POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
AI algorithms in electrical and mechatronic systems [S1Eltech2>PO9-AAIwUE]

Course

Field of study
Electrical Engineering

Year/Semester
4/7

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
15

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

A student starting this subject should have basic knowledge of procedural and object-oriented programming, as well as knowledge of electronics and digital systems. They should have the ability to program in a high-level language (e.g., C++, Python, Java).

Course objective

The objective of the course is to familiarize the student with artificial intelligence issues in the context of electrical and mechatronic systems. Understanding the structures of both classical neural networks and convolutional models. Acquiring the skills to create and train neural network models and implement them in technical systems.

Course-related learning outcomes

Knowledge:
• Has knowledge regarding the application of artificial intelligence elements in electrical engineering and mechatronics.
• Knows machine learning application frameworks, models, and algorithms used in control and diagnostic systems.

Skills:
• Is able to use high-level languages to develop models of neural networks for technical issues. Is able to use machine learning algorithms to create a functional project supporting the operation of an electrical or mechatronic system.
• Is able to use machine learning algorithms to create a functional project supporting the operation of an electrical or mechatronic system.

Social competences:
Is aware that knowledge and skills in the area of AI and mechatronics evolve quickly and require continuous learning.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: credit based on an exam consisting of general and test questions. Grading scale: 50-60% pts - dst, 60-70% pts - dst+, 70-80% pts - db, 80-90% pts - db+, 90-100% pts - bdb.
Laboratory: rewarding practical knowledge acquired during previous laboratory classes, verification of practical programming skills in Python (final test), assessment of knowledge and skills related to the implementation of individual and group programming projects.
Obtaining additional points for activity during classes, especially for: ability to cooperate within a team practically implementing a detailed task in the laboratory, use of elements and techniques extending beyond the material covered in the lecture and laboratory classes, aesthetic quality of implemented projects.

Programme content

Lecture:
Fundamentals of machine learning (regression, classification). Structures of artificial neural networks (neuron model, multi-layer networks). Learning algorithms (backpropagation). Deep Learning methods, Convolutional Neural Networks (CNN). Network optimization and regularization.
Laboratory classes:
Practical implementation of algorithms in the Python environment (e.g., TensorFlow/Keras). Data preparation, building a network model, training and validation of models for classification or regression issues in an engineering context.

Course topics

Fundamentals of machine learning - artificial intelligence, machine learning, types of machine learning systems, regression and classification problems, main machine learning problems.
Introduction to artificial neural networks - biological neurons, logical operations using neurons, perceptron, XOR problem.
Structures of artificial neural networks - neuron model (inputs, weights, activation functions), multi-layer neural networks, recurrent networks.
Training neural networks - backpropagation algorithm, gradient descent method, network quality assessment methods (sensitivity, efficiency, specificity, learning curves).
Tuning neural network hyperparameters (number of layers, selection of activation functions, number of neurons in a layer, etc.).
Introduction to deep learning methods - deep learning, vanishing/exploding gradient problem, application frameworks (Tensorflow, Keras), optimizers, regularization.
Convolutional neural networks - visual cortex architecture, convolutional layer, filters, pooling layer, architectures of convolutional neural networks.

Teaching methods

Lecture: presentation of issues using multimedia presentations and presentation of writing and running selected programs presenting the fundamentals of machine learning.
Laboratory classes: practical exercises regarding machine learning, use of Anaconda/Visual Studio environments to build a model and implement machine learning algorithms in a classification problem.

Bibliography

Basic:
Basic:
1. Stanisław Osowski, Sieci neuronowe do przetwarzania informacji, Oficyna Wydawnicza Politechniki Warszawskiej, 2020.
2. Aurélien Géron, Uczenie maszynowe z użyciem Scikit-Learn i TensorFlow, Helion, 2020.
3. Bharath Ramsundar, Reza Bosagh Zadeh, Głębokie uczenie z TensorFlow: od regresji liniowej po uczenie przez wzmacnianie, Helion, 2020.
4. Seth Weidman, Uczenie głębokie od zera: podstawy implementacji w Pythonie, Helion, 2020.
5. Giuseppe Bonaccorso, Algorytmy uczenia maszynowego: zaawansowane techniki implementacji, Helion, 2019.

Additional:
1. Michał Białko, Podstawowe właściwości sieci neuronowych i hybrydowych systemów ekspertowych, Wydaw. Uczelniane Politechniki Koszalińskiej, 2000.
2. Piotr Grądzki, Klasyfikatory neuronowo-rozmyte w inteligentnych systemach wspomagania decyzji, Politechnika Poznańska, PP, 2000.

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	32	1,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	43	1,50