the presented solutions is encouraged. At the end of each chapter discussion, a practical learning example is presented, which is to be solved during laboratory exercises. Students are provided with detailed study material. In the first part of the laboratory exercises, students gradually learn how to use the dedicated sensors and the software environment. Students then assemble and deploy a working solution to the problem. Students work on the problem in a group. The maximum number of students participating in one group is three. During the laboratory exercise, students consult with the teaching assistant. In the second part of the laboratory exercises, students are encouraged to use the acquired knowledge in a practical way - to solve a specific problem in the form of a project task. Here again

<p>naloge. Na projektni nalogi delajo študentje v skupini, ki šteje največ tri študente. Izdelava projektne naloge poteka ob sprotnih rednih konzultacijah s pedagogom.</p> <p>Ob koncu semestra študentje demonstrirajo delovanje izdelanega senzorskega sistema in poročajo o končnih rezultatih z morebitno primerjavo izsledkov iz literature.</p>	<p>students work in groups of maximum three participators. The project task is carried out during regular consultations with teachers.</p> <p>At the end of the semester, students demonstrate the operation of the designed sensor system and report their final results with a possible literature comparison.</p>
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#### Načini ocenjevanja:

#### Delež/Weight

#### Assessment:

<p>Način: laboratorijske vaje, projektna naloga, ustni izpit. Ocena 5 je negativna ocena, ocene od vključno 6 do 10 so pozitivne. Pozitivna ocena laboratorijskih vaj je pogoj za pristop k izpitu.</p>		<p>Type: laboratory exercise, project task, oral exam. Negative grade is 5, positive grades are from 6 to 10. Positive evaluation of work during the laboratory exercises is a prerequisite for the exam.</p>
Prispevki k oceni: projektno delo	50,00 %	Contributions to final grade: project task
ustni izpit	50,00 %	oral exam

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

1. Stančin S., Tomažič S. *Time- and computation-efficient calibration of MEMS 3D accelerometers and gyroscopes*. Sensors, 2014, vol. 14, no. 8, 14885-14915.
2. Stančin S., Tomažič S. *Early improper motion detection in golf swings using wearable motion sensors: the first approach*. Sensors, 2013, vol. 13, no. 6, 7505-7521.
3. Stančin S., Tomažič S. *Angle estimation of simultaneous orthogonal rotations from 3D gyroscope measurements*. Sensors, 2011, vol. 11, no. 9, 8536-8549.
4. Djordjević S., Stančin S., Meglič A., Milutinović V., Tomažič S. *MC sensor - a novel method for measurement of muscle tension*. Sensors, 2011, vol. 11, no. 10, 9411-9425.
5. Stančin S., Tomažič S. *User data synchronization*. In Furht B. Encyclopedia of wireless and mobile communications. Boca Raton; New York: Taylor & Francis, cop. 2008, 1-6.

# SODOBNE METODE RAZVOJA PROGRAMSKE OPREME

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Sodobne metode razvoja programske opreme
<b>Course title:</b>	Advanced Software Development Methods
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik	2. semester	obvezni

<b>Univerzitetna koda predmeta/University course code:</b>	0086903
<b>Koda učne enote na članici/UL Member course code:</b>	63515

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	10	20			105	6

**Nosilec predmeta/Lecturer:**

**Vrsta predmeta/Course type:**

<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

**Prerequisites:**

### Vsebina:

**Predavanja:**  
Vsebina predmeta se prilagaja trenutno aktualnim trendom na področju razvoja programske opreme in programskega inženirstva. Poudarek je na obravnavi agilnih metod in izbranih naprednih tematikah s področja programskega inženirstva:

1. Pregled področja programskega inženirstva in sodobnih metod razvoja programske opreme
2. Vodenje agilnih in iterativnih projektov razvoja programske opreme
  - iterativni in inkrementalni razvoj (Unified process)
  - obvladovanje tveganj na projektih
  - agilni pristopi (Scrum, XP, Kanban, Vitek razvoj)
  - primerjava agilnih in tradicionalnih pristopov
3. Izbrane prakse agilnih pristopov (Programiranje v parih, Testno voden razvoj programske opreme, Sprotno preoblikovanje kode (refactoring))

### Content (Syllabus outline):

**Lectures:**  
The contents adapts to current trends in software development and software engineering. The focus is on agile methods for software development and selected advanced topics in software engineering:

1. Overview of software engineering and contemporary methods for software development
2. Agile and iterative software project management
  - Iterative and incremental development (Unified process)
  - Project risk management
  - Agile development (Scrum, XP, Kanban, Lean)
  - Comparison of agile approach to traditional software development process
3. Selected agile practices (Pair programming, Test driven development (TDD), Refactoring)
4. Advanced requirements engineering
  - Requirements engineering process

