POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Modal analysis and machine learning [S1IBio1>AMiUM]

Course

Field of study	Year/Semester
Biomedical Engineering	3/6
Area of study (specialization)	Profile of study
–	general academic
Level of study	Course offered in
first-cycle	Polish
Form of study	Requirements
full-time	elective

Number of hours

Lecture	Laboratory classes	Other
15	15	0
Tutorials	Projects/seminars	
0	0	

Number of credit points

2,00

Coordinators

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Lecturers

Prerequisites

KNOWLEDGE: the student has basic knowledge of information technology and biomedical engineering SKILLS: the student is able to integrate the obtained information and interpret it SOCIAL COMPETENCES: the student is able to cooperate in a project team, is aware of the responsibility for the tasks performed, understands the need to acquire new knowledge

Course objective

Students gain knowledge about the techniques of analysis and processing of medical data. They will learn selected data analysis techniques, such as modal analysis (on the example of principal component analysis - PCA, locally linear embedding - LLE, and other techniques),), support vector machines (SVM) and others in the field of machine learning and artificial intelligence, in order to further interpret medical data and create 3D tissue-specific models for the patient.

Course-related learning outcomes

Knowledge:
Has a basic knowledge of computer science that allows to use the basics of algorithmics, compilers and programming languages, multimedia techniques, software and Internet tools, computer-aided

engineering systems in biomedical engineering and technology.
He knows the basic methods of techniques and tools in the area of computer graphics, thanks to which he can understand and describe: processing real images into digital form, digital image processing, methods of improving the quality of digital images.
He has detailed knowledge of digital image processing, thanks to which he can describe: images and signals, observations and measurements, digital image processing, image analysis methods, reduction of feature space dimensionality - cluster analysis, classification and recognition; can recognize images; present selected classification problems, IT tools for image processing, analysis and recognition..

Skills:
Can use the methods of image analysis and processing to carry out tasks in the field of biomedical engineering.
Can plan computer simulations, interpret the obtained results and draw conclusions. He can use computer aids to solve technical tasks, in particular in the field of visualization and analysis of data from medical imaging, segmentation, registration and detection of shapes and their contours.
Has the ability to self-educate. s.

Social competences:
Understands the need for lifelong learning; can inspire and organize the learning process of other people.
Can properly define priorities for the implementation of a task set by himself or others.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Test / colloquium and evaluation of tasks performed during the laboratory classes. Points are awarded for both items. The condition for receiving a positive evaluation is obtaining at least 50% of the possible points.

Programme content

Data sources in medical diagnostics. Basics of working in the Python. Image transformations.
Segmentation and registration.
Low-dimensional (modal) analysis of medical data. Principal Component Analysis (PCA).
Machine learning and artificial intelligence in biomedical engineering. Support vector machines (SVM), neural networks.

Course topics

Lecture:
Data sources in medical diagnostics.
Basics of working in the Python + OpenCV environment. Image transformations.
Detection of objects and contours. Segmentation and registration. Creation of 3D models based on DICOM data.
Low-dimensional (modal) analysis of medical data. Principal Component Analysis (PCA) and derivative methods. Locally linear embedding (LLE).
Machine learning and artificial intelligence in biomedical engineering. Support vector machines (SVM) in regression and classification applications, logistic and linear regression. Neural networks.

Lab:
- Introduction to Python
- OpenCV. Processing of medical data
- Modal analysis and model order reduction
- Machine learning using support vector machines (SVM), random forests, linear regression
- Artificial neural networks. Recurrent neural networks

Teaching methods

Information / problem lecture, case study, multimedia presentation, computer lab.

Bibliography

Basic:
A. Geron. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow. O'Reilly Media, 2019. ISBN: 978-14-920-3264-9
A. Kaehler, G. Bradski. OpenCV 3. Komputerowe rozpoznawanie obrazu w C++ przy użyciu biblioteki OpenCV. Helion, 2017. ISBN: 978-83-283-1656-0
M. Gągolewski, M. Bartoszuk, A. Cena. Przetwarzanie i analiza danych w języku Python. PWN, Warszawa, 2016. ISBN: 978-83-011-8940-2

Additional:
M. Dawson: Python dla każdego. Podstawy programowania. Helion, 2014. ISBN: 978-83-246-9358-0
B. Menze, G. Langs, Z. Tu, A. Criminisi. Medical Computer Vision. Recognition Techniques and Applications in Medical Imaging. Springer, 2011.
J. Howse. OpenCV Computer Vision with Python. Packt Publishing Limited, 2013. ISBN: 9781782163923

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	20	1,00