GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Artificial Intelligence in Modern Telecommunications, PG_00064025		
Field of study	Electronics and Telecommunications		
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 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	2	Language of instruction	Polish
Semester of study	3	ECTS credits	1.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Teleinformation Networks -> Faculty of Electronics Telecommunications and Informatics -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Bartosz Czaplewski	
	Teachers	dr inż. Bartosz Czaplewski	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	0.0	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

The aim of the course is to introduce students to the fundamentals of artificial intelligence and its applications in telecommunication systems. Students will learn key machine learning and deep learning techniques, identify problems that can be addressed using AI, and acquire practical skills in analyzing, processing, and interpreting telecommunication data with AI methods.

Particular emphasis is placed on AI applications in next-generation networks (5G/6G), the Internet of Things (IoT), localization systems, network optimization, as well as service quality and cybersecurity improvement.

Students will also gain knowledge of practical aspects of model training, including data management and augmentation, model evaluation metrics (loss, accuracy, F1 score, etc.), cross-validation, overfitting prevention (regularization, dropout, early stopping), hyperparameter tuning (grid search, random search), learning rate scheduling, and weight initialization.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W03] knows and understands, to an increased 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 has an in-depth knowledge and understanding of the architecture and operating principles of components and systems using artificial intelligence in telecommunications, including machine learning and deep learning methods, as well as their applications in data analysis, network resource management, quality of service improvement, cybersecurity, automation of functions in modern telecommunications, and other related topics.	[SW1] Assessment of factual knowledge
[K7_W10] knows and understands, to an increased extent, the basic processes occurring in the life cycle of equipment, objects and technical systems, as well as methods of supporting processes and functions, specific to the field of study	The student has an in-depth understanding of the lifecycle of artificial intelligence models in telecommunication systems, including data acquisition and processing, model training and validation, deployment, and performance monitoring. They are familiar with methods supporting optimization, diagnostics, and automation of network functions using AI techniques specific to next-generation telecommunication systems.	[SW1] Assessment of factual knowledge

Subject contents

1. Introduction to AI in telecommunication systems: What are AI, ML, DL? Challenges of modern networks. The role of AI in telecommunications.
2. Basic AI techniques: Regression, classification (binary, multiclass, multilabel), clustering, and other methods. Types of learning: supervised, unsupervised, reinforcement learning, and others. Backpropagation method. Activation functions (ReLU, sigmoid, tanh, softmax). Network architectures: MLP, CNN, RNN, LSTM, GAN, Autoencoders. Other methods: SVM, K-means, Bayesian networks. Introduction to deep learning.
3. Practical aspects of model training: Dataset management. Data augmentation. Metrics: loss, accuracy, confusion matrix, F1 score, recall, precision. Cross-validation (10-fold cross-validation). Overfitting and underfitting issues. Overfitting prevention methods: L2 regularization, dropout, early stopping. Learning rate scheduling. Hyperparameter tuning (grid search vs random search). Weight initialization.
4. AI in telecommunication signal processing
5. AI in 5G/6G networks and resource management
6. AI in data analysis and quality of service (QoS/QoE)
7. AI in cybersecurity
8. Natural language processing (NLP) and chatbots in telecommunications
9. Edge AI and federated learning in telecommunications
10. AI in network design and optimization
11. AI in error correction coding
12. AI in the Internet of Things (IoT)
13. AI in indoor localization
14. AI in antenna design

Prerequisites and co-requisites

- Basic knowledge of telecommunications networks and their architecture
- Knowledge acquired from the course **Telecommunications**
- Basic programming skills (e.g., Python) and fundamental mathematics, including linear algebra and calculus
- Basics of statistics and probability

Assessment methods and criteria

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

Recommended reading	Basic literature	• Jon Krohn, Grant Beyleveld, Aglae Bassens: Uczenie głębokie i sztuczna inteligencja. Interaktywny przewodnik ilustrowany / Deep Learning Illustrated: A Visual, Interactive Guide to Artificial Intelligence, Addison-Wesley Data & Analytics Series, Helion, 2022. • Valentino Zocca, Gianmario Spacagna, Daniel Slater, Peter Roelants: Deep Learning. Uczenie głębokie z językiem Python. Sztuczna inteligencja i sieci neuronowe / Python Deep Learning, Helion, 2018.
	Supplementary literature	• Maxim Lapan: Głębokie uczenie przez wzmacnianie. Praca z chatbotami oraz robotyka, optymalizacja dyskretna i automatyzacja sieciowa w praktyce. Wydanie II / Deep Reinforcement Learning Hands-On: Apply modern RL methods to practical problems of chatbots, robotics, discrete optimization, web automation, and more, Helion, 2022. • Wojciech Jędruch: Sztuczna Inteligencja, WETI PG, 2011.
	eResources addresses	
Example issues/ example questions/ tasks being completed		
Work placement	Not applicable	

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