GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Introduction to Artificial Intelligence, PG_00067490					
Field of study	Automatic Control, Cybernetics and Robotics					
Date of commencement of studies	October 2026		Academic year of realisation of subject		2027/2028	
Education level	first-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	2		Language of instruction		Polish	
Semester of study	4		ECTS credits		2.0	
Learning profile	general academic profile		Assessment form		exam	
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	30.0	0.0	0.0	0.0	0.0	30
	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	30	2.0	18.0	50	
Subject objectives	The aim of the course is to present various branches of artificial intelligence, including those that are currently the subject of intensive research and development, as well as those that lie outside the mainstream focus but remain useful, have specific applications, and continue to evolve. Some of the topics covered will be explored in greater depth in later stages of the study program, some may prove useful in professional practice, and others will serve as an important extension of the student's general knowledge, even if they have no immediate practical application.					

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 understands the fundamental graph search algorithms such as A*, minimax, alpha-beta pruning, and Monte Carlo methods, and knows their applications in decision-making and games. The student is able to explain the principles of knowledge representation in AI systems, including first-order logic, fuzzy reasoning, and Bayesian networks. The student understands the main paradigms of machine learning: supervised, unsupervised, and reinforcement learning, and can distinguish between their applications. The student is able to describe and compare optimization algorithms used in machine learning, such as gradient descent, simulated annealing, evolutionary algorithms, and particle swarm optimization.	[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge
	[K6_W10] knows and understands, to an advanced extent, the parameters, functions, and methods of analysis, design, and optimization of electronic circuits and systems, the definitions of error and measurement uncertainty, measurement methods, including time, frequency, and phase measurements, the properties of converters, and methods of digital signal processing, as well as the basic processes occurring in the life cycle of technical devices, objects, and systems, and methods of supporting processes and functions, specific to the field of study	The student applies fundamental learning structures, such as neural networks, decision trees, k-NN, SVM, PNN, and fuzzy systems (ANFIS), for classification and regression tasks. The student understands the mechanisms of unsupervised learning algorithms, including k-means clustering and Self-Organizing Maps (SOM), as well as their limitations. The student is able to explain the basics of reinforcement learning, such as Q-learning, and distinguish between tabular, evolutionary, and neural network-based approaches. The student understands the concepts of deep learning, including convolutional neural networks (CNNs), encoding methods, transfer learning, and language models. The student is able to discuss the philosophical aspects of artificial intelligence, including the distinction between strong and weak AI, and the views of selected thinkers (e.g., Penrose, Dennett). The student understands current trends in artificial intelligence development and can identify both intensively researched areas and niche techniques with specific applications.	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects

Subject contents

Course content – lecture

1. Graph search methods. A algorithm. Minimax. Alpha-beta pruning. Monte Carlo methods (including Monte Carlo Tree Search).

2. Knowledge representation and reasoning. First-order logic. Fuzzy reasoning. Bayesian networks.

3. Machine learning (main part of the course). Supervised learning. Optimization algorithms: gradient descent, random search, simulated annealing, evolutionary algorithms, particle swarm optimization (PSO). Learning structures: neural networks, adaptive neuro-fuzzy inference systems (ANFIS), decision trees, k-NN (k-nearest neighbors), SVM (Support Vector Machines), PNN (Probabilistic Neural Networks). Unsupervised learning: k-means clustering, Self-Organizing Maps (SOM). Reinforcement learning: Q-learning, evolutionary methods, tabular methods, neural networks in RL, elements of multi-agent learning.

4. Introduction to deep learning. Deep neural networks. Convolutional neural networks (CNN). Encoding methods. Transfer learning. Language models.

5. Philosophical and cognitive aspects of artificial intelligence. Strong and weak AI. "Chinese Room" thought experiment. Views of Roger Penrose. Views of Daniel Dennett and other philosophers.

Prerequisites and co-requisites

Basic knowledge of Boolean algebra, fundamentals of higher mathematics at the level of first-year technical university courses, elements of probability theory, and basic computer programming skills.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Written exam (midterm and final session)	50.0%	100.0%

Recommended reading

Basic literature

1. Duch W., Korbicz J., Rutkowski L., Tadeusiewicz R.: Sieci neuronowe. AOW Exit, Warszawa 2000
2. Michalewicz Z.: Algorytmy genetyczne + struktury danych = programy ewolucyjne. WNT, Warszawa 2003
3. Żurada J., Barski M., Jędruch W.: Sztuczne sieci neuronowe. PWN, Warszawa 1996.
4. Bengio Y, i inni: Deep Learning, PWN, Warszawa, 2018
5. Mitchell, Tom M. *Machine Learning*, McGraw-Hill, 1997.
6. Trevor Hastie, Robert Tibshirani, Jerome Friedman *The Elements of Statistical Learning*, Springer, 2009.
7. Michael Negnevitsky *Artificial Intelligence: A Guide to Intelligent Systems*, 3rd Edition, Pearson, 2011.

Supplementary literature

1. Duch W., Korbicz J., Rutkowski L., Tadeusiewicz R.: Sieci neuronowe. AOW Exit, Warszawa 2000
2. Michalewicz Z.: Algorytmy genetyczne + struktury danych = programy ewolucyjne. WNT, Warszawa 2003
3. Żurada J., Barski M., Jędruch W.: Sztuczne sieci neuronowe. PWN, Warszawa 1996.
4. Bengio Y, i inni: Deep Learning, PWN, Warszawa, 2018
5. Mitchell, Tom M. *Machine Learning*, McGraw-Hill, 1997.
6. Trevor Hastie, Robert Tibshirani, Jerome Friedman *The Elements of Statistical Learning*, Springer, 2009.
7. Michael Negnevitsky *Artificial Intelligence: A Guide to Intelligent Systems*, 3rd Edition, Pearson, 2011.

eResources addresses

Example issues/ example questions/ tasks being completed	1. Explain the relationship between the Turing Test and Searles Chinese Room thought experiment. 2. What philosophical questions do both models raise regarding the concepts of "understanding" and "intelligence"? 3. Identify the leaf nodes whose values do not affect the decision in a given game tree when alpha-beta pruning is applied. 4. Apply the resolution method to carry out an example of logical inference. 5. Calculate the output value of a simple fuzzy system based on the given input data and rule set. 6. Explain the two typical stages of learning in fuzzy systems (e.g., ANFIS). 7. Calculate the given conditional probabilities in a simple Bayesian network. Justify your calculations using Bayes theorem. 8. Perform one step of the gradient descent method for a given function. Indicate the direction of movement on the contour plot. Plot the particle trajectory after one step in a particle swarm optimization (PSO) algorithm for a graphically defined function. 9. Calculate the weights of a simple neural network that classifies several given points. Use either a single-layer or two-layer perceptron. 10. Build a simple decision tree using the ID3 algorithm based on a provided dataset. 11. Explain the VapnikChervonenkis inequality (VC-bound) and its significance for model generalization. 12. Plot the trajectory of cluster centers after one iteration of the k-means algorithm in a simple example. 13 Calculate the Q-value in a deterministic example of reinforcement learning (Q-learning) for a multi-step decision process.
Practical activites within the subject	Not applicable