COURSE DESCRIPTION CARD - SYLLABUS

Course name
Introduction to neural networks and machine learning [N1Inf1>SNUM]

Course

Field of study
Computing

Year/Semester
4/8

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
part-time

Requirements
compulsory

Number of hours

Lecture
20

Laboratory classes
20

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

Students starting this subject should have knowledge in the field of artificial intelligence, probability calculus, linear algebra, and mathematical statistics. They should also possess basic programming skills (using the Python language and selected libraries), the ability to gather information from literary sources, and be capable of working collaboratively in a group while completing tasks.

Course objective

The lectures aim to present students with the theoretical aspects of selected machine learning algorithms, including neural networks (a detailed description of the topics covered can be found in the "Programme content" section). The laboratories are dedicated to the practical application of methods presented during lectures. Students use existing tools (WEKA, sklearn, tensorflow), and in the case of certain learning algorithms, they implement them on their own.

Course-related learning outcomes

Knowledge:
1. Has systematically organized and theoretically grounded knowledge in the field of machine learning systems, can analyze and describe their functioning, and understands the scope of their applications -

[K1st_W4]
2. Has knowledge of directions of development and key achievements of machine learning and artificial neural networks - [K1st_W5]
3. Is familiar with basic techniques, methods, and tools used in the process of solving computer tasks using machine learning methods - [K1st_W7]

Skills:
1. Can identify specialized subject knowledge necessary for the realization of a task and justify its use - [K1st_U1]
2. Can develop and implement a solution for classification or clustering problem using machine learning methods, and evaluate the significance of the obtained results - [K1st_U3]
3. Can utilize machine learning methods appropriate for the particular problem to solve computer tasks - [K1st_U4]
4. Can use knowledge in the field of machine learning systems to design a complex application using machine learning as a subsystem - [K1st_U10]
5. Possesses the practical ability to apply machine learning algorithms to solve programming tasks - [K1st_U11]
6. Can independently update and deepen their knowledge in the field of machine learning - [K1st_U19]

Social competences:
1. The student understands the need to constantly enrich his knowledge and develop their skills in the area of methods and tools of machine learning - [K1st_K1]
2. The student is aware of the potential role that machine learning systems can play in the transformations of a social and economic nature - [K1st_K2]
3. The student can identify the possibilities of using the known methods of machine learning in the areas of IT applications and development of useful software - [K1st_K3]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Formative assessment:
a) Lecture: based on answers to questions regarding the material discussed during lectures.
b) Laboratories: based on the ongoing assessment of progress in tasks.

Summative assessment:
a) Lecture: based on a test covering the material discussed in the lecture. To receive a passing grade for the lecture, the student must get at least half of the possible points on the test.
b) Laboratories: after each class, students are required to complete a homework assignment for which they can earn a certain number of points. To receive a passing grade for the laboratories, the student must get at least half of the total possible points.

Programme content

The module program includes the following topics:
1) The task of machine learning and its practical applications
2) Representation and preliminary processing of training data
3) Evaluation of classifiers and the problem of overfitting
4) The curse of dimensionality and methods of attribute selection
5) Selected supervised machine learning algorithms
6) Selected unsupervised machine learning algorithms
7) Introduction to artificial neural networks

Course topics

The lecture program includes the following topics:
1) The task of machine learning and its practical applications
2) Representation and preliminary processing of training data
 - data normalization

- handling missing values
3) Evaluation of classifier quality and the phenomenon of overfitting
- classification accuracy, confusion matrix, precision, recall, specificity
- classifier evaluation for imbalanced data
4) The curse of dimensionality and methods of attribute selection
- filter methods
- wrapper methods
- basics of feature extraction
5) Selected supervised learning algorithms
- decision tree learning: ID3, C4.5, pre- and post-pruning of decision trees, handling continuous values
- k-nearest neighbors (k-NN) algorithm
6) Selected unsupervised learning algorithms
- k-means
- density-based clustering: DBSCAN
- hierarchical clustering
7) Introduction to artificial neural networks
- definition of a neuron and neural network, types of activation functions
- gradient descent algorithm, backpropagation, stochastic gradient descent algorithm
- basics of regularization
- convolutional networks
- autoencoders

The laboratory program is based on practical exercises covering the topics discussed in the lectures, and includes the following topics:
1) WEKA environment
2) Numpy and sklearn libraries (Python)
3) ID3 and C4.5 decision tree induction algorithms
4) k-nearest neighbors (k-NN) algorithm
5) k-means algorithm
6) TensorFlow library (Python)
7) Implementation and training of neural networks, including convolutional networks and autoencoders

Teaching methods

Lecture: multimedia presentation, illustrated examples, solving simple tasks, demonstration of the use of selected software.

Laboratories: solving tasks, practical exercises with limited programming using specified libraries, conducting experiments, case studies, discussion.

Bibliography

Basic:
1. Machine Learning: The Art and Science of Algorithms that Make Sense of Data, P.Flach, Cambridge University Press, 2012.
2. Pattern recognition and machine learning. Ch. Bishop, Springer, 2006.
3. Introduction to machine leaning. E. Alpaydin, MIT Press (3rd ed.), 2014.
Additional:
1. Statystyczne systemy uczące się. J.Koronacki, J.Ćwik, EXIT, Warszawa 2008.
2. Uczenie maszynowe i sieci neuronowe, K.Krawiec, J.Stefanowski, Wydawnictwo PP, Poznań, 2004.

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	40	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	60	2,00