POZNAN UNIVERSITY OF TECHNOLOGY
EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)
pl. M. Skłodowskiej-Curie 5, 60-965 Poznań

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Machine learning in vision systems

Course

Field of study
Automatic Control and Robotics

Year/Semester
1/2

Area of study (specialization)
Vision systems

Profile of study
general academic

Level of study
Second-cycle studies

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
30		
Tutorials	Projects/seminars	
	30	

Number of credit points

4

Lecturers

Responsible for the course/lecturer:
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Faculty of Automatic Control, Robotics and Electrical Engineering

ul. Piotrowo 3A, 60-965 Poznań

Responsible for the course/lecturer:

Prerequisites

Knowledge: The student starting this course should have basic knowledge of algebra, discrete mathematics, the basics of signal theory, signal and information processing, and the basics of computer science.

Skills: The student should have the ability to solve basic problems in digital signal processing and the ability to obtain information from the indicated sources.

Social competences: The student should also understand the necessity of expanding his competences and be ready to cooperate in a team. In addition, in terms of social competences, the student must show such features as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, respect for other people.

Course objective

1. Provide students with knowledge about the algorithms used in modeling and identification processes, including applications in video signal processing systems.

2. Developing students' skills in analyzing modeling processes in computer design and simulation environments.

3. Shaping in students the importance of knowing the selection of appropriate identification techniques, taking into account the standards and recommendations related to data processing in electronic systems.

Course-related learning outcomes

Knowledge

A student:

1. has extended and deepened knowledge of selected mathematics areas necessary to formulate and solve complex tasks in the field of control theory, optimization, modeling, identification and signal processing - [K2_W1]

2. has extended knowledge of modeling and identification of systems - [K2_W5]

Skills

A student:

1. is able to critically use literature information, databases and other sources in Polish and a foreign language - [K2_U1]

2. is able to simulate and analyze the operation of complex automation and robotics systems as well as plan and carry out experimental verification - [K2_U9]

3. is able to designate models of simple systems and processes, and to use them for the purposes of analysis and design of automation and robotics systems - [K2_U10]

4. is able to formulate and verify (simulation or experimentally) hypotheses related to engineering tasks and simple research problems in the field of automation and robotics - [K2_U15]

5. is able to design improvements of the existing design solutions for automation and robotics elements and systems - [K2_U20]

6. is able to build an algorithm for solving a complex and unusual engineering task and a simple research problem and implement, test and run it in a selected programming environment for selected operating systems - [K2_U25]

Social competences

A student:

1. understands the need and knows the possibilities of continuous training - improving professional, personal and social competences, can inspire and organize the learning process of other people - [K2_K1]

2. is aware of the need for a professional approach to technical issues, scrupulous reading of the documentation and the environmental conditions in which the devices and their components can function - [K2_K4]

3. is aware of the social role of a technical university graduate and understands the need to formulate and transmit to the society (in particular through the mass media) information and opinions on the achievements of automation and robotics in the field of research and application works and other aspects of engineering activities; makes efforts to provide such information and opinions in a commonly understandable manner with justification of different points of view - [K2_K6]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Formative assessment:

a) in the scope of lectures:

based on answers to questions about the material discussed in previous lectures

b) in the field of project activities:

on the basis of the assessment of knowledge and understanding of the current issues presented in the course.

Summative assessment:

a) in the field of lectures, verification of the assumed learning outcomes is carried out by:

i. assessment of the knowledge and skills demonstrated in the problem-based written exam (the student may use didactic materials); The exam consists of 4 tasks, with a total of 20 points for correct answers. Rating scale: 0 ... 10 points. - unsatisfactory, 11 ... 12 points - satisfactory, 13 ... 14 points - sufficient plus, 15 ... 16 points - good, 17 ... 18 points - good plus, 19 ... 20 points - very good,

ii. discussion of the exam results,

b) in the field of project activities, verification of the assumed learning outcomes is carried out by:

i. assessment of the student's preparation for individual project classes

ii. assessment of knowledge and skills related to the implementation of project tasks

iii. evaluation of the technical documentation of the developed project; this assessment also takes into account the ability to work in a team.

Obtaining additional points for activity during classes, in particular for:

i. discuss of additional aspects of the issue,

ii. effectiveness of applying the acquired knowledge while solving a given problem,

iii. comments related to the improvement of teaching materials,

iv. indicating students' perceptive difficulties enabling ongoing improvement of the didactic process.

Programme content

The lecture program includes the following topics:

1. Elements of a modern vision system, classification tasks, training and validation sets, databases (MNIST, CIFAR, ImageNet), machine learning problems.

2. Python in machine learning: Anaconda, Jupyter, syntax, structures, functions, generators, NumPy, Pandas, Matplotlib, SciPy.

3. Data pre-processing: cleaning, filtering, sorting, correlation. Data visualization.

4. Binary, multi-class, multi-label and multi-output classification.

5. Linear, polynomial and logistic regression.

6. Support vector machines (SVM), the nearest neighbor method (KNN).

7. Decision trees and random forests.

8. Cluster analysis: k-means method, hierarchical cluster analysis, EM algorithm.

8. Principal component analysis (PCA) and its application to dimensionality reduction.

9. Bayesian inference and classification, linear discriminant analysis (LDA), applications in object classification.

10. Model tuning: aggregation, cross-validation, amplification.

11. Deep learning (DNN), multi-layer perceptron, use of autocoders.

12. Architectures of convolutional neural networks (CNN).

13. Application of machine learning to simulate driving an autonomous vehicle.

14. Implementation of neural networks in embedded systems.

15. Summary.

Projects:

The project consists in the preparation of software implementing the identification process on the basis of a set of images or video sequences. The project is carried out by 2-person teams, and the classes are held in a computer laboratory. Conducting experimental research takes place with the use of integrated programming environments.

Teaching methods

1. Lecture: multimedia presentation illustrated with computer simulations

2. Design classes: integrated environments such as PyCharm, Matlab / Simulink, Statistica.

Bibliography

Basic

1. Uczenie maszynowe z użyciem Scikit-Learn i TensorFlow - pojęