

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Analiza omrežij
Course title:	Network Analysis

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Informatika v sodobni družbi, visokošolski strokovni in univerzitetni študijski program prve stopnje	-	Drugi	Četrta
Informatics in Contemporary Society, first cycle Professional Study Programme and Academic Study programme	-	Second	Fourth

Vrsta predmeta / Course type

Obvezni / Obligatory

Univerzitetna koda predmeta / University course code:

1-ISD-VS,UN-AO-2019-05-13

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	-	45	-	-	105	6

Nosilec predmeta / Lecturer:

Jeziki /

Languages:

Predavanja /

Lectures:

Slovenski, angleški / Slovene, English

Vaje / Tutorial:

Slovenski, angleški / Slovene, English

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

Študent/študentka mora pred pristopom k izpitu pripraviti in zagovarjati projekt.

Prerequisites:

Project work has to be prepared and presented before the examination.

Vsebina:

- Uvod
 - kaj so omrežja in zakaj jih preučujemo?
 - šest stopenj ločenosti, pomen centralnosti
 - socialna, informacijska, tehnološka in biološka omrežja, spletni socialni mediji
- Osnovni grafološki koncepti

Content (Syllabus outline):

- Introduction
 - What are networks and why we study them?
 - Six degrees of separation, the importance of being central
 - Social, Information, Technological and Biological Networks, online social media
- Basic Graph Concepts

<ul style="list-style-type: none"> - vozlišče, povezava, usmerjene/neusmerjene, obtežene/neobtežene povezave, povezana omrežja, glavna komponenta - stopnja in povprečna stopnja, vhodna in izhoda stopnja - matrika sosednosti, seznam sosednosti - elementarni grafi: drevesa, cikli (prstani), klikli, zvezde - planarna (geografska) omrežja, Eulerov problem Konigsberških mostov - bipartitna omrežja - multiplex omrežja • Software za vizualizacijo omrežij <ul style="list-style-type: none"> - Pajek, Gephi, Cytoscape, NetworkX, GraphViz, R - računalniška kompleksnost omrežnih problemov • Osnove teorije omrežij <ul style="list-style-type: none"> - koncept statistične obravnave omrežij - gručenje, najkrajša pot, povprečna najkrajša pot - premer omrežja, breadth-first iskanje - distribucija stopenj, centralnosti vozlišča in povezave, closeness in betweenness centralnost - elementarni algoritmi za obravnavo omrežij: distribucija stopenj, gručenje, najkrajša pot, particija grafa • Modeli omrežij <ul style="list-style-type: none"> - Erdos-Renyi naključno omrežje - Small world fenomen, model Watts in Strogatz - polinomialni zakoni v naravi, model Barabasi in Alberta, preferencialno povezovanje - Zipfov zakon, razlika med eksponentnimi in polinomskimi distribucijami - geometrijska omrežja, ostali modeli - modeli naraščanja omrežij, naraščajoča in statična omrežja - naključna omrežja s določenim stopnjami • Struktura skupnosti 	<ul style="list-style-type: none"> - Node (vertex), link (edge), directed and non-directed, weighted and non, connected and non, giant connected component - degree and mean degree, in- and out- degree - adjacency matrix and adjacency list - simple graphs: trees, cycles (rings), cliques, stars - planar (geographic) networks, Euler Konigsberg problem - bipartite networks - multiplex networks • Network visualization software <ul style="list-style-type: none"> - Pajek, Gephi, Cytoscape, NetworkX, GraphViz, R - computational complexity of networks-related problems • Fundamentals of Network Theory <ul style="list-style-type: none"> - concept of statistical treatment of networks - clustering, shortest path, average shortest paths, diameter, breadth-first search - degree distribution, Node and link centrality, closeness and betweenness centrality - simple algorithms: degree distributions, clustering coefficients, Shortest-path algorithms, Graph partitioning • Network models <ul style="list-style-type: none"> - Erdos-Renyi random networks - Small world phenomena, Watts-Strogatz model - power laws in nature, Barabasi-Albert model, preferential attachment and hubs - Zipf's law, the difference between the exponential and potential distributions - geometric networks, other network models - models for network generation and growth, growing vs static networks - random graphs with a given degree sequence • Community structure <ul style="list-style-type: none"> - Networks with communities, community detection, modularity
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<ul style="list-style-type: none"> - omrežja s skupnostmi, odkrivanje skupnosti, modularnost in modularna omrežja, motivi, grafki • Procesi na omrežjih <ul style="list-style-type: none"> - širjenje bolezni, SIS in SIR modeli, difuzija, trači, perkolacija, formiranje mnenj, igre - naključni sprehod, iskanje in navigacija, iskanje po spletu, Google in PageRank algoritmi, decentralizirano iskanje - odpornost omrežja na nepričakovane izpade in napade 	<p>and modular networks, network motifs, graphlets</p> <ul style="list-style-type: none"> • Processes on networks <ul style="list-style-type: none"> - contagions and SIS/SIR models, diffusion, rumors, percolation, opinion formation models, games - random walks, Search and navigation methods, Searching the Web, Google and the PageRank algorithms, Decentralized search - network resilience to random failures and intentional attacks
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Temeljni literatura in viri / Readings:

- de Nooy, W., Mrvar, A. in Batagelj, V. (2005). *Exploratory Social Network Analysis with Pajek*. New York, NY: Cambridge University Press.
- Wasserman, S., Faust, K. in Iacobucci, D. In Granovetter, M. (1999). *Social Network Analysis: Methods and Applications*: New York, NY: Cambridge University Press.
- Kolaczyk, E. D. (2009). *Statistical Analysis of Network Data: Methods and Models*. New York, NY: Springer.
- David Easley and Jon Kleinberg (2010). *Networks, Crowds, and Markets*. Cambridge University Press.
- Mark Newman (2010). *Networks: An introduction*. Oxford University Press.
- S.N.Dorogovtsev (2010). *Lecture notes on complex networks*. Calderon press, Oxford.

