



Subject card

Subject name and code	Computational Intelligence - Laboratory, PG_00064254						
Field of study	Automatic Control, Cybernetics and Robotics						
Date of commencement of studies	February 2027	Academic year of realisation of subject				2027/2028	
Education level	second-cycle studies	Subject group				Optional 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	2	ECTS credits				1.0	
Learning profile	general academic profile	Assessment form				assessment	
Conducting unit	Department of Decision Systems and Robotics -> Faculty of Electronics Telecommunications and Informatics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Tomasz Białaszewski					
	Teachers	dr inż. Tomasz Białaszewski					
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	0.0	0.0	15.0	0.0	0.0	15
	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	15	2.0	8.0	25		
Subject objectives	Widening the students knowledge about the selected methods of artificial intelligence						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	[K7_W04] knows and understands, to an increased extent, the principles, methods and techniques of programming and the principles of computer software development or programming devices or controllers using microprocessors or other elements or programmable devices specific to the field of study, and organization of work of systems using computers or such devices	A student is able to implement algorithms in the LISP programming language. A student performs function approximation using radial basis function neural networks.			[SW3] Assessment of knowledge contained in written work and projects		
	[K7_U04] can apply knowledge of programming methods and techniques as well as select and apply appropriate programming methods and tools in computer software development or programming devices or controllers using microprocessors or programmable elements or systems specific to the field of study, making assessment and critical analysis of the prepared software as well as a synthesis and creative interpretation of information presented with it	A student applies methods for learning the parameters of a Bayesian network from data. A student implements algorithms for learning the structure of a Bayesian network from data.			[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools		

Subject contents	<p>Course content – laboratory  Laboratory organization and working environment. Discussion of assessment rules and preparation of the programming environment. Introduction to experimental work and documentation of results. LISP syntax and fundamentals. Exercises covering LISP syntax, list operations, and recursion. Implementation of simple algorithms for symbolic structure processing. LISP high-level definitions. Development of higher-order functions and macros. Genetic Programming fundamentals. Implementation of basic genetic programming operators. Representation of programs as tree structures in LISP. Genetic Programming experimental analysis. Investigation of the influence of algorithm parameters on solution quality. Analysis of convergence and the problem of tree bloat. Bayesian Networks fundamentals. Representation of a Bayesian network as a directed acyclic graph (DAG). Learning parameters of Bayesian networks. Parameter estimation from complete data. Comparison of Maximum Likelihood Estimation (MLE) and Bayesian estimation methods. Bayesian networks incomplete data. Application of the EM algorithm for parameter learning with missing data. Analysis of the convergence process. Structure learning of Bayesian networks. Implementation of a selected structure learning method. Evaluation of model quality using information criteria. Radial Basis Function (RBF) neural networks. Implementation of an RBF network and center selection methods. Application to regression or classification problems.  RBF applications in machine learning. Experimental application of RBF networks to a selected machine learning task. Analysis of error and model generalization performance.</p>		
Prerequisites and co-requisites	Knowledge acquired during the lectures and laboratory classes in Computational Intelligence is required.		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Laboratory	50.0%	100.0%
Recommended reading	Basic literature	1. Neapolitan R.: Learning Bayesian Networks, Prentice Hall, 2003 2. Koza J., et al: Genetic Programming IV, Springer, 2005 3. <a href="http://www.scheme.com/tspl4/">http://www.scheme.com/tspl4/</a> The Scheme Programming Language Fourth Edition R. Kent Dybvig 4. <a href="https://racket-lang.org/">https://racket-lang.org/</a> 5. <a href="http://www.genetic-programming.org/">http://www.genetic-programming.org/</a> 6. <a href="https://www.mathworks.com/help/deeplearning/ug/radial-basisneural-networks.html">https://www.mathworks.com/help/deeplearning/ug/radial-basisneural-networks.html</a>	
	Supplementary literature	<a href="https://htdp.org/">https://htdp.org/</a>	
	eResources addresses		
Example issues/ example questions/ tasks being completed	<ol style="list-style-type: none"> <li>1. Explain a mechanism of mutation by changing the intermediate node in genetic programming?. Show an example of the situation. Write a mutant program as a s-expressions of LISP.</li> <li>2. Define the procedure power-list, which takes a nonnegative integer n and an list of numbers and returns a new list, each element of which is the number of the power n</li> <li>3. Explain the Bayes network parameter learning algorithm for incomplete data.</li> </ol>		
Practical activities within the subject	Not applicable		

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