GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Optimization methods, PG_00021010		
Field of study	Technical Physics		
Date of commencement of studies	October 2021	Academic year of realisation of subject	2023/2024
Education level	first-cycle studies	Subject group	
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	5.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Theoretical Physics and Quantum Information -> Faculty of Applied Physics and Mathematics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr Maciej Kuna	
	Teachers	dr hab. Jan Franz dr Maciej Kuna	

Lesson types and methods of instruction

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	0.0	0.0	60

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_U07	The student is able to present the areas of application of optimization methods in physical sciences.	[SU5] Assessment of ability to present the results of task [SU2] Assessment of ability to analyse information
K6_W02	The student has ordered knowledge related to the use of optimization methods in the field of physics.	[SW3] Assessment of knowledge contained in written work and projects
K6_U08	The student has the ability to prepare an oral presentation, presenting modern optimization algorithms used in physics.	[SU5] Assessment of ability to present the results of task [SU4] Assessment of ability to use methods and tools

Subject contents

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.

Prerequisites and co-requisites

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Test	50.0%	20.0%
Positive completion of laboratories	50.0%	60.0%
Written exam	50.0%	20.0%

Recommended reading	Basic literature	1. A. Geron - Uczenie maszynowe z użyciem Scikit-Learn i TensorFlow, 2 wydanie Helion, 2020 2. Singiresu S.Rao Engineering Optymalization - Theory and Practie, Wiley 2009. 3. Findestein. Metody obliczeniowe optymalizacji, PWN, 1977 4. R.Wieczorkowski, Z, Zieliński, Komputerowe generatory liczb losowych, WNT, 1997 5. X. Yang. Engineering Optimization - An Introduction With Metaheuristic Applications, Wiley, 2010
	Supplementary literature	1. K.Kukuła, Badania Operacyjne w przykładach i zadaniach, PWN 2011 2. M. Wahde, Biologically Inspired Optimization Methods - An Introduction (WIT, 2008) 3. S. Luke, Essentials of Metaheuristics, Lulu, second edition, available at http://cs.gmu.edu/sean/book/metaheuristics/ 4. G. Rozenberg, Handbook of Natural Computing, Springer 2012 5. T.Weise Global Optimization Algorithms Theory and Application , http://www.it-weise.de/, 2013
	eResources addresses	Adresy na platformie eNauczanie:
Example issues/ example questions/ tasks being completed	Application of linear regression to data optimization. Regularization of linear models. Linear and nonlinear SVM regression. Learning deep neural networks.	
Work placement	Not applicable	