GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

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| Subject name and code | Computational Intelligence - Laboratory, PG_00064254 | | |
| Field of study | Automatic Control, Cybernetics and Robotics | | |
| Date of commencement of studies | February 2025 | Academic year of realisation of subject | 2025/2026 |
| Education level | second-cycle studies | Subject group | Optional subject group<br>Specialty subject group<br>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 | | | | | | |
| eNauczanie source addresses:<br>Moodle ID: 2767 Inteligencja obliczeniowa - laboratorium - sem. 2025/2026<br>https://enauczanie.pg.edu.pl/2025/course/view.php?id=2767 | | | | | | |

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 | The student is able to implement algorithms in the LISP programming language.<br>The 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 | The student applies methods for learning the parameters of a Bayesian network from data.<br>The student implements algorithms for learning the structure of a Bayesian network from data. | [SU1] Assessment of task fulfilment<br>[SU4] Assessment of ability to use methods and tools |

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| Subject contents | Course content – laboratory<br>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. 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. |
| Prerequisites and co-requisites | Knowledge acquired during the lectures and laboratory classes in Computational Intelligence is required. |
| Assessment methods and criteria | see table below |

| Subject passing criteria | Passing threshold | Percentage of the final grade |
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| Laboratory | 50.0% | 100.0% |

| Recommended reading | | |
|---|---|---|
| | Basic literature | 1. Neapolitan R.:Learning Bayesian Networks, Prentice Hall, 2003<br>2. Koza J., et al: Genetic Programming IV, Spriger, 2005<br>3. http://www.scheme.com/tspl4/ The Scheme Programming LanguageFourth Edition R. Kent Dybvig<br>4. https://racket-lang.org/<br>5. http://www.genetic-programming.org/<br>6. https://www.mathworks.com/help/deeplearning/ug/radial-basisneural-networks.html |
| | Supplementary literature | https://htdp.org/ |
| | eResources addresses | |

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| Example issues/ example questions/ tasks being completed | 1. Explain a mechanism of mutation by changing the intermediate node in genetic programming?. Showan example of the situation. Write a mutant program as a s-expressions of LISP.<br>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<br>3. Explain the Bayes network parameter learning algorithm for incomplete data. |
| Practical activites within the subject | Not applicable |

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