



Subject card

Subject name and code	PROCESS OPTIMIZATION, PG_00070145						
Field of study	InfoBioChem						
Date of commencement of studies	February 2027		Academic year of realisation of subject		2027/2028		
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		3.0		
Learning profile	general academic profile		Assessment form		assessment		
Conducting unit	Department of Teleinformation Networks -> Faculty of Electronics Telecommunications and Informatics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Tomasz Krzywicki				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	0.0	45.0	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		2.0		13.0	75
Subject objectives	Familiarizing students with modern popular optimization methods used with the use of programming tools.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	[K7_W05] has knowledge of theoretical computational and computer methods used to solve problems appropriate to the curriculum InfoBioChem.		has knowledge to to formulate solutions to optimization problems relevant to the fields of computer science, chemistry, and biology, using modern tools.		[SW3] Assessment of knowledge contained in written work and projects		
	[K7_U07] can apply machine learning and artificial intelligence methods to analyze large sets of biological data.		is able to use modern and popular optimization and learning methods in processing and reasoning based on biological data sets.		[SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment		
	[K7_K02] is ready to work in a team, taking on various roles depending on the needs of the task.		is ready to cooperate in a team implementing complex projects of a diverse nature.		[SK1] Assessment of group work skills [SK3] Assessment of ability to organize work [SK5] Assessment of ability to solve problems that arise in practice		

Subject contents	Course content – lecture		
	<div>1. 1. Introduction to mathematical modeling: 4-step optimization process, generalized model formalization.</div> <div>2. Introduction to practical optimization: naive optimization, computational complexity and dependence on the number of model parameters, use of dedicated optimization algorithms and libraries, fuzzy optimization, representation and optimization of chemical processes.</div> <div>3. Mathematical programming: applications, modern solutions and tools, integer and mixed-integer linear programming, integer and mixed-integer nonlinear programming, solving selected problems using popular programming libraries and solvers.</div> <div>4. Metaheuristics: applications, evolutionary and genetic algorithms, selection, crossover, and mutation operators, solving selected problems using popular programming libraries.</div> <div>5. Gradient-based optimization: applications, the problem of local and global function extrema, simulation of gradient-based optimization with varying learning rates, solving selected problems using popular programming libraries.</div> <div>6. Machine learning: applications in classification and regression, selected classifiers and regressors trained via gradient-based optimization, solving selected problems using popular programming libraries.</div> <div>7. Data preprocessing: the issue of raw data, the need for data preprocessing in machine learning, dataset splitting methods, handling missing values, scaling and transforming dataset values, pipelines automating full data processing and model optimization workflows, solving selected problems using popular programming libraries.</div> <div>8. Uncertain knowledge and classification: the concept of uncertain knowledge, fuzzy sets, fuzzy logic and decision rules, classification of uncertain knowledge, and solutions to selected problems using popular programming libraries.</div>		
	Course content – project		
	Solving field problems by implementing projects using selected methods learned in the lecture.		
Prerequisites and co-requisites			
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Lecture: final test	50.0%	50.0%
	Project: completion of project exercises	50.0%	50.0%
Recommended reading	Basic literature	<div>• Kochenderfer, M. and Wheeler, T.,. Algorithms for Optimization. MIT Press, 2019.</div> <div>• Jung, A. Machine Learning. Springer Singapore, 2022.</div>	
	Supplementary literature	No requirements	
	eResources addresses		
Example issues/ example questions/ tasks being completed	<div>1. Mathematical modeling and formalization of real-world processes</div> <div>2. Black box optimization methods</div> <div>3. Advantages and disadvantages of optimization methods in relation to functions with an explicit formula and meeting the discussed properties</div> <div>4. Applications of optimization methods in relation to chemical processes</div> <div>5. Representation of certain and uncertain knowledge in relation to the field of biological and chemical sciences</div> <div>6. Data processing methods for improving the efficiency of classification and regression processes</div> <div>7. Applications of optimization methods in machine learning on the example of classification and regression</div> <div>8. Applications and selection of the discussed tools for software solution of optimization, decision-making and regression problems</div>		
Practical activities within the subject	Not applicable		

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