



Subject card

Subject name and code	, PG_00066699						
Field of study	Technical Physics						
Date of commencement of studies	February 2027	Academic year of realisation of subject				2026/2027	
Education level	second-cycle studies	Subject group				Specialty 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	1	Language of instruction				Polish	
Semester of study	1	ECTS credits				2.0	
Learning profile	general academic profile	Assessment form				assessment	
Conducting unit	Division of Theoretical Physics and Quantum Informaton -> Institute of Physics and Applied Computer Science -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Paweł Syty				
	Teachers		dr inż. Paweł Syty				
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	0.0	0.0	30.0	0.0	0.0	30
	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	30		2.0		18.0	50
Subject objectives	The aim of the course is to teach students the practical use of Python in the field of machine learning.						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	[K7_U02] demonstrates advanced programming skills in a selected language and the ability to use specialised software packages.	The student is able to write advanced source code in Python using selected libraries and other specialist tools.			[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools		
	[K7_W04] possesses advanced knowledge of mathematical, numerical and simulation methods used in the description and modelling of physical phenomena.	The student has an in-depth understanding of selected mathematical, statistical, numerical and simulation methods necessary for modelling physical phenomena using machine learning.			[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects		
	[K7_K01] demonstrates readiness for continuous professional development, including updating and critically evaluating knowledge in physics and related fields, and recognising its importance in solving practical and theoretical problems.	The student is able to independently expand and update their knowledge of machine learning, artificial intelligence and computational methods in Python, critically evaluate the algorithms and tools used, and recognise their significance in solving practical, research and engineering problems.			[SK5] Assessment of ability to solve problems that arise in practice [SK2] Assessment of progress of work [SK1] Assessment of group work skills		
	[K7_U05] is able, individually or as part of a team (including in a leadership role), to plan and conduct advanced theoretical calculations, experimental studies and computer simulations aimed at solving complex and non-standard scientific and engineering problems, and to critically analyse results and formulate well-founded conclusions	The student is able, either independently or as part of a team, to design, implement and evaluate machine learning models in Python, conduct computational experiments using real-world data, critically analyse the results obtained, and select appropriate methods and tools for solving complex scientific and engineering problems.			[SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools		

Subject contents	<p>Course content – laboratory Python language</p> <p>1. Types of data and operations on them. Conditions. Different types of loops. Exceptions. Lists, tuples, dictionaries.</p> <p>2. Functions. Function with an optional argument. Modules. Creating own module and using it. Writing/reading data to/from files. YAML files. Classes and objects. Introduction to multithreading.</p> <p>3. Analysis of the selected dataset. Reading observations for selected variables. Checking selected statistics for individual variables. Creating histograms. Identification of variables with potentially incorrect data (observations) or missing data. Data repair. Calculation of normalized correlations between individual variables. Conducting linear regression for selected variables, including graphs.</p> <p>5. The scikit-learn package and the linear regression model. The coefficient of determination R^2, MSE, MAE. Division of the data set into a training and test part. Prediction using the created model.</p> <p>6. The scikit-learn and preprocessing package. Polynomial model. Feature engineering. Reduction of variables in the model - the Schwarz criterion (Bayesian Information Criterion - BIC). Operation of the polynomial model in practice.</p> <p>7. The scikit-learn package, the k-nearest neighbors method, decision trees and random forests. Classification problem. The choice of features - predictors and the target variable. Parameters of the model. Model quality assessment - confusion matrix, sensitivity, specificity, precision, accuracy, ROC curve, LIFT curve. Cross-validation: k-fold, n-fold and Monte-Carlo (bootstrap).</p> <p>8. The scikit-learn package and the k-means algorithm as a case of unsupervised learning. Cluster analysis - clustering. Parameters of the model. The Fowlkes-Mallows index, i.e. the consistency between the two divisions of the dataset into clusters. Analysis of the principal components - PCA.</p> <p>9. XGBoost, LightGBM packages as examples of reinforcement learning.</p> <p>10. Introduction to neural networks using TensorFlow and PyTorch.</p>											
Prerequisites and co-requisites	Basic programming skills in the selected object-oriented language. Basic knowledge of probability calculus and statistics.											
Assessment methods and criteria	<table border="1" data-bbox="448 1357 1477 1451"> <thead> <tr> <th data-bbox="448 1357 794 1391">Subject passing criteria</th> <th data-bbox="794 1357 1141 1391">Passing threshold</th> <th data-bbox="1141 1357 1477 1391">Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td data-bbox="448 1391 794 1451">The report of the analysis and modeling of the selected data set</td> <td data-bbox="794 1391 1141 1451">60.0%</td> <td data-bbox="1141 1391 1477 1451">100.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade	The report of the analysis and modeling of the selected data set	60.0%	100.0%			
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Example issues/ example questions/ tasks being completed	<p>Guidelines for creating the report: 1. Report Title 2. Introduction motivation, objectives 3. Data Description dataset structure, variables, origin 4. Description of the Data Preparation Process step-by-step approach 5. Data Analysis assumptions, brief overview of methods and chosen analysis methodology 6. Data Modeling assumptions, brief overview of methods and chosen modeling methodology 7. Results, Conclusions, and Discussion</p> <p>The report, along with all code, should be placed in a chosen repository (e.g., GitLab, GitHub).</p>											

Practical activities within the subject	Not applicable
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