COURSE DESCRIPTION CARD - SYLLABUS

Course name
Machine learning [S2TIIZM1E>UM]

Course

Field of study
Information Technology for Smart and Sustainable Mobility

Year/Semester
1/1

Area of study (specialization)
–

Profile of study
general academic

Level of study
second-cycle

Course offered in
English

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
24

Laboratory classes
0

Other
0

Tutorials
24

Projects/seminars
0

Number of credit points

3,00

Coordinators

dr inż. Szymon Maćkowiak
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Lecturers

Prerequisites

Knowledge: Basic knowledge of programming Foundations of mathematics (linear algebra, probability, statistics, and basic calculus) Knowledge of how algorithms work and how to manipulate data efficiently Basic understanding of algorithms and data structures Skills: Introductory data analysis skills (Experience with data preprocessing, visualization, and analysis using tools like Pandas, NumPy, or Excel) Analytical thinking - ability to approach complex problems methodically

Course objective

The aim of the course is to understand how the main data mining techniques and machine learning methodologies work and when to apply each of them.

Course-related learning outcomes

Knowledge:
The student has advanced and detailed knowledge of issues in the field of machine learning, including topics related to clustering, time series algorithms, image recognition, and computer vision.
The student has knowledge of development trends and the most significant recent achievements in the

field of machine learning.

Skills:
The student is able to obtain information from literature, databases, and other sources, integrate it, interpret and critically evaluate it, draw conclusions, and formulate well-justified opinions
The student is able to use information and communication technologies applied in the implementation of projects in the field of transport systems, in particular is able to apply data mining techniques and machine learning methods
The student is able to assess the suitability of methods and tools used to solve an engineering task involving the construction or evaluation of an IT system or its components, including recognizing the limitations of these methods and tools
The student is able to assess the usefulness and applicability of new achievements (methods and tools) as well as new IT products
The student has knowledge about the dilemmas, including benefits and risks, associated with the use of machine learning techniques

Social competences:
The student understands the importance of using the latest knowledge in machine learning to solve research and practical problems

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Written exam
Multiple choice test
Written report

Programme content

Clustering, Time series algorithms, Image recognition, Computer vision

Course topics

• Clustering
Students will learn unsupervised learning techniques to group data into clusters based on similarity. Algorithms such as K-means, DBSCAN, and hierarchical clustering will be explored. Applications may include detecting traffic congestion zones, grouping similar travel behavior patterns, or identifying regions with similar transportation demand.
• Time Series Algorithms
This module covers methods for analyzing and forecasting sequential data over time. Students will work with models such as ARIMA, Prophet, and LSTM neural networks. Practical examples may include traffic volume forecasting, public transportation usage trends, and predicting vehicle speeds or travel times.
• Image Recognition and Computer Vision
Students will be introduced to image processing and deep learning techniques for interpreting visual data. Topics include convolutional neural networks (CNNs), object detection, and image classification. Use cases may involve vehicle detection in camera footage, traffic sign recognition, and analyzing aerial or satellite images for infrastructure assessment.
• Case Study Examples in the Traffic and Transportation Domain
Through hands-on case studies, students will apply machine learning to real-world problems in traffic and transportation. Example projects may include designing a model to classify traffic incidents, developing a predictive model for urban mobility, or using image recognition to monitor road conditions. These case studies will emphasize problem-solving, data preparation, model evaluation, and practical deployment.

Teaching methods

The course is conducted remotely (online) in a synchronous format. Classes may also be held in person. Multimodal presentation. Practical examples, Case study examples in traffic and transportation domain.

Bibliography

Basic:
Alpaydin, E. (2014) Introduction to Machine Learning, 3rdEdition, MIT Press.
Rogers, S. , Girolami, M. (2017) A First Course in Machine Learning, 2nd Edition, CRC Press.

Additional:
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Breakdown of average student's workload

	Hours	ECTS
Total workload	78	3,00
Classes requiring direct contact with the teacher	48	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00