<p>4. Napredno inženirstvo zahtev:</p> <ul style="list-style-type: none"> <li>· proces inženirstva zahtev</li> <li>· upravljanje zahtev in sprememb zahtev</li> <li>· napredne tehnike zajema zahtev</li> </ul> <p>5. Arhitekturno načrtovanje (arhitekturne odločitve, arhitekturni pogledi, arhitekturni vzorci)</p> <p>6. Načrtovanje zanesljivih sistemov (zanesljivost, varnost, odpornost)</p> <p>7. Testiranje</p> <ul style="list-style-type: none"> <li>· testiranje v razvoju</li> <li>· testiranje izdaj</li> <li>· uporabniško testiranje</li> <li>· posebnosti testiranja pri agilnem razvoju</li> </ul> <p>8. Upravljanje konfiguracij (upravljanje verzij, izgradnja sistema, upravljanje sprememb, upravljanje izdaj)</p> <p>9. Agilni razvoj in DevOps (zvezna dostava, zvezna postavitve, postavitveni cevovod)</p> <p>10. Merila v programskem inženirstvu:</p> <ul style="list-style-type: none"> <li>· merila kakovosti programske opreme</li> <li>· merila kakovosti razvojnega procesa</li> </ul> <p>11. Uporaba sodobnih pristopov razvoja programske opreme v razvojnih skupinah (vpeljevanje, sprejemanje, prilagajanje, spremljanje in vrednotenje)</p> <p><b>Vaje:</b> Namen vaj je dvojen:</p> <ol style="list-style-type: none"> <li>1. seznanjanje s sodobnimi pristopi in orodji za razvoj programske opreme;</li> <li>2. Študija primera: empirično ovrednotenje posameznih pristopov k razvoju programske opreme na podlagi praktičnega dela na projektih, ki so čim bolj podobni realnim.</li> </ol> <p><b>Delo izven kontaktnih ur:</b> Študenti v okviru študije primera razvijajo programe skladno s pravili izbranega razvojnega procesa ter razvojni proces ovrednotijo.</p>	<ul style="list-style-type: none"> <li>• Management of requirements and requirements change</li> <li>• Advanced requirements elicitation techniques)</li> </ul> <p>5. Architectural design (Architectural design decisions, Architectural views, Architectural patterns)</p> <p>6. Designing dependable systems (reliability, safety, security, resilience)</p> <p>7. Testing</p> <ul style="list-style-type: none"> <li>• Development testing</li> <li>• Release testing</li> <li>• User testing</li> <li>• Specifics of testing in agile development</li> </ul> <p>8. Configuration management (version management, system building, change management, release management)</p> <p>9. Agile development and DevOps (continuous delivery, continuous deployment, deployment pipeline)</p> <p>10. Metrics in Software Engineering</p> <ul style="list-style-type: none"> <li>• Metrics of software quality</li> <li>• Metrics of software development process quality</li> </ul> <p>11. Use of software development processes in development teams (implementation, adoption, tailoring, monitoring and evaluation)</p> <p><b>Lab practice:</b> The purpose of lab practice is twofold:</p> <ol style="list-style-type: none"> <li>1. to acquaint students with modern approaches and tools for software development;</li> <li>2. Case study: to empirically evaluate different approaches to software development through practical work on (almost) real software projects.</li> </ol> <p><b>Individual work outside of contact hours:</b> In the context of the case study students develop programs that are part of the project following the selected development process and evaluate the process.</p>
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### Temeljna literatura in viri/Readings:

<ol style="list-style-type: none"> <li>1. I. Sommerville: Software Engineering, Addison-Wesley, 10. izdaja, 2016.</li> <li>2. R. Stephens: Beginning Software Engineering, Wrox, 2015.</li> <li>3. D. Anderson, Kanban – Successful Evolutionary Change for Your Technology Business, Sequim, WA: Blue Hole Press, 2010.</li> </ol> <p>Dodatna literatura:</p> <ol style="list-style-type: none"> <li>1. M. Cohn: User stories applied, Addison-Wesley, 2011, cop. 2004.</li> <li>2. K. Beck, A. Cynthia: Extreme Programming Explained, Addison-Wesley, cop. 2005.</li> <li>3. K. Schwaber: Agile Project Management with Scrum, Microsoft Press, 2004.</li> </ol>
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### Cilji in kompetence:

Cilj predmeta je poglobljena obravnava naprednih tematik s področja programskega inženirstva s poudarkom na sodobnih metodah razvoja programske opreme v primerjavi z že uveljavljenimi pristopi. Študenti delajo na obsežnejšem projektu, ki služi kot študija primera za ovrednotenje novih pristopov, da bi ugotovili njihove prednosti in pomanjkljivosti.

Predvidene kompetence:

### Objectives and competences:

In depth study of advanced topics in program engineering with emphasis on modern software development methods in comparison to traditional approach. Students work on a project that serves as a case study for evaluation of modern approaches in order to find their strengths and weaknesses.

The competences students gain are:

<ul style="list-style-type: none"> <li>• sposobnost opredelitve, razumevanja in reševanja kreativnih strokovnih izzivov na področju računalništva in informatike;</li> <li>• sposobnost uporabe pridobljenega znanja pri samostojnem delu za reševanje tehničnih in znanstvenih problemov na področju računalništva in informatike; sposobnost nadgradnje pridobljenega znanja,</li> <li>• sposobnost skupinskega dela v profesionalnem delovnem okolju; vodenje manjše strokovne skupine;</li> <li>• sposobnost administrativnega vodenja procesov, povezanih z raziskovanjem,</li> <li>• industrijo, izobraževanjem in drugimi področji;</li> <li>• sposobnost razumevanja in uporabe znanja računalništva in informatike na drugih tehničnih in relevantnih področjih (ekonomija, organizacijske vede ipd.);</li> <li>• praktično znanje in spretnosti, potrebne za uspešno strokovno delo na področju računalništva in informatike;</li> <li>• samostojno reševanje zahtevnih razvojnih, inženirskih in organizacijskih nalog kot tudi povprečno zahtevnih raziskovalnih nalog na področju računalništva in informatike.</li> </ul>	<ul style="list-style-type: none"> <li>• the ability to define, understand and solve creative professional challenges in computer and information science;</li> <li>• the ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge.</li> <li>• the ability of teamwork within the professional environment; management of a small professional team;</li> <li>• the ability for administrative management of processes related to research, industry, education and other fields;</li> <li>• the ability to understand and apply computer and information science knowledge to other technical and relevant fields (economics, organisational science, etc);</li> <li>• practical knowledge and skills of computer hardware, software and information technology necessary for successful professional work in computer and information science;</li> <li>• independently tackle demanding developmental, engineering, and organisational tasks as well as moderately demanding research tasks in their fields of study.</li> </ul>
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#### **Predvideni študijski rezultati:**

