GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Modern Neural Networks, PG_00067974		
Field of study	Automatic Control, Cybernetics and Robotics		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2026/2027
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	2	Language of instruction	Polish
Semester of study	4	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Decision Systems and Robotics -> Faculty of Electronics Telecommunications and Informatics -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Michał Czubenko	
	Teachers	dr hab. inż. Michał Czubenko	

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	15.0	15.0	0.0	45
	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	45	3.0	27.0	75

Subject objectives	
	The aim of the course is to provide students with structured and advanced knowledge on the basics of artificial neural networks, their structure, operating principles and methods of their training and optimization in a supervised manner. As part of the course, the student will become familiar with the functioning of neurons as computational units, the architecture of shallow neural networks and methods of selecting and preparing data used in the process of training models. The student will learn to analyze the architecture of neural networks and assess their effectiveness, as well as select appropriate learning methods and cost functions depending on the nature of the problem. In addition, the student will gain practical skills in planning and conducting experiments using neural networks and interpreting the obtained results. The student will use the acquired knowledge and skills to solve problems related to data processing and supporting automation and robotics processes using neural networks, developing competences in creating and modifying programs using neural networks in high-level programming languages and using basic programming techniques related to this subject.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_W01] knows and understands, to an advanced extent, mathematics necessary to formulate and solve simple issues related to the field of study	The student is able to design and conduct experiments using neural networks, analyze data and draw conclusions based on the results of model operation.	[SW1] Assessment of factual knowledge
[K6_U07] can apply methods of process and function support, specific to the field of study	The student analyzes and solves basic data processing problems using neural networks, implements and modifies programs that train neural networks, and is able to identify and remove operation errors using appropriate programming techniques.	[SU3] Assessment of ability to use knowledge gained from the subject
[K6_W03] knows and understands, to an advanced extent, the construction and operating principles of components and systems related to the field of study, including theories, methods and complex relationships between them and selected specific issues - appropriate for the curriculum	The student knows the different types of applications of neural networks, is able to analyze architectures used in automation and robotics, and select the appropriate types of networks for the problem being solved.	[SW1] Assessment of factual knowledge
[K6_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	The student is able to implement experiments using neural networks, analyze data and draw conclusions based on the results of model operation.	[SU1] Assessment of task fulfilment

Subject contents

Lecture:
1. Introduction
2. History and development of artificial neural networks
3. The operation of a neuron. A neuron as a computational unit
4. Shallow neural networks
5. Basic architecture of a neural network.
6. The process of training neural networks
7. Basic cost functions and their importance in the training process
8. Backward gradient propagation
9. Calculating gradients using the chain method
10. Data preprocessing. Normalization, standardization
11. Data sets. Data set divisions.
12. Methods of assessing the quality of neural networks. Cross-validation, accuracy, confusion matrix, sensitivity, specificity
13. Coding 1 out of N in classification.
14. Designing shallow neural networks.
15. Activation functions and their impact on the operation of neural networks.

Laboratory:
1. Preparing the environment for working with neural networks.
2. Implementation of a simple perceptron for data classification.
3. Training shallow neural networks on selected data sets.
4. Analysis of the impact of activation functions on network performance.
5. Application of data normalization and standardization before network training.
6. Application of methods for assessing the quality of network performance (cross-validation, error matrix analysis).
7. Design and optimization of parameters of simple neural networks to solve a given problem.

Prerequisites and co-requisites

- Basics of linear algebra (matrices, vectors, derivatives)
- Basics of mathematical analysis,
- Basics of probability,
- Basics of statistics
- Basics of programming, including the ability to use a high-level programming language.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Laboratory exercises	60.0%	50.0%
Exam	60.0%	50.0%

Recommended reading

Basic literature	Charu Aggarwal, Neural Networks and Deep Learning: A Textbook, Springer, 2023 Géron, Aurélien. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems. O'Reilly Media, 2023
Supplementary literature	Chollet, François. Deep Learning with Python. Manning Publications, 2021 (Second Edition).
eResources addresses	

Example issues/ example questions/ tasks being completed	List and describe the basic activation functions used in neural networks and their impact on the learning process. Explain the principle of the backpropagation algorithm in the process of training neural networks. State the advantages and limitations of using neural networks in classification tasks. Describe the process of preparing data (normalization, standardization) for training a neural network. Discuss the role of the cost function and the method of assessing the quality of a neural network's performance
Work placement	Not applicable

Document generated electronically. Does not require a seal or signature.