POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Introduction to Artificial Inteligence [S1MiKC1E>WdSI]

Course

Field of study
Microelectronics and Digital Communication

Year/Semester
2/3

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
English

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
24

Laboratory classes
24

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

dr inż. Mateusz Lorkiewicz
mateusz.lorkiewicz@put.poznan.pl

dr hab. inż. Olgierd Stankiewicz prof. PP
olgierd.stankiewicz@put.poznan.pl

Lecturers

Prerequisites

Basic mathematical knowledge: Students should have a solid basic knowledge of mathematics, including linear algebra, differential and integral calculus, and statistics. Machine learning often relies on mathematical fundamentals such as differential equations, statistical formulas and matrix algebra. Programming: knowledge of programming fundamentals is crucial, especially in languages such as Python or R, which are commonly used in machine learning. Students should be able to write and understand code, create functions and analyze data using programming tools. Statistics and data analysis: An understanding of basic statistical concepts and the ability to analyze data are essential to working in machine learning. Understanding of basic algorithm concepts: many machine learning algorithms are based on optimization algorithms, graph algorithms and other algorithmic structures.

Course objective

A subject focused on the fundamentals of artificial intelligence, in particular the theory, algorithms and practical applications of machine learning and neural networks. Students in this course gain basic knowledge of data analysis and machine learning techniques, including supervised learning, unsupervised learning, reinforcement learning , deep learning and artificial intelligence. The hallmark of this course is a practical approach that includes analyzing artificial intelligence systems, rearranging its applications, the potential and limitations of the models. In the laboratory classes, the emphasis is on learning extensively about the applications of artificial intelligence and running systems and software using artificial intelligence. The course emphasizes both the use of tools and their creation.

Course-related learning outcomes

Knowledge:
Understand the concepts and fundamentals of Artificial Intelligence, its use in practical systems and tools K1_W05, K1_W08
Understanding of machine learning theories and algorithms: knowledge of different types of machine learning algorithms, both supervised and unsupervised, and will be able to choose the appropriate method to solve different types of problems. K1_W01, K1_W08
Knowledge of advanced concepts in deep learning: familiar with deep neural networks, network architectures and artificial intelligence techniques, learning techniques , K1_W02, K1_W08
Familiarity with modern trends in Artificial Intelligence (e.g. Large Language Models), awareness of the great dynamics of change and development in the topic of Artificial Intelligence, K1_W08
Understanding of the importance of learning data and learning in the context of Artificial Intelligence, knowledge of popular learning datasets, awareness of the drawbacks and limitations of learning data, K1_W08
Awareness of the ethical aspects of machine learning: Students will acquire knowledge of the ethical and social implications associated with machine learning, including bias, discrimination, and data privacy. K1_W16, K1_W17

Skills:
Skills related to designing and teaching basic Artificial Intelligence algorithms, solving basic problems.
Practical experience in implementing machine learning models: use of frameworks (e.g. TensorFlow or PyTorch), and customize them for specific applications. K1_U01, K1_U06.
Data analysis and model evaluation skills: Students will learn to analyze data, evaluate model performance, and adjust parameters to get the best results. ,K1_U06, K1_U07.
Skills related to the use of available Artificial Intelligence tools (e.g., Large Language Models) K1_U07
Problem solving using machine learning: Students will acquire the ability to identify problems that can be solved using machine learning, and to design and implement solutions in practice. K1_U07.

Social competences:
Is open to opportunities for continuing education and understands the need to improve professional competence. K1_K01.
Has basic knowledge necessary to understand non-technical conditions of engineering activities K1_K03.
Knows the basic principles of health and safety at work. K1_K04.
Has a sense of responsibility for the designed artificial intelligence systems, understands the ethical aspects associated with the use of Artificial Intelligence. K1_K02.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

1. Lecture:
Problem-solving task: case studies that require cooperation in teams to analyze and solve problems. Assessment of the ability to collaborate, set priorities and propose effective solutions. Assessment of critical thinking, problem-solving skills and team dynamics. The passing threshold is 50% of the points. In the case of written and oral credit, the points are totaled.
Grading scale: <50% - 2.0 (ndst); 50% to 59% - 3.0 (dst); 60% to 69% - 3.5 (dst+) ; 70% to 79% - 4.0 (db); 80% to 89% - 4.5 (db+); 90% to 100% - 5.0 (bdb).
2. Laboratory
The skills achieved in the laboratory are determined on the basis of reports (reports) of 3 laboratory exercises carried out (OL) and the final credit (ZK) in the form of a self-implemented exercise or project.

Social competence (KS) is assessed on the basis of evaluation of active listening skills, ability to cooperate and effectively participate in team discussions and the level of involvement in problem-solving processes .
A weighted average is determined: OK = 0.5 x OL + 0.3 x ZK + 0.2 x KS and grades are given: 5.0 for OK > 4.75; 4.5 for 4.75 > OK > 4.25; 4.0 for 4.25 > OK > 3.75; 3.5 for 3.75 > OK > 3.25; 3.0 for 3.25 > OK > 2.75; 2.0 for OK < 2.75.