<p>Po uspešnem zaključku tega predmeta bo študent zmožen:</p> <ul style="list-style-type: none"> <li>• poznati in razumeti sodobne pristope k razvoju programske opreme</li> <li>• razumeti ključne prednosti sodobnih metod razvoja programske opreme (v primerjavi z že uveljavljenim tradicionalnim pristopom)</li> <li>• uporabljati orodja, ki podpirajo sodobne metode razvoja programske opreme</li> <li>• uporabiti sodobne metode razvoja programske opreme pri razvoju dejanskih softverskih projektov</li> <li>• empirično ovrednotiti rezultate novih metod</li> <li>• bolje razumeti različne faktorje in okoliščine, ki vplivajo na uspešnost softverskih projektov</li> <li>• izboljšati sposobnosti za skupinsko delo, vodenje, načrtovanje in organizacijo, medsebojno komuniciranje, pisno in ustno poročanje.</li> </ul>
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#### **Intended learning outcomes:**

<p>After the completion of the course a student will be able to:</p> <ul style="list-style-type: none"> <li>• know and understand modern approaches to software development</li> <li>• understand key benefits of modern software development methods (in comparison to traditional software development)</li> <li>• use tools that support modern software development methods</li> <li>• apply modern software development methods in the context of a real software development project</li> <li>• empirically evaluate the outcomes of new methods</li> <li>• increase understanding of different factors and circumstances that affect the success of a software development project</li> <li>• increase professional skills like team-work, management, planning and organization, written and oral communication</li> </ul>
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#### **Metode poučevanja in učenja:**

<p>Predavanja z aktivno udeležbo študentov (razlaga, diskusija, primeri, reševanje problemov). Laboratorijske vaje s praktičnim delom na večjem projektu, ki služi kot študija primera za ovrednotenje posameznih pristopov k razvoju programske opreme.</p>
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#### **Learning and teaching methods:**

<p>Lectures with active participation on the part of students (discussion, examples, problem solving). Lab practice requires practical work on an almost real project that serves as a case study for evaluation of different approaches to software development.</p>
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#### **Načini ocenjevanja:**

#### **Delež/Weight Assessment:**

Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, kolokviji in projektno delo)	50,00 %	Continuing (homework, midterm exams, project work)
Končno preverjanje (pisni izpit)	50,00 %	Final (written exam)
Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL).		Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana).

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

Damjan Vavpotič, Marko Robnik Šikonja, Tomaž Hovelja, "Exploring the relations between net benefits of IT projects and CIOs perception of quality of software development disciplines", *Business & information systems engineering*, [Print ed.], 2020, vol. 62, no. 4, str. 347-360

Damjan Fujs, Simon Vrhovec, Damjan Vavpotič, "Know your enemy : user segmentation based on human aspects of information security", *IEEE access*, 2021, vol. 9, str. 157306-157315, ilustr., ISSN 2169-3536

Damjan Fujs, Simon Vrhovec, Boštjan Žvanut, Damjan Vavpotič, "Improving the efficiency of remote conference tool use for distance learning in higher education : a kano based approach", *Computers & Education : an international journal*, [Print ed.], May 2022, vol. 181, str. 1-15, ilustr., ISSN 0360-1315

Damjan Vavpotič, Saimir Bala, Jan Mendling, Tomaž Hovelja, "Software process evaluation from user perceptions and log data", *Journal of software*, Apr. 2022, vol. 34, iss. 4, str. 1-14, ilustr., ISSN 2047-7473

Damjan Vavpotič, Diana Kalibatiene, Olegas Vasilecas, Tomaž Hovelja, "Identifying key characteristics of business rules that affect software project success", *Applied sciences*, Jan. 2022, vol. 12, iss. 2, str. 1-10, ilustr., ISSN 2076-3417

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<http://www.sicris.si/search/rsr.aspx?lang=slv&id=13311>.

# SPLOŠNO IZBIRNI PREDMET

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Splošno izbirni predmet
<b>Course title:</b>	Specialist elective course
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	2. letnik	2. semester	izbirni
Računalništvo in informatika, prva stopnja, visokošolski strokovni	Ni členitve (študijski program)	2. letnik, 3. letnik	2. semester	izbirni
Računalništvo in informatika, druga stopnja, magistrski	Računalništvo in informatika (smer)	1. letnik	2. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0069530
<b>Koda učne enote na članici/UL Member course code:</b>	0002

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			105	6

**Nosilec predmeta/Lecturer:**

**Vrsta predmeta/Course type:**

**Jeziki/Languages:**

Predavanja/Lectures:	
Vaje/Tutorial:	

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

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**Prerequisites:**

**Vsebina:**

	<b>Content (Syllabus outline):</b>
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**Temeljna literatura in viri/Readings:**

