



Univerza v Mariboru

Fakulteta za naravoslovje
in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Napredne računske metode za biofizikalne in biomedicinske aplikacije
Course title:	Advanced computational methods for biophysical and biomedical applications

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
FIZIKA, 3. stopnja		1. ali 2.	1., 2. ali 4.
PHYSICS, 3 rd cycle		1. or 2.	1. or 2.

Vrsta predmeta / Course type

Izbirni za vse module

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
10	5				165	6

Nosilec predmeta / Lecturer:

Marko Gosak

Jeziki /

Languages:

Predavanja /

Lectures:

Vaje / Tutorial:

Slovenski/ Slovenian

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

Ni pogojev. Priporočljivo je predznanje osnov programiranja.

Prerequisites:

None. Basic programming skills are recommended.

Vsebina:

Content (Syllabus outline):

Linearna in nelinearna analiza časovnih vrst, valčna analiza, filtriranje podatkov, statistične analize, vizualizacija podatkov.

Teorija kompleksnih mrež, korelacijska analiza, ekstrakcija funkcionalne povezanosti, večplastne mreže.

Metode za kvantitativno obdelavo in procesiranje biomedicinskih slik in video posnetkov.

Deterministično in stohastično modeliranje bioloških sistemov na različnih nivojih organiziranosti, večslakni modeli, stabilnostna analiza.

Linear and non-linear time series analysis, wavelet analysis, data filtration, statistical analyses, data visualization.

Complex network theory, correlation analysis, functional connectivity patterns, multilayer networks.

Methods for quantitative biomedical image and video processing and analysis.

Deterministic and stochastic modelling of biological systems at different levels of biological organization, multiscale models, stability analysis.

Temeljni literatura in viri / Readings:

1. J. A. Etchings, Strategies in Biomedical Data Science: Driving Force for Innovation, John Wiley & Sons, Inc. 2017 New Jersey USA.
2. R. H. Shumway & D. S. Stoffer, Time Series Analysis and Its Applications, Springer 2011, New York USA.
3. A.-L. Barabasi, Network Science, Cambridge University Press 2016, Cambridge UK.
4. C.P. Fall, Computational Cell Biology, Springer-Verlag 2002, New York USA.
5. J. Keener & J. Sneyd, Mathematical Physiology, Springer-Verlag 1998, New York USA.
6. K. Sameshima & L. A. Baccala, Methods in Brain Connectivity Inference through Multivariate Time Series Analysis, CRC Press 2014, Boca Raton USA.

Cilji in kompetence:

Študentje pridobijo poglobljeno znanje s področja teoretičnih in računskih metod pri preučevanju realnih biomedicinskih podatkov in biofizikalnih sistemov. Spoznajo najnovejše raziskave na tem področju.

Objectives and competences:

Students acquire advanced knowledge on theoretical and computational methods for exploring real biomedical data and biophysical systems. Students become familiar with recent research activities in this field.

Predvideni študijski rezultati:

Znanje in razumevanje:

Sposobnost izdelave lastnih algoritmov za napredne analize konkretnih primerov biomedicinskih sistemov, poglobljanje znanj s področij biofizikalnega modeliranja in numeričnih metod.

Intended learning outcomes:

Knowledge and understanding:

The ability to create own algorithms for advanced analysis of concrete examples of biomedical systems, upgrading the knowledge of biophysical modelling and numerical methods.

<p>Prenosljive ključne spretnosti in drugi atributi:</p> <p>Sposobnost oblikovanja in implementacije izvirnih znanstvenih rešitev v danih biofizikalnih in medicinskih problemih.</p> <p>Sposobnost predstavitve pridobljenih znanstvenih izsledkov in rezultatov s področja biofizike in biomedicine na nivoju mednarodnih konferenc in publikacij.</p>	<p>Transferable/key skills and other attributes:</p> <p>Ability of defining and implementing unique scientific solution within defined biophysical and medical problems.</p> <p>Ability of presenting the acquired results and scientific findings on biophysical and biomedical systems on the level of international conferences and publications.</p>
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Metode poučevanja in učenja:

Predavanja, seminar, individualno raziskovalno delo.

Learning and teaching methods:

Lectures, seminar, individual research work.

Delež (v %) /

Weight (in %)

Načini ocenjevanja:

Assessment:

Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Ustni izpit	25	Oral examination
Domače naloge	25	Homework
Projekt	50	Project

Reference nosilca / Lecturer's references:

1. MARKOVIČ, Rene, PELTAN, Julien, GOSAK, Marko, HORVAT, Denis, ŽALIK, Borut, SEGUY, Benjamin, CHAUVEL, Remi, MALANDAIN, Gregoire, COUFFINHAL, Thierry, DUPLÁA, Cécile, MARHL, Marko, ROUX, Etienne. Planar cell polarity genes frizzled4 and frizzled6 exert patterning influence on arterial vessel morphogenesis. PloS one, ISSN 1932-6203, 2017, vol. 12, iss. 3, str. 1-19, doi: 10.1371/journal.pone.0171033. [COBISS.SI-ID 22990856]
2. GOSAK, Marko, STOŽER, Andraž, MARKOVIČ, Rene, DOLENŠEK, Jurij, MARHL, Marko, RUPNIK, Marjan, PERC, Matjaž. The relationship between node degree and dissipation rate in networks of diffusively coupled oscillators and its significance for pancreatic beta cells. Chaos, ISSN 1054-1500, July 2015, vol. 25, iss. 7, 073115-1-073115-8, doi: 10.1063/1.4926673. [COBISS.SI-ID 512523576]
- 3 GOSAK, Marko, MARKOVIČ, Rene, FAJMUT, Aleš, MARHL, Marko, HAWLINA, Marko, ANDJELIĆ, Sofija. The analysis of intracellular and intercellular calcium signaling in human anterior lens capsule epithelial cells with regard to different types and stages of the cataract. PloS one, ISSN

1932-6203, 2015, vol. 10, iss. 12. <http://dx.doi.org/10.1371/journal.pone.0143781>, doi: 10.1371/journal.pone.0143781. [COBISS.SI-ID 2645676]

4. GOSAK, Marko, GUIBERT, Christelle, BILLAUD, Marie, ROUX, Etienne, MARHL, Marko. The influence of gap junction network complexity on pulmonary artery smooth muscle reactivity in normoxic and chronically hypoxic conditions. *Experimental physiology*, ISSN 0958-0670, 2014, vol. 99, no. 1, str. 272-285, doi: 10.1113/expphysiol.2013.074971. [COBISS.SI-ID 20068872]

5. GOSAK, Marko, MARKOVIČ, Rene, DOLENŠEK, Jurij, RUPNIK, Marjan, MARHL, Marko, STOŽER, Andraž, PERC, Matjaž. Network science of biological systems at different scales : a review. *Physics of life reviews*, ISSN 1873-1457, 2018, vol. 24, str. 118-135, doi: 10.1016/j.pprev.2017.11.003. [COBISS.SI-ID 512746040]