GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Artificial intelligence in biomedical engineering, PG_00057491		
Field of study	Mechanical and Medical Engineering		
Date of commencement of studies	February 2023	Academic year of realisation of subject	2023/2024
Education level	second-cycle studies	Subject group	Obligatory subject group in the field of study Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	2	ECTS credits	5.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Katedra Inteligentnych Systemów Sterowania i Wspomagania Decyzji -> Faculty of Electrical and Control Engineering		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Michał Grochowski	
	Teachers	mgr inż. Maria Ferlin dr hab. inż. Michał Grochowski	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	0.0	15.0	15.0	0.0	60

E-learning hours included: 0.0

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	60	10.0	55.0	125

Subject objectives

The aim of the course is to provide students with comprehensive knowledge of the dynamically developing field of Artificial intelligence (AI) and Machine Learning (ML) and to indicate its practical applications in the field of medicine.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U03] He/she can prepare an elaboration and presentation related to the general and specific engineering tasks located in Polish and foreign languages	Student, on the basis of conducted research, is able to process the results using appropriate measures and indicators, is able to draw conclusions and present the results of experiments and analyses in an understandable form.	[SU5] Assessment of ability to present the results of task [SU2] Assessment of ability to analyse information
[K7_W01] He/she has broad knowledge referring to the high level math to solve numerical problems and tasks related to planning and to work out results of research in the scope of the field of study of mechanical-medical engineering	The student learns basic computational techniques of artificial intelligence, selects an AI algorithm to solve a specific practical task, e.g. analysis and classification of medical images, implements the AI algorithm in a selected programming language (Matlab or Python).	[SW1] Assessment of factual knowledge
[K7_U04] He/she can use programming-communicative techniques concerning to the scope of engineering tasks	Students can apply known tools and algorithms of artificial intelligence and dedicated software environments and libraries to solve research problems, e.g. automatic analysis of large amounts of data.	[SU4] Assessment of ability to use methods and tools [SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment

Subject contents	AI and ML are rapidly gaining popularity due to, among others, their features that allow efficient and effective information processing in conditions of large amount of data, its uncertainty and diversity. AI and ML find application wherever the large size of data sets and their nature prevent their "manual" analysis, wherever the system must dynamically and autonomously adapt to changing conditions, and where the analysed problems are so complex and complicated that there are no reliable and/or easy to implement and analyse theoretical models. AI and ML algorithms are well suited to problems such as: exploration and extraction of new knowledge from data; decision support or decision making; processing and analysis of signals, images, or videos, scene analysis (also 3D), speech processing and analysis; intelligent diagnostic systems; intelligent and adaptive control systems or prediction. Most of these problems can be found in medical engineering issues. The content of the programme will be implemented in four thematic blocks: 1. Artificial intelligence - introduction; 2. Data analysis, 3. AI models and methods for their training, 4. Model performance analysis and improvement. All programme contents will have reference to issues in the field of medical engineering. During laboratory classes, selected contents of the programme will be illustrated by examples of their practical use in the field of medicine. During project classes, students will have the opportunity to design and implement a decision support system in medicine for a selected problem, e.g. diagnosis of brain lesions. For the implementation of the course, Students will be provided with access to relevant tools and data, and extensive support materials will be prepared. The programme content will be implemented in four thematic blocks: 1. Introduction to artificial intelligence methods: - Basic domains and definitions related to artificial intelligence, - Genetic algorithms, fuzzy inference, artificial neural networks, - Review of the most successful AI and ML algorithms and their applications in medicine. 2. Data analysis with special emphasis on medical data: - data exploring, - data grouping, clustering, - feature selection and extraction, - dimension reduction, - data normalization, - visualisation of multidimensional data. 3. Models and methods for their training, e.g: - regression models, - support vector machines

	- neural networks, - deep neural networks, - learning: supervised, unsupervised, semi-supervised, - analysis of medical image data, e.g. classification, detection, segmentation. 4. Analysis of the performance of models and improvement of their performance, including - model performance quality measures, - regularisation techniques, - model validation, - analysis of algorithm performance using explainable artificial intelligence (XAI), - Fairness, responsibility and trustworthiness issues of intelligent systems in medicine.
Prerequisites and co-requisites	

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Project	50.0%	30.0%
Laboratory classes	50.0%	30.0%
Lectures	50.0%	40.0%

Recommended reading

Basic literature	• Zhang, Aston and Lipton, Zachary C. and Li, Mu and Smola, Alexander J. Dive into Deep Learning, 2021. • Bonaccorso, G. Algorytmy uczenia maszynowego. Zaawansowane techniki implementacji. Helion, 2019 • Szeliga, M. Data Science i uczenie maszynowe. Wydawnictwo Naukowe PWN, 2017. • Bengio, Y., Courville A., Goodfellow I. Deep Learning. Systemy uczące się. Wydawnictwo Naukowe PWN, 2018. • Chollet, F. Deep Learning. Helion, 2019
Supplementary literature	• Lei Xing, Maryellen l. Giger, James K. Min. Artificial intelligence in medicine - Technical Basis and Clinical Applications. Academic Press, ELSEVIER, 2021. • Morra Lia, Silvia Delsanto and Loredana Correale. Artificial Intelligence in Medical Imaging - From Theory to Clinical Practice. Taylor & Francis Group, 2020. • Alpaydin, E. Introduction to Machine Learning. The MIT Press Cambridge, Massachusetts London, England 2010. • Haykin, S. Neural Networks and Learning Machines (3rd Edition), Prentice Hall, 2009. • Grus, J. Data science od podstaw. Analiza danych w Pythonie. Helion, 2019. • MATLAB Statistics and Machine Learning Toolbox User's Guide, 2021.
eResources addresses	Adresy na platformie eNauczanie:

Example issues/ example questions/ tasks being completed	• Feature extraction and knowledge mining from large datasets, data normalization, treatment of missing data, dimension reduction, data clustering, visualization of multidimensional data. • Classification of skin lesions. • Classification, detection and segmentation of brain lesions • Human health assessment based on data from sports/medical bands. • Detection of arrhythmias in ECG signal. • Analysis of factors taken into account by the neural system using XAI tools.
Work placement	Not applicable