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**Cilji in kompetence:**

	<b>Objectives and competences:</b>
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**Predvideni študijski rezultati:**

	<b>Intended learning outcomes:</b>
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**Metode poučevanja in učenja:**

	<b>Learning and teaching methods:</b>
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**Načini ocenjevanja:**

**Delež/Weight Assessment:**

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

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# SPLOŠNO IZBIRNI PREDMET

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Splošno izbirni predmet
<b>Course title:</b>	
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	2. letnik	1. semester	izbirni
Računalništvo in informatika, druga stopnja, magistrski	Podatkovne vede (smer)	2. letnik	1. semester	izbirni
Računalništvo in informatika, druga stopnja, magistrski	Računalništvo in informatika (smer)	2. letnik	1. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0086926
<b>Koda učne enote na članici/UL Member course code:</b>	0008

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			105	6

**Nosilec predmeta/Lecturer:**

**Vrsta predmeta/Course type:**

**Jeziki/Languages:**

Predavanja/Lectures:	
Vaje/Tutorial:	

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

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**Prerequisites:**

**Vsebina:**

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**Content (Syllabus outline):**

**Temeljna literatura in viri/Readings:**

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**Cilji in kompetence:**

--	--

**Objectives and competences:**

**Predvideni študijski rezultati:**

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**Intended learning outcomes:**

**Metode poučevanja in učenja:**

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**Learning and teaching methods:**

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**Načini ocenjevanja:**

**Delež/Weight Assessment:**

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

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# STROJNO UČENJE

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Strojno učenje
<b>Course title:</b>	Machine Learning
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik	1. semester	izbirni
Računalništvo in informatika, druga stopnja, magistrski	Podatkovne vede (smer)	2. letnik	1. semester	izbirni
Računalništvo in informatika, druga stopnja, magistrski	Računalništvo in informatika (smer)		1. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0073694
<b>Koda učne enote na članici/UL Member course code:</b>	63519

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	6	24			105	6

**Nosilec predmeta/Lecturer:** Jana Faganeli Pucer

**Vrsta predmeta/Course type:** strokovni izbirni predmet/specialist elective course

<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

### Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Potrebno je poznavanje verjetnostnega računa, statistike, programiranja in osnov strojnega učenja.

### Prerequisites:

Knowledge of probability calculus, statistics, programming, and machine learning basics

### Vsebina:

Predavanja:  
- Kaj je strojno učenje, kaj so osnovni principi, kaj želimo doseči.  
- Linearna regresija in poglobljeno obravnavanje regulariziranih metod linearne regresije.  
- Klasifikacija z metodo logistične regresije.  
- Cenovne funkcije.  
- Gradientni sestop in stohastičen gradientni sestop in zakaj sta metodi uporabni v strojnem učenju  
- Generalizirani linearni modeli.  
- Vrednotenje modelov strojnega učenja (prečno preverjanje, metoda stremena)

### Content (Syllabus outline):

Lectures:  
- What is machine learning, what are its basic principles, what are we trying to achieve with it.  
- A review of linear regression and an in-depth overview of regularised linear regression methods.  
- Classification using logistic regression.  
- What is a cost function and which are the most commonly used cost functions.  
- Gradient descent and stochastic gradient descent and why they are useful methods in machine learning.  
- Generalised linear models.  
- Evaluation of machine learning models (cross-validation, the bootstrap method)

<ul style="list-style-type: none"> <li>- Ansambelske metode (predvsem bagging in boosting in naključni gozdovi)</li> <li>- Jedrne metode (Gaussovi procesi, metoda podpornih vektorjev)</li> <li>- Umetne nevronske mreže (aktivacijska funkcija, metoda vzvratnega razširjanja napake, učenje nevronske mreže, regularizacija)</li> <li>- Metode za zmanjšanje dimenzionalnosti prostora (analiza glavnih komponent, matrična faktorizacija, clustering)</li> <li>- Razlaga modelov strojnega učenja</li> <li>- Spodbujevano učenje</li> </ul> <p>Vaje:</p> <p>Na vajah študenti utrjujejo snov, ki jo obravnavajo na predavanjih, tako da jo uporabijo pri reševanju praktičnih problemov. Pri tem je poudarek na samostojnem delu študentov ob pomoči asistentov. Namen vaj je, da s pomočjo programiranja pristopov različnih algoritmov študenti razumejo metode strojnega učenja in kako te delujejo v praksi.</p>	<ul style="list-style-type: none"> <li>- Ensemble methods (especially bagging and boosting and random forests)</li> <li>- Kernel methods (Gaussian processes, support vector machines)</li> <li>- Artificial neural networks (activation function, backpropagation, neural network training, regularisation)</li> <li>- Methods for dimensionality reduction (principal component analysis, matrix factorisation, clustering)</li> <li>- Explainable machine learning models</li> <li>- Reinforcement learning</li> </ul> <p>Lab work:</p> <p>At the lab work, students consolidate the material covered in lectures by applying it to practical problems. The emphasis is on students working independently with the help of lab assistants. The aim of the lab work is to explore how different methods work in practice through programming approaches.</p>
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**Temeljna literatura in viri/Readings:**

