University of Gdańsk

Subject card

Subject name and code	Introduction to Machine Learning for Medical Physics, PG_00210202		
Field of study	Medical Physics		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2026/2027
Education level	Bachelor's studies	Subject group	Optional subject group 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	2	Language of instruction	Polish pl
Semester of study	3	ECTS credits	3.0
Learning profile	academic	Assessment form	credit
Conducting unit			
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Krzysztof Dorywalski	
	Teachers		

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	0.0	0.0	45.0	0.0	0.0	45

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	45	0.0	30.0	75

Subject objectives

Introduction to machine learning methods used in the analysis of clinical data and medical imaging. Students learn the principles of building predictive models (in particular artificial neural networks) and their practical application in optimizing diagnostic and therapeutic processes.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[FIZMEDL3_U01] He can formulate, analyse, and solve complex problems in physics and medicine, using mathematical formalism, based on the physical phenomena, principles, and theories he has learned.	Is able to translate a complex diagnostic or therapeutic problem into a formal machine learning model, using mathematical formalism (including matrix calculus, loss functions, gradient-based optimization, and probabilistic evaluation metrics) for quantitative analysis and solving problems in medical physics.	[SU2] presentation/project/paper/ report [SU5] implementation of a problem task [SU6] demonstration of practical skills
[FIZMEDL3_U04] He can independently search for information in Polish and English professional and popular science literature, databases, and on the Internet, as well as from other sources. He can integrate and interpret this information, draw conclusions, and formulate opinions.	Is able to independently search Polish and English literature as well as online databases (e.g., Kaggle, UCI Machine Learning Repository) for descriptions of open medical datasets and algorithm documentation, and to integrate and interpret this information in order to optimally select a model architecture and evaluation metrics for a given clinical problem.	[SU2] presentation/project/paper/ report [SU5] implementation of a problem task [SU6] demonstration of practical skills
[FIZMEDL3_W07] Knows and understands at an advanced level the concepts of diagnostic and therapeutic methods and their quality control in medical applications.	Knows and understands the principles of machine learning algorithms and neural networks used in modern diagnostic and therapeutic methods, as well as the theoretical foundations of their validation, testing, and quality control methods necessary to ensure the safety and accuracy of medical procedures.	[SW4] test/exam - oral or written [SW2] presentation/project/paper/ report [SW5] implementation of a problem task
[FIZMEDL3_W03] Knows and understands at an advanced level the most important topics of higher mathematics, including statistics, to the extent necessary for the quantitative description, understanding and modelling of physical and medical processes.	Knows and understands the mathematical framework of linear algebra, differential calculus, and mathematical statistics to the extent necessary for correctly formulating, training, and mathematically describing machine learning models and artificial neural networks used in medicine.	[SW4] test/exam - oral or written [SW2] presentation/project/paper/ report [SW5] implementation of a problem task

Subject contents

1. Introduction to Machine Learning in medicine

2. Feature engineering and preparation of clinical data

3. Classical classification and regression algorithms

4. Unsupervised learning

5. Model evaluation

6. Introduction to neural networks

7. Building and training multilayer perceptrons (MLPs)

8. Preventing overfitting in neural networks

Prerequisites and co-requisites

Knowledge of the Python programming language, including basic object-oriented programming and familiarity with libraries for numerical computations and data processing.

Fundamentals of linear algebra (matrices, vector operations) and mathematical analysis (partial derivatives, gradients, function optimization).

<table>
<tr><td>Assessment methods and criteria</td><td colspan="2"><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td></td><td>51.0%</td><td>20.0%</td></tr>
<tr><td></td><td>51.0%</td><td>60.0%</td></tr>
<tr><td></td><td>51.0%</td><td>20.0%</td></tr>
</table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>1. G. James, D. Witten, T. Hastie, R. Tibshirani, An Introduction to Statistical Learning: with Applications in Python, Springer.

2. A. Zhang, Z. C. Lipton, M. Li, A. J. Smola, Dive into Deep Learning, Cambridge University Press.</td></tr>
<tr><td>Supplementary literature</td><td>1. I. Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIT Press.

2. Official documentation of the Scikit-Learn and PyTorch libraries</td></tr>
<tr><td>eResources addresses</td><td>Basic
https://github.com/KrzysztofDorywalski - Student materials</td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="2">Final project: implementation in Python of a neural network (e.g., an MLP) that, based on a raw clinical dataset of patients, performs automatic classification of the risk of a selected cardiological or oncological disease.</td></tr>
<tr><td>Work placement</td><td colspan="2">Not applicable</td></tr>
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