Study Programme: Applied Mathematics – Data Science

Course Unit Title: Big Data in Medicine and Biology

Course Unit Code: MDS22

Name of Lecturer(s): Dušan Jakovetić, Mirjana Ivanović

Type and Level of Studies: master

Course Status (compulsory/elective): elective

Semester (winter/summer): winter

Language of instruction: English/Serbian

Mode of course unit delivery (face-to-face/distance learning):

Number of ECTS Allocated: 5

Prerequisites: Pattern analysis and machine learning, Introduction to digital signal processing

Course Aims:

- Understanding basic principles and use of computer vision in medicine, image registration, shape and appearance modelling
- Understanding decision support analysis, pattern recognition and predictive model construction and evaluation in the context of medical applications
- Understanding basic computational methods for analysis and interpretation of Big Data in bioinformatics

Learning Outcomes: Experience in analysis and processing of medical images using advanced algorithms such as image registration, active shape and appearance modelling. Experience in using decision support, knowledge-based and learning systems in computer-based diagnosis, planning and monitoring of therapeutic interventions. Experience in using algorithms for sequence analysis and alignment, microarray data analysis, biological networks.

Syllabus:

Introduction to medical imaging: basic notions, modalities, resolution, interpolation, optimization Shape and appearance modelling - shape determinants, registration, texture and appearance, statistical modelling of shape and texture variations, dimensionality reduction, classification of image populations, active shape and appearance models: for object parametrization in images

Image registration - establishing structural and geometric correspondence between medical images, normalization and objective measures, transformations and deformations

Introduction to biomedical signals (1D, multichannel), application of basic time and/or frequency analysis procedures, and feature representation and parametrization. Signal analysis and pattern recognition algorithms for efficient noninvasive diagnostics, on-line monitoring and rehabilitation. Basics of computational neuroscience and big data perspectives.

Introduction to genomic data (sequences, gene expression, protein-protein interactions), finding information in biological databases (GenBank, Swiss-Prot, MIPS, GEO, ArrayExpress). Integration of heterogeneous data. Methods for inferring information from genomic data in gene function prediction, linking genes and diseases, phylogenetic analysis, drug-protein interactions, metagenomics analysis.

Required Reading:

1. Rangaraj M. Rangayyan Biomedical Signal Analysis a Case-Study Approach IEEE Press, Willey Interscience 2002.
2. Jure Leskovac, Anand Rajaraman, Jeffrey D. Ullman, Mining of Massive Datasets, Cambridge University Press, 2010.
3. Vivien Marx, Biology: The big challenges of big data, 2013.
4. Phillip Compeau, Pavel Pevzner, Bioinformatics Algorithms: An Active Learning Approach, Active Learning Publishers, 2014.

Weekly Contact Hours: 4	**Lectures:** 2	**Practical work:** 2

Teaching Methods: Lectures; revisions of the material; active students' participation in problem solving; lab reports, application of the taught material on real-world examples from one of the three major topics within the course project.

Knowledge Assessment (maximum of 100 points):			
Pre-exam obligations	points	**Final exam**	points
Active class participation		written exam	
Practical work	10	oral exam	
Preliminary exam(s)		final project	90
Seminar(s)			
The methods of knowledge assessment may differ; the table presents only some of the options: written exam, oral exam, project presentation, seminars, etc.			