<ul style="list-style-type: none"> <li>• James, G., Witten, D., Hastie, T., &amp; Tibshirani, R. (2013). <i>An introduction to statistical learning</i> (Vol. 112, p. 18). New York: Springer.</li> <li>• Trevor, H., Robert, T., &amp; Jerome, F. (2016). <i>The elements of statistical learning: data mining, inference, and prediction</i> (second edition).</li> <li>• Murphy, K. P. (2022). <i>Probabilistic machine learning: An introduction</i>. MIT press.</li> </ul>
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**Cilji in kompetence:**

<p>Cilj predmeta je poglobiti znanje iz strojnega učenja, ki so ga študenti pridobili na dodiplomskem študiju. Študenti bodo spoznali najbolj uspešne pristope in se poglobiti vanje, spoznali kako delujejo kaj so njihove omejitve. Predmet pripravi študenta na nadaljnji, bolj poglobljen študij pristopov strojnega učenja. Študente pripravi tudi na uporabo metod strojnega učenja v praksi, saj bodo ob zaključku predmeta za dani problem sposobni presoje, katero od predstavljenih tehnik uporabiti, ter sestaviti prototip rešitve.</p>	<p><b>Objectives and competences:</b></p> <p>The course aims to deepen the knowledge of machine learning that students have acquired in their undergraduate studies. Students learn about the most successful approaches and delve deeper into them to understand how they work and what their limitations are. The course prepares the student for further, more in-depth study of machine learning approaches. It also prepares students to apply machine learning methods in practice, as at the end of the course they will be able to judge which of the presented techniques to use for a given problem and build a prototype solution.</p>
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**Predvideni študijski rezultati:**

<p>Z uspešno zaključenim predmetom je študent:</p> <ul style="list-style-type: none"> <li>- sposoben uporabe različnih tehnike in metode, ki se uporabljajo pri modeliranju podatkov s strojnim učenjem v praksi.</li> <li>- znal izbrati najbolj primerno tehniko za rešitev problema.</li> <li>- sposoben ovrednotiti različne rešitve in njihove omejitve.</li> <li>- sposoben razložiti naučen model.</li> </ul>	<p><b>Intended learning outcomes:</b></p> <p>On successful completion of the course, the students will:</p> <ul style="list-style-type: none"> <li>- be able to apply various machine learning techniques and methods used in data modelling in practice.</li> <li>- be able to choose the most appropriate technique to solve a problem.</li> <li>- be able to evaluate different solutions and their limitations.</li> <li>- be able to explain a machine learning model.</li> </ul>
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**Metode poučevanja in učenja:**

**Learning and teaching methods:**

Predavanja, vaje in domače naloge. Poseben poudarek bo na implementaciji različnih metod s čimer bodo študenti spoznali njihovo delovanje.	Lectures, lab work and homework. Special emphasis will be placed on the implementation of different methods to give students an understanding of how they work.
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Načini ocenjevanja:	Delež/Weight	Assessment:
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, vaje)	50,00 %	Continuing (homework, lab work)
Končno preverjanje (pisni in/ali ustni izpit)	50,00 %	Final (written and/or oral exam)
Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statuom UL).		Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana).

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

<ul style="list-style-type: none"> <li>- Demaeyer, J., Bhend, J., Lerch, S., Primo, C., Van Schaeybroeck, B., Atencia, A., Ben Bouallègue, Z., Chen, J., Dabernig, M., Evans, G. &amp; Faganeli Pucer, J., (2023). The EUPPBench postprocessing benchmark dataset v1.0. <i>Earth System Science Data</i>, 15(6), 2635-2653.</li> <li>- Mlakar, P., &amp; Faganeli Pucer, J. (2023). Mixture Regression for Clustering Atmospheric-Sounding Data: A Study of the Relationship between Temperature Inversions and PM10 Concentrations. <i>Atmosphere</i>, 14(3), 481.</li> <li>- Faganeli Pucer, J., &amp; Štrumbelj, E. (2018). Impact of changes in climate on air pollution in Slovenia between 2002 and 2017. <i>Environmental pollution</i>, 242, 398-406.</li> <li>- Faganeli Pucer, J., Pirš, G., &amp; Štrumbelj, E. (2018). A Bayesian approach to forecasting daily air-pollutant levels. <i>Knowledge and Information Systems</i>, 57(3), 635-654.</li> <li>- Pucer, J. F., &amp; Kukar, M. (2018). A topological approach to delineation and arrhythmic beats detection in unprocessed long-term ECG signals. <i>Computer methods and programs in biomedicine</i>, 164, 159-168.</li> </ul>
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# STROKOVNO IZBIRNI PREDMET FE

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Strokovno izbirni predmet FE
<b>Course title:</b>	
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik	1. semester, 2. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0165290
<b>Koda učne enote na članici/UL Member course code:</b>	6401

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
90		60			210	12

**Nosilec predmeta/Lecturer:**

**Vrsta predmeta/Course type:**

**Jeziki/Languages:**

Predavanja/Lectures:	
Vaje/Tutorial:	

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

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**Prerequisites:**

**Vsebina:**

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**Content (Syllabus outline):**

**Temeljna literatura in viri/Readings:**

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**Cilji in kompetence:**

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**Objectives and competences:**

**Predvideni študijski rezultati:**

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**Intended learning outcomes:**

**Metode poučevanja in učenja:**

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**Learning and teaching methods:**

**Načini ocenjevanja:**

**Delež/Weight Assessment:**

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

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# STROKOVNO IZBIRNI PREDMET FRI

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Strokovno izbirni predmet FRI
<b>Course title:</b>	
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik	1. semester, 2. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0165289
<b>Koda učne enote na članici/UL Member course code:</b>	6301