Programme content

Explanation of the concept of Artificial Intelligence, different concepts of Artificial Intelligence ,History and development of machine learning/artificial intelligence, current development directions of Artificial Intelligence, limitations of Artificial Intelligence.
Fundamentals of machine learning (Concept of training, validation and test sets. Classification of machine learning problems: supervised,unsupervised and with reinforcement).
Concept of learning and validation sets, Review of popular datasets, probelms of datasets (e.g., size of data, number of learning data, correctness of labels), data mining and data preparation. Data cleaning: removing missing data, handling outliers. Feature extraction: selecting appropriate features for modeling. Feature engineering: creating new features from existing data.
Machine learning methods (Supervised learning algorithms: linear regression, decision trees, ensemble algorithms (e.g. Random Forest, Gradient Boosting). Unsupervised learning algorithms: clustering, principal component analysis (PCA), dimensionality reduction. Extrinsic learning algorithms: Q-learning, exploratory strategies.
Deep machine learning (perceptron, back propagation algorithm, Neural networks: architectures, layers, activation functions. Deep learning: convolutional neural networks (CNN), recurrent neural networks (RNN). Image processing and natural language processing using deep networks).
Neural network learning scenarios, popular machine learning tasks, use of artificial neural networks in real systems (e.g. data detection, semantic segmentation), content generation, Large Language Models (LLM).
Ethical aspects of artificial intelligence.

Course topics

Compatible with program content, including, but not limited to:
Explanation of the concept of Artificial Intelligence, different concepts of Artificial Intelligence ,History and development of machine learning/artificial intelligence, current development directions of Artificial Intelligence, limitations of Artificial Intelligence.
Fundamentals of machine learning (Concept of training, validation and test sets. Classification of machine learning problems: supervised,unsupervised and with reinforcement).
Concept of learning and validation sets, Review of popular datasets, probelms of datasets (e.g., size of data, number of learning data, correctness of labels), data mining and data preparation. Data cleaning: removing missing data, handling outliers. Feature extraction: selecting appropriate features for modeling. Feature engineering: creating new features from existing data.
Machine learning methods (Supervised learning algorithms: linear regression, decision trees, ensemble algorithms (e.g. Random Forest, Gradient Boosting). Unsupervised learning algorithms: clustering, principal component analysis (PCA), dimensionality reduction. Extrinsic learning algorithms: Q-learning, exploratory strategies.
Deep machine learning (perceptron, back propagation algorithm, Neural networks: architectures, layers, activation functions. Deep learning: convolutional neural networks (CNN), recurrent neural networks (RNN). Image processing and natural language processing using deep networks).
Neural network learning scenarios, popular machine learning tasks, use of artificial neural networks in real systems (e.g. data detection, semantic segmentation), content generation, Large Language Models (LLM).
Ethical aspects of artificial intelligence.

Teaching methods

1 Active learning techniques: Active learning strategies such as group discussions, problem solving, and case studies to actively engage students in the learning process. Encouraging collaborative learning and interaction to foster critical thinking and application of knowledge.
2 Technology integration: Using technology tools and platform to enhance learning. Using online collaboration tools for brainstorming sessions, virtual simulations for problem solving, and multimedia

presentations to deliver engaging content. Also, using online discussion forums or learning management systems for asynchronous learning and resource sharing.
3. case-based learning: incorporate real-world case studies into lectures and labs to demonstrate the practical application of creative thinking in solving technical problems. This will encourage analyzing and discussing cases, identifying creative solutions, and reflecting on the decision-making process.
4 Student feedback and teaching: Introduce student feedback mechanisms in which students provide constructive feedback on the problem-solving approaches or design solutions of their peers. Encourage student teaching sessions where students can share their knowledge and creative techniques with their peers.
5 Project-based learning: Integrate project-based learning into the curriculum, where students work on real-world problems or design challenges that require creative thinking. This approach allows them to apply their skills, conduct in-depth research and work on innovative solutions through hands-on, experiential learning.

Bibliography

Basic:
Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006
Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Springer, 2009
Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016
Richard S. Sutton, Andrew G. Barto, "Reinforcement Learning: An Introduction", The MIT Press, 2018
Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", Cambridge University Press, 2012

Additional:
J. Redmon and A. Farhadi, "YOLOv4: Optimal Speed and Accuracy of Object Detection," Proceedings ofthe IEEE/CVF Conference on Computer Vision and Pattern Recognition, 2020.
A. Rosebrock, "Deep Learning for Computer Vision with Python," 2nd ed., PyImageSearch, 2020.
R. Girshick, "Fast R-CNN," Proceedings of the IEEE International Conference on Computer Vision, 2015

Breakdown of average student's workload

	Hours	ECTS
Total workload	111	4,00
Classes requiring direct contact with the teacher	48	1,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	63	2,50