Cilji in kompetence:

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

- poznavanje in razumevanje širokega nabora aplikacij informacijsko komunikacijske tehnologije v sodobni družbi,
- obvladanje raziskovalnih metod, postopkov in procesov
- sposobnost interdisciplinarnega pristopa, ki se kaže kot razumevanje splošne strukture družbenih ved ter povezanosti med njenimi posameznimi disciplinami in poddisciplinami
- sposobnost fleksibilne in aplikativne uporabe teoretičnega znanja
- sposobnost pridobivanja, selekcije, ocenjevanja in umeščanja novih informacij in zmožnost interpretacije v kontekstu družboslovja
- usposobljenost za samostojno in avtonomno uporabo, nadzor in

Objectives and competences:

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

- knowledge and understanding of a wide range of applications of information communication technology in the modern society
- competence in research methods, procedures and processes
- ability for an interdisciplinary approach, shown as an understanding of general structure of social sciences and interconnections between its individual scientific disciplines and sub disciplines
- ability to flexibly apply knowledge in practice
- the ability to acquire, select, evaluate and place new information and the ability to interpret this new information in the context of social science

vzdrževanje informacijsko komunikacijske tehnologije v organizaciji

- competence for independent and autonomous use, monitoring and maintenance of information communication technology in an institution

Predvideni študijski rezultati:

Znanje in razumevanje:

Študent/študentka:

- se seznani s teoretskimi osnovami in s praktičnimi vidiki statističnih metod iz področja multivariatne statistike
- se seznani z algoritmi za modeliranje velikih socialnih in informacijskih omrežij, predvsem v kontekstu uporabe v realnih primerih
- se seznani z metodami teoretičnega računalništva in analize ter načrtovanja algoritmov na primeru velikih omrežij
- se seznani z algoritmi in metodami za analizo socialnih omrežij
- spozna računsko zahtevne metode za analizo malih omrežij, ter hitrejše metode za analizo večjih omrežij
- se usposobi za izvedbo najzahtevnejše statistične analize: za izvedbo raziskav, kjer se obravnava povezava med večimi statističnimi spremenljivkami hkrati
- se nauči uporabljati nekaj najaktualnejših programskih orodij za to najzahtevnejšo statistično analizo

Intended learning outcomes:

Knowledge and understanding:

The student:

- becomes familiar and learn about Social network analysis
- learns methods and algorithms for analysis and modeling of large social and information networks, experiences the real world applications and learns how to use the existing tools and software packages for social network analysis
- is informed with teoretical bases and practical views of statistical methods in the field of multivariate statistics
- is informed with methods of theoretical computing and analysis as well as planning algoritms in case of large scale networks
- is informed with algoritms and methods of network analysis, encounter computational demanding methods small scale networks as well as quicker methods of analysis of large scale networks
- is trained for the performance of most demanding statistical analysis: realisation of the research where links with various statistical variables are dealt with simultaneously
- learns how to use some most up-to-date program tools for this most demanding statistical analysis

Metode poučevanja in učenja:

- *predavanja* z aktivno udeležbo študentov (razlaga, diskusija, vprašanja, primeri, reševanje problemov). *Naloge in projekti*, kjer študenti ponovijo in preizkusijo svoje razumevanje predavane snovi, predvsem skozi reševanje specifičnih problemov.

Learning and teaching methods:

- *lectures* with active student participation (explanation, discussion, questions, case studies, problem solving)
- *assignments* and *Projects* where students revise and test their comprehension of lectured material, primarily via solving specific problems on

Zaključni projekt bo v bistvu enak zaključenemu izpitu

- *laboratorijske vaje*, kjer bodo študentje pri konkretnih problemih ponovili, utrdili in dodatno osvetlili pojme in metode, spoznane na predavanjih
- *vaje v računalniški učilnici*: pri teh vajah bodo študentje spoznali nekaj najaktualnejših programskih orodij za analizo omrežij

their own. Final project will in essence amount to completing the course

- *lab work* where concepts and methods dealt with at lectures will be additionally revised and lit up
- *computer lab work* where some most up-to-date program tools will be used; students learn to use software packages for social network analysis

Delež (v %) /

Weight (in %)

Načini ocenjevanja:

Assessment:

Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
<ul style="list-style-type: none"> • Zaključni projekt 	50	<ul style="list-style-type: none"> • Project work
<ul style="list-style-type: none"> • Domače naloge 	50	<ul style="list-style-type: none"> • Assignments