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
90		60			210	12

**Nosilec predmeta/Lecturer:**

**Vrsta predmeta/Course type:**

**Jeziki/Languages:**

Predavanja/Lectures:	
Vaje/Tutorial:	

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

	<b>Prerequisites:</b>
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**Vsebina:**

	<b>Content (Syllabus outline):</b>
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**Temeljna literatura in viri/Readings:**

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**Cilji in kompetence:**

	<b>Objectives and competences:</b>
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**Predvideni študijski rezultati:**

	<b>Intended learning outcomes:</b>
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**Metode poučevanja in učenja:**

	<b>Learning and teaching methods:</b>
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**Načini ocenjevanja:** **Delež/Weight** **Assessment:**

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

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# UPORABNIKU PRILAGOJENA KOMUNIKACIJA

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Uporabniku prilagojena komunikacija
<b>Course title:</b>	User- adapted communication
<b>Članica nosilka/UL Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik	1. semester	obvezni

<b>Univerzitetna koda predmeta/University course code:</b>	0075704
<b>Koda učne enote na članici/UL Member course code:</b>	64M22

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			105	6

**Nosilec predmeta/Lecturer:** Andrej Košir

**Vrsta predmeta/Course type:** obvezni predmet/compulsory course

**Jeziki/Languages:**

Predavanja/Lectures:	Angleščina, Slovenščina
Vaje/Tutorial:	Angleščina, Slovenščina

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

Vpis v letnik predmeta.	Enrolment in the year of the course.
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Vsebina:	Content (Syllabus outline):
Uvod v uporabniku prilagojeno komunikacijo (principi, pristopi, povezana področja, terminologija); Uporabniško prilagajanje, uporabniki, storitve, nivoji prilagajanje, inteligenca v adaptaciji); Komunikacija med uporabniki in storitvami (modalnosti, kanali, komunikacijski vzorci in tipi interakcije, socialna interakcija, naravna komunikacija); Socialna inteligenca in storitve (uvod, kognitivni vidiki adaptacije, socialno zavedno računanje); Na kaj prilagajamo (kontekst, osebnost, razpoloženje, čustva); Kako prilagajamo – uporabniško modeliranje in priporočilni sistemi (vsebinsko in skupinsko filtriranje, hibridni pristopi, modeliranje preferenc); Zajem podatkov o uporabniku in analiza (tipi, impliciten in ekspliciten zajem, zajem v realnem času); Personalizirane storitve (dobre prakse v izbranih domenah, primeri, kritično ovrednotenje); Ovrednotenje in poskusi z uporabniki (mere,	Introduction to user adapted communication (principles, approaches, related fields, terminology); User adaptation, users, services, communication (users and user groups, roles, levels of adaptation, intelligence of the adaptation); User to service communication (modalities, channels, communication patterns and interaction types, social interaction, natural communication); Socially intelligence and services (introduction, cognitive aspects of adaptation, socially aware computing); What we adapt to (context, user personality, mood and emotion); How we adapt – user modelling and recommender systems (key aspect, collaborative and content filtering, hybrid techniques, preference modelling); User data acquisition and analysis (key issues, types, explicit and implicit, real time acquisition); Personalized services (good practices in selected domains, examples, evaluation, critique);

načrtovanje poskusov, ovrednotenje z uporabniki v središču, procedure, interpretacija); Zaščita vsebin v uporabniku prilagojenih storitvah (osnovni problemi, varnost v načrtu); Raziskovalne aktivnosti in izzivi v prihodnosti	Evaluation and user experiments (evaluation measures, design of experiments, human-centred evaluation, procedures, interpretation); Information protection in user adapted services (key issues, privacy by design); Research activities and future challenges of the domain.
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### Temeljna literatura in viri/Readings:

<ol style="list-style-type: none"> <li>1. J. A. Jacko: Human-Computer Interaction Handbook, CRC Press, 2012.</li> <li>2. A. Dix, J. E. Finlay, G. D. Abowd, R. Beale: Human-Computer Interaction, Prentice Hall, 2004.</li> <li>3. F. Ricci, L. Rokach, B. Shapira, P. B. Kantor: Recommender system handbook, Springer, 2011.</li> <li>4. Jonathan Lazar and Jinjuan H. Feng: Research Methods in Human-Computer Interaction, Elsevier, 2017</li> <li>5. M. Tkalcic, B. de Carolis, M. de Gemmis, A. Odić, A. Košir: Emotions and Personality in Personalized Services, Springer 2016 (in print).</li> </ol>
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### Cilji in kompetence:

<p>Cilj predmeta je podati znanje o uporabniku prilagojeno komunikacijo med uporabnikom in komunikacijskimi storitvami ter pametnimi sistemi. Predmet vključuje kontekstualizacijo komunikacije in umetno socialno inteligenco v komunikaciji med uporabnikom in obravnavanim sistemom.</p> <p>Predmet podaja osnove, principe, postopke in vodila v načrtovanju, analizi in ovrednotenju uporabniku prilagojene komunikacije. Pridobljeno znanje je podlaga za načrtovanje, implementacijo in testiranje komunikacijskih sistemov med uporabniki in pametnimi napravami.</p>	<p><b>Objectives and competences:</b></p> <p>The goal of the course is to familiarize students with a comprehensive insight into the user adapted communication. This course include contextualization of communication and artificial social intelligence in user (human) to (smart) system communication.</p> <p>The course gives the basic knowledge on principles, approaches and guidelines in design, analysis and evaluation of user adapted communication. The knowledge is fundamental in development of personalised, contextualized socially intelligent communication systems.</p>
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### Predvideni študijski rezultati:

