Study program: Information technologies and systems

Type and level of studies: undergraduate academic studies

Course unit: Fundamentals of Machine Learning

Teacher in charge: Miroslava Jordović Pavlović

Language of instruction: English

ECTS: 6

Prerequisites: /

Semester: winter

Course unit objective:

The course Fundamentals of Machine Learning introduces students to the field of artificial intelligence that studies methods and algorithms for developing models of intelligent systems capable of autonomously acquiring knowledge from large data sets to predict, classify, or make decisions based on new data with a satisfactory level of accuracy. Students will learn the basic concepts and algorithms of supervised, unsupervised, and reinforcement learning and will practically apply them in the development of machine learning models using popular Python libraries: NumPy, SciPy, Pandas, Scikit-learn, Matplotlib, Keras, and TensorFlow. Specifically, by presenting many examples of machine learning applications, the course guides students on which problems machine learning is applicable to and which model or models would be most appropriate in each case.

Learning outcomes of the course unit

•The student understands the difference between supervised, unsupervised, and reinforcement learning.

• The student understands the advantages and limitations of different machine learning algorithms and techniques.

• The student can select and apply different machine learning algorithms depending on the type, nature, and complexity of the real-world problem being solved.

• The student applies theoretical concepts from machine learning to real-world problems.

• The student understands and applies exploratory data analysis in data preprocessing.

• The student understands and implements specific steps in the development of machine learning models.

• The student can create machine learning projects using the Python programming language.

• The student uses Python libraries to solve machine learning problems.

• The student applies best practices for developing machine learning models by creating models that generalize to real-world data and tasks.

• The student applies various tests to compare different algorithms, conducts statistical analyses, and interprets test results.

• The student can combine different models and algorithms to improve prediction performance.

Course unit contents

Theoretical classes

Why machine learning: definition, basic concepts, and applications of machine learning. Fundamental concepts of supervised and unsupervised learning. Characteristics of classification techniques. Decision trees. Ensemble learning – random forest. Logistic regression. Non-parametric models – k-nearest neighbors and support vector machines. Linear regression. Developing machine learning models, overfitting problem, optimization, regularization, evaluation, and maintenance of models. Bayesian models in machine learning. Bayesian networks and clustering. General theory of neural networks. Basic concepts of deep learning. Applications of deep learning. Basic concepts of reinforcement learning. Markov decision processes. Q-learning. Examples of machine learning in practice.

Practical classes

Work in the computer lab with at least 3 hours per week: 2 hours of demonstration exercises and 1 hour of additional forms of instruction in the form of individual exercises with active consultation with the course instructor and assistant. Work with demonstration examples. Work on individually assigned tasks. Work on homework assignments. Development of a project that demonstrates the student has mastered the knowledge and skills in developing machine learning models using the Python programming language and its libraries: NumPy, SciPy, Pandas, Scikit-learn, Matplotlib, Keras, and TensorFlow.

Literature

Basic literature:

1. S. Russell and P. Norvig. Prentice Hall, Artificial Intelligence: A Modern Approach. 4th Edition, Pearson, 2021.

2. Machine Learning – Laboratory Exercise Manual, Emilija Kisić, Miroslava Jordović Pavlović, Vladimir Milićević, 2023., Faculty of Mechanical Engineering and Civil Engineering in Kraljevo, ISBN 978-86-82434-03-0.

Additional literature:

3. I.Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIT Press, 2016.

4. M. J. Zaki, W. Meira, Jr., Data Mining and Machine Learning: Fundamental Concepts and Algorithms, Cambridge University Press, 2nd edition, 2020.

5. F. Chollet, Deep Learning with Python, Second Edition, Manning, 2021.

6. W. McKinney, Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter, O'Reilly Media, 3rd edition, 2022.

Number of active teaching hours				**Other classes**
Lectures: 3	Practice: 2	Other forms of classes: 1	Independent work: 1	

Teaching methods

Examination methods (maximum 100 points)

Exam prerequisites	**No. of points:**	**Final exam**	**No. of points:**
Student's activity during lectures	10		
practical classes/tests	/	written examination 1	15
Seminars/homework	5 x 6 = 30	written examination 2	15
Project	30		
Other	/		

Grading system

Grade	**No. of points**	**Description**
10	**95-100**	Excellent
9	**85-94**	Exceptionally good
8	**75-84**	Very good
7	**65-74**	Good
6	**55-64**	Passing
5	**Less than 55**	Failing