Study program: Artificial Intelligence

Name of the subject: Big Data in Medicine and Biology

Teacher(s): Sanja Brdar, Oskar Marko

Status of the subject: elective

Number of ECTS credits: 5

Conditions: none

Subject goal

- Understanding the basic principles and usage of computer vision and image processing for data preparation (image reconstruction, image denoising and image segmentation).
- Understanding the basic computational methods for analysis and interpretation of heterogeneous data in bioinformatics.
- Understanding of decision analysis, artificial intelligence and predictive model construction and evaluation in the context of various multidimensional data modalities (hyperspectral and multispectral images, synthetic aperture radar images(SAR), magnetic resonance imaging (MRI), computer tomography (CT) images, digital holography (DH) data and bioinformatics data (sequences, graphs and tabular data)
- Practical work on data from bio-related fields (biology, ecology, agriculture, medicine)

Outcome of the subject

- Experience in analysis and processing of different image modalities, using advanced imaging algorithms for image denoising, reconstruction and segmentation.
- Experience in analysis and processing of bioinformatics data.
- Experience in using decision support and knowledge-based systems, learning systems in computer-based planning and monitoring the current state of the observed phenomena in biosystems.

Subject content

Theory

Representation of multidimensional signals using harmonic analysis (wavelet and wavelet-like decompositions) and compressed sensing theory. Introduction to computational imaging: modalities (MRI, CT, SAR, DH), reconstruction and denoising methods. Modeling of image structure using spatial statistics (Markov Random Field MRF based models) applied on various sparse image representation for the purpose of image segmentation.

Practical learning

Implementation of advanced algorithms for image reconstruction, denoising and segmentation of region of interest (ROI) in mentioned image modalities; Implementation of advanced algorithms for bioinformatics data analysis.

Introduction to genomic data (sequences, gene expression, protein-protein interactions), finding information in biological databases . Integration of heterogeneous data. Expert from the industry will be included into the project assignment realization as an external tutor.

Literature

1. Kutyniok, G. and Labate, D. eds., 2012. *Shearlets: Multiscale analysis for multivariate data*. Springer Science & Business Media.
2. Eldar, Y.C. and Kutyniok, G. eds., 2012. *Compressed sensing: theory and applications*. Cambridge university press.
3. Li, S.Z., 2012. *Markov random field modeling in computer vision*. Springer Science & Business Media
4. http://www.shearlab.org/
5. Phillip Compeau, Pavel Pevzner, Bioinformatics Algorithms: An Active Learning Approach, Active Learning Publishers, 2014

Number of active teaching classes	**Theoretical teaching: 2**	**Practical teaching: 2**

Method of carrying out the teaching

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

Evaluation of knowledge (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
Course project	70	Oral exam	30