<p>Po uspešno opravljenem modulu naj bi bili študenti zmožni:</p> <ul style="list-style-type: none"> <li>- Določiti segmente uporabnikov in person v komunikaciji</li> <li>- Načrtati dialog z upoštevanjem domenskih znanj na področju</li> <li>- Določiti relevantne kontekste in socialne signale v komunikaciji in ovrednotiti uspešnost njihovega določanja</li> <li>- Izbrati in ovrednotiti komunikacijske modalnosti</li> <li>- Načrtati in ovrednotiti zajem podatkov o uporabniku v in izven realnega časa (senzorji, instrumenti)</li> <li>- Načrtati in implementirati poskuse z uporabniki</li> <li>- Ovrednotiti kvaliteto uporabniku prilagojene komunikacije</li> </ul>	<p><b>Intended learning outcomes:</b></p> <p>After successful completion of the course, students should be able to:</p> <ul style="list-style-type: none"> <li>- Determine user segments and personas in user adapted communication</li> <li>- Use domain knowledge in a communication dialogue design</li> <li>- Determine relevant contexts and social signals in communication and evaluate the success rate of its extraction</li> <li>- Select and evaluate communication modalities</li> <li>- Design and evaluate user data acquisition procedures in real time and off-line (sensors, instruments)</li> <li>- Design and implement user experiments</li> <li>- Evaluate the quality of user adapted communication</li> </ul>
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### Metode poučevanja in učenja:

<p>Na predavanjih so predstavljene teoretične osnove obravnavanih poglavij skupaj s prikazom rešitev enostavnih praktičnih primerov. Študentom je na voljo študijski material s podrobno vsebino. Praktično delo poteka v okviru laboratorijskih vaj in domačih nalog. Vključuje načrtovanje, izdelavo in</p>	<p><b>Learning and teaching methods:</b></p> <p>The lectures provide a theoretical background on particular subjects together with presentation of simple practical examples. A complete study material is available to the students.</p> <p>Practical work is being performed in the laboratory environment and home work. In includes design,</p>
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ovrednotenje konkretnih rešitev uporabniku prilagojene komunikacije	implementation and evaluation of solutions of user adapted communication.
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<b>Načini ocenjevanja:</b>	<b>Delež/Weight</b>	<b>Assessment:</b>
Način (pisni izpit, ustno izpraševanje, naloge, projekt)		Type (examination, oral, coursework, project):
Sprotno (domače naloge, kolokviji in projektno delo)	50,00 %	Continuing (homeworks, midterm exams, project work)
Končno (pisni in ustni izpit)	50,00 %	Final: (written and oral exam)
Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 5 fail.

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

1. ASLAN OĞUZ, Evin, STRLE Gregor, KOŠIR Andrej. Multimedia ad exposure scale: measuring short-term impact of online ad exposure, *Multimed Tools Appl* 83, (2023). <https://doi.org/10.1007/s11042-023-14401-5>.
2. MEŽA, Marko, KOŠIR, Janja, STRLE, Gregor, KOŠIR, Andrej. Towards automatic real-time estimation of observed learner's attention using psychophysiological and affective signals : the touch-typing study case. *IEEE access*, ISSN 2169-3536, 2017, vol. , str. 1-18, ilustr
3. VODLAN, Tomaž, TKALČIČ, Marko, KOŠIR, Andrej. The impact of hesitation, a social signal, on a user's quality of experience in multimedia content retrieval. *Multimedia tools and applications*, ISSN 1380-7501, 2014, vol. , no. , str. 1-26
4. TKALČIČ, Marko, ODIĆ, Ante, KOŠIR, Andrej. The impact of weak ground truth and facial expressiveness on affect detection accuracy from time-continuous videos of facial expressions. *Information sciences*, ISSN 0020-0255. [Print ed.], 10. Nov. 2013, vol. 249, str. 13-23, ilustr
5. M. Tkalcic, B. de Carolis, M. de Gemmis, A. Odić, A. Košir: *Emotions and Personality in Personalized Services*, Springer 2016 (in print).

# VGRAJENI SISTEMI V MULTIMEDIJI

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Vgrajeni sistemi v multimediji
<b>Course title:</b>	Embedded Systems in Multimedia
<b>Članica nosilka/UL</b>	
<b>Member:</b>	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Multimedija, druga stopnja, magistrski	Ni členitve (študijski program)	2. letnik	1. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0090467
<b>Koda učne enote na članici/UL Member course code:</b>	64M31

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			105	6

<b>Nosilec predmeta/Lecturer:</b>	Iztok Fajfar
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<b>Vrsta predmeta/Course type:</b>	strokovni izbirni predmet/specialist elective course
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<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

<b>Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:</b>	<b>Prerequisites:</b>
Vpis v letnik študija.	Enrolment in the year of the course.

