



Subject card

Subject name and code	Optimization methods, PG_00060231						
Field of study	Technical Physics						
Date of commencement of studies	October 2026	Academic year of realisation of subject			2028/2029		
Education level	first-cycle 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	3	Language of instruction			Polish		
Semester of study	6	ECTS credits			6.0		
Learning profile	general academic profile	Assessment form			exam		
Conducting unit	Division of Electron Collisions Physics -> 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 Maciej Kuna					
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	30.0	0.0	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	5.0		85.0		150
Subject objectives	The aim of the lecture is to present classical and machine learning inspired optimization methods to allow quick implementation them in the form of appropriate algorithms. There are discussed in the lecture modern optimizing algorithms with an emphasis on their inspiration in physics and biology.						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	[K6_W03] possesses structured knowledge of higher mathematics, including algebra, analysis, probability and numerical methods, sufficient to describe, understand and model complex physical phenomena and selected technical processes.	The student understands how to apply mathematical analysis and algebra tools to evaluate the modeling of phenomena			[SW1] Assessment of factual knowledge		
	[K6_U04] is able, individually or in a team, to plan and conduct experiments in physics and related fields, including applied computer science or energy engineering, and to analyse and interpret results and formulate conclusions.	The student is able to use algorithmic methods to verify and analyze data.			[SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject		
	[K6_K01] demonstrates readiness for continuous learning and updating knowledge in physics and related fields, critically evaluating it and recognising its importance in solving practical and theoretical problems.	The student is ready to explore new algorithms in light of changes in modern optimization.			[SK5] Assessment of ability to solve problems that arise in practice		

Subject contents	<p>Course content – lecture Mathematical foundations of optimization. Numerical linear algebra. Vector norms, operations on vectors and matrices. Mathematical analysis. Conditions of existence of extremes of functions of one and many variables and methods of their checking. Methods of finding derivatives. Classic optimization methods. Algorithms for optimizing functions of one variable: dividing the interval into half, golden ratio, Fibonacci, Newton-Raphson and secant method. Algorithms for optimization of multivariable functions: cubic interpolation, Nelder-Mead, conjugate directions, Cauchy, Newton. Optimization issues in machine learning: Linear regression, simple gradient regression, polynomial regression, regularized linear models, logistic regression, linear and non-linear SVM regression, decision trees, team learning, including random forests, dimensionality reduction, deep neural network training.</p> <p>Course content – laboratory PyCharm: IDE for Software Development with Python Linear regression Singular value decomposition (SVD) and pseudo-inverse of a matrix Optimization using KKT conditions Scikit-learn Non-linear SVM (changing kernels and kernel parameters) Bagging classifier VotingClassifier (hard and soft voting) Kernel PCA using radial basis functions Neural Networks: Stochastic Gradient Descent, Momentum, RMSprop, AdaGrad, Adam Tensorflow Keras: functional API Q Learning, Generative Adversarial Networks</p>											
Prerequisites and co-requisites												
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Example issues/ example questions/ tasks being completed	<p>Application of linear regression to data optimization.</p> <p>Regularization of linear models.</p> <p>Linear and nonlinear SVM regression.</p> <p>Learning deep neural networks.</p>											
Practical activites within the subject	Not applicable											

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