MACHINE LEARNING IN BIOMEDICAL DATA

Basic Information

This is a course, which contributes to MSc award in Biology

Course period	From February 1st till June 1st, and from September 1st till February 1st, 2 semesters
Study credits	8 ECTS credits
Duration	288 hours
Language of instruction	English
Academic requirements	- BSc degree in Biology, Chemistry, Physics or Environmental Sciences or equivalent (transcript of records), - Good command of English (certificate or other official document)

Course Description

«Machine Learning in Biochemical Data» is the key extensive course, which was designed to provide a student with the ability to construct and use the machine learning algorithms for the various medical problems: test the treatment efficiency, detect the anomalies on the medical images or predict the quality-of-life index after the treatment.

The students are expected to be able to construct their own neural networks on the chosen programming language, combine the multiple images to gain more information for the machine learning algorithm and estimate the whole body biochemistry alteration as the response to a given treatment strategy.

The most important parts of this course are the non-image and image medical data analysis. The students are expected to gain skills in neural networks construction. Also, these parts include the machine-learning algorithms that can be possibly applied to solve a given problem.

The course is designed to cover a wide range of possible neural network structures and algorithms, which are special for a given area or a given organ.

Course Aims

- To help students study new discipline or to ameliorate the existing knowledge in machine learning.
- To assist students to construct their own strategy of medical data machine learning analysis.
- To give students the understanding of how to estimate the errors of the given machine learning algorithm.
- To introduce the basic principles machine learning analysis of medical data.

Course Objectives

The course has been designed to:

- ensure that students are familiar with a basic machine learning routines.
- ensure that students know the main regression methods, which are suitable for the most medical data analysis.
- give students the optimal structures of the neural networks for the medical data analysis.
- give students an appreciation of the anomaly detection routines.
- provide students with the principles of the quality-of-life analysis.
- provide students with the basic routines of medical image analysis.

Learning Outcomes of the Course

By the end of the course, the students will be able to:

- construct their own neural network,
- estimate the error of the given neural network prediction,
- detect anomalies on the medical images,
- analyze the biochemical data tests and to estimate the treatment efficiency with the machine learning algorithms.

Course (module) Structure

Learning Activities	Hours
Lectures	46
Practice sessions / Seminars,	64
Self-study Assignments	178
Final Exam (including preparation)	-
Total study hours	**288**

Course Outline

Week	Lectures	Practice session / Assignments	Hours
Semester 2			
1-6	Mathematics for Machine Learning in Medicine	• Regression in Medical Data • Optimal Scaling Techniques • Factor and Cluster Analysis • Home assignment No 1	(14/14/44)
7-14	Non-Image Medical Data Analysis	• Quality-of-Life Analysis • Biochemical Tests Analysis • Multiple Response Tests • Validation of the Treatment Effects • Home assignment No 2	(14/14/44)
	Pass/Fail Exam		
Semester 3			
1-18	Image Medical Data Analysis	• Structures Edges Detection and Image Segmentation • Anomaly Detection on the Medical Images • Combining the Multiple Images • Classification on Medical Images • Home assignment No 3	(18/36/90)
	Pass/Fail Exam		

Course Instructors and Tutors, Contact Information

Instructor	Contact Information
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Assessment

The final exam is an individual problem in the form of a simulated experimental dataset. The student must demonstrate the abilities in:

• rescale and preprocess the data for the machine learning analysis (20 points maximum),

• construct the neural network for a given problem of the medical image classification, anomaly detection or multiple images combination (40 points maximum),

• perform the multiple response test or the biochemical examination test (40 point maximum).

Grade policy:

A (excellent work)	91-100 %
B (above average work)	81-90 %
C (average work)	71-80 %
D (below average work)	50-70 %
F (failed work)	<50 %

Core reading

1. Cleophas, T. and Zwinderman, A. (2013) *Machine Learning in Medicine* (in 3 books). Springer, Dordrecht.
2. Cleophas, T. and Zwinderman, A. (2014) *Machine Learning in Medicine – Cookbook* (in 3 books). Springer, Cham.
3. Naqa, I, Li, R. and Murphy, R. (2015) *Machine Learning in Radiation Oncology*. Springer, Cham.
4. Wang, F., Shen, D., Yan, P. and Suzuki, K (ed.) (2012) *Machine Learning in Medical Imaging*. Springer, Berlin, Heidelberg.