<b>Vsebina:</b>	<b>Content (Syllabus outline):</b>
Osnove vgrajenih sistemov in sistemov v realnem času. <ul style="list-style-type: none"><li>Pregled področja sodobnih vgrajenih sistemov z multimedijsko funkcionalnostjo.</li><li>Strojna oprema, operacijski sistemi, programski jeziki ter orodja za vgrajene multimedijske sisteme.</li><li>Razvoj lastnega sistema na enem od komercialno dostopnih učnih razvojnih sistemov (Arduino, Raspberry Pi,...).</li></ul>	Basics of embedded systems and real-time systems <ul style="list-style-type: none"><li>State-of-the-art embedded systems with multimedia functionalities.</li><li>Hardware, operating systems, programming languages, and tools for embedded multimedia systems.</li><li>Development of a customized embedded system using a commercially available training development system (Arduino, Raspberry Pi,...).</li></ul>

### Temeljna literatura in viri/Readings:

- Edward Ashford Lee, Sanjit Arunkumar Seshia, Introduction to Embedded Systems: A Cyber-Physical Systems Approach, MIT Press, 2017
- Elecia White, Making Embedded Systems: Design Patterns for Great Software, O'Reilly, 2012
- David E. Simon, An Embedded Software Primer, Pearson Education (Singapore), 2005
- Tay Vaughan, Multimedia: Making It Work, Ninth Edition 9th Edition, McGraw-Hill, 2014
- Mark Lutz, Learning Python, 5th Edition, O'Reilly, 2017

**Cilji in kompetence:**

Spoznavanje osnovnih pojmov s področja vgrajenih sistemov na področju multimedije, njihove zgradbe, delovanja, snovanja in izdelave.  
Poudarek praktičnega dela predmeta je razvoj sistemov s programskim jezikom Python.

**Objectives and competences:**

Knowledge of fundamentals of embedded systems in multimedia, their structure, operation, design and implementation.  
A hands-on focus of the subject is a system development using Python programming language.

**Predvideni študijski rezultati:**

Po uspešno opravljenem modulu naj bi bili študenti zmožni:  
-prepoznati različne komponente tipičnega vgrajenega sistema  
-pojasniti prednosti in pasti, ki jih prinaša uporaba prograskih knjižnic  
-pojasniti izzive, ki jih prinaša implementacija vgrajenega sistema kot multimedijskega sistema  
-izluščiti poglobitve komponente sistema v realnem času  
-razviti preprost sistem na podlagi seznama naročnikovih zahtev ter ga implementirati v konkretnem računalniškem jeziku  
- ovrednotiti algoritmsko učinkovitost podanega algoritma  
-presoditi, kako učinkovita je konkretna rešitev z vidika porabe sredstev, pravilnosti, in zanesljivosti delovanja, prijaznosti do uporabnika, ter možnosti vzdrževanja in nadgradnje

**Intended learning outcomes:**

After a successful completion of the course, students should be able to:  
-identify various components of a typical embedded system  
-explain the advantages and drawbacks of using software libraries  
-explain the challenges brought about by implementing an embedded system as a multimedia system  
-extract the main components of a real-time system  
-develop a simple system based on a list of customer requirements and implement it using a specific programming language  
- evaluate algorithmic efficiency of a given algorithm  
-evaluate the efficiency of a specific solution in terms of the usage of resources, correctness and reliability, user-friendliness, and maintainability

**Metode poučevanja in učenja:**

Predavanja, praktični prikazi, laboratorijske vaje, individualno delo z zahtevnejšimi študenti, uporaba spletnih tehnologij, domače naloge.

**Learning and teaching methods:**

Lectures, practical demonstrations, laboratory work, individual work with advanced students, web technologies, homeworks.

**Načini ocenjevanja:****Delež/Weight****Assessment:**

Zagovor projekta in ustno izpraševanje. Ocenjevalna lestvica: Ocena 5 je negativna ocena, ocene od vključno 6 do 10 so pozitivne. Prispevki k končni oceni:		Presentation of the project work and an oral exam. Grading System: Negative grade is 5, positive grades are from 6 to 10. Contributions to the final grade:
zagovor projekta	50,00 %	Project presentation
ustni izpit	50,00 %	oral exam

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

1. FAJFAR, Iztok, PUHAN, Janez, BÜRMEIN, Arpad. Evolving a Nelder–Mead Algorithm for Optimization with Genetic Programming. *Evolutionary Computation*, 2017, vol. 25, no. 3, str. 351-373
2. FAJFAR, Iztok, TUMA, Tadej, PUHAN, Janez, OLENŠEK, Jernej, BÜRMEIN, Arpad. Towards smaller populations in differential evolution = K manjšim populacijam v diferencialni evoluciji. *Informacije MIDEM*, ISSN 0352-9045, sep. 2012, letn. 42, št. 3, str. 152-163
3. FAJFAR, Iztok, PUHAN, Janez, TOMAŽIČ, Sašo, BÜRMEIN, Arpad. On selection in differential evolution. *Elektrotehniški vestnik*, ISSN 2232-3228. [English print ed.], 2011, vol. 78, no. 5, str. 275-280
4. PUHAN, Janez, BÜRMEIN, Arpad, TUMA, Tadej, FAJFAR, Iztok. Teaching assembly and C language concurrently. *International journal of electrical engineering education*, ISSN 0020-7209, Apr. 2010, vol. 47, no. 2, str. 120-131

5. FAJFAR, Iztok, TUMA, Tadej, BÜRMEŃ, Arpad, PUHAN, Janez. A top down approach to teaching embedded systems programming = Pristop k učenju programiranja vgrajenih sistemov z vrha navzdol. Informacije MIDEŃ, ISSN 0352-9045, mar. 2009, letn. 39, št. 1, str. 53-60