COURSE DESCRIPTION CARD - SYLLABUS

Course name
Artificial Neural Networks [S1DSwB1>SSN]

Course

Field of study
Data Science in Business

Year/Semester
3/5

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
0

Other
0

Tutorials
30

Projects/seminars
0

Number of credit points

5,00

Coordinators

dr Grzegorz Nowak
grzegorz.nowak@put.poznan.pl

dr inż. Marcin Nowak
marcin.nowak@put.poznan.pl

Lecturers

Prerequisites

Students should have a basic knowledge of programming in Python, including object-oriented programming. A fundamental understanding of machine learning, as well as the ability to analyze and process data, is required. Additionally, mathematical competencies, including calculus and discrete mathematics, are essential for understanding the functioning of artificial neural networks.

Course objective

The objective of the course is to introduce students to the fundamentals of artificial neural networks, their architecture, and learning methods. Students will learn to implement and train neural models using Python and dedicated libraries. The course emphasizes the practical applications of neural networks in data analysis.

Course-related learning outcomes

Knowledge:

Characterizes the basic architectures of artificial neural networks, including perceptron, MLP, CNN, and RNN [DSB1_W01].
Describes the mathematical foundations of neural networks, including activation functions, learning algorithms, and optimization methods [DSB1_W02].
Explains the process of regularization and preparation of input data for neural network models [DSB1_W03].
Characterizes the applications of neural networks in image analysis, sound processing, and natural language processing [DSB1_W05].

Skills:
Selects appropriate optimization and regularization methods in the training process of neural networks [DSB1_U02].
Designs and implements neural network models in Python, considering their application to various data analysis problems [DSB1_U03].
Creates a data analysis process for training models, preparing appropriate input structures and applying transfer learning and fine-tuning techniques [DSB1_U08].
Utilizes machine learning and deep learning tools, implementing neural networks in practical business and analytical tasks [DSB1_U09].

Social competences:
Critically analyzes their own knowledge and skills in neural networks, striving for development and updates in the context of new technologies [DSB1_K01].
Takes initiatives in implementing and testing deep learning models in business and research applications [DSB1_K04].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture:
There will be two tests, each graded in the form of points-50 points per test. The final grade is determined by the sum of points from both tests. The first test takes place midway through the course, while the second is at the end. The passing threshold is a total of 50 points from both tests.
Laboratories:
There will be two tests, each graded in the form of points-50 points per test. The final grade is determined by the sum of points from both tests. The first test takes place midway through the course, while the second is at the end. The passing threshold is a total of 50 points from both tests.

Programme content

The course provides an introduction to artificial neural networks, their mathematical foundations, and learning algorithms. Students will study the perceptron, multilayer neural networks (MLP), and advanced architectures such as convolutional neural networks (CNN) and recurrent neural networks (RNN), including LSTM and GRU models. The course covers optimization techniques, regularization methods, and input data preprocessing. Applications of neural networks in image analysis, audio processing, and natural language processing (NLP) will be discussed. Students will also explore transfer learning, unsupervised learning, and model interpretability.

Course topics

Introduction to Artificial Neural Networks
Mathematical Foundations of Neural Networks
Perceptron and Its Limitations
Multilayer Perceptron (MLP)
Optimization Algorithms in Neural Network Training
Regularization in Neural Networks
Data Preparation and Preprocessing
Implementing a Basic Neural Network in Python
Convolutional Neural Networks (CNN)
Recurrent Neural Networks (RNN)
Long Short-Term Memory (LSTM) and GRU Networks

Applications of Neural Networks in Image and Audio Analysis
Transfer Learning and Model Fine-Tuning
Unsupervised Learning in Neural Networks
Neural Networks for Natural Language Processing (NLP)
Performance and Scalability of Neural Networks
Attention Models and Deep Reinforcement Learning
Interpretability and Explainability of Neural Networks
Challenges in Neural Network Development

Teaching methods

Lecture: Multimedia presentation and live coding in a selected programming IDE or data analysis environment.
Laboratories: Hands-on exercises in a selected programming IDE or data analysis environment (e.g., PyCharm or Google Colaboratory).

Bibliography

Basic:
Krzywicki, T. (2022). Sztuczne sieci neuronowe i uczenie głębokie: systemy uczące się. Wydawnictwo Uniwersytetu Warmińsko-Mazurskiego
Rashka, S., Mirjalili, V. (2021). Python. Machine learning i deep learning. Biblioteki scikit-learn i TensorFlow 2

Additional:
Kirk, M., (2018). Python w uczeniu maszynowym. Podejście sterowane testami, APN Promise
Kosiński, R.A. (2017), Sztuczne sieci neuronowe, Wydawnictwo Naukowe PWN
Zocca, V., Spacagna, G., Slater, D., Roelants, P. (2018).Deep Learning. Uczenie głębokie z językiem Python. Sztuczna inteligencja i sieci neuronowe, Helion

Breakdown of average student's workload

	Hours	ECTS
Total workload	125	5,00
Classes requiring direct contact with the teacher	60	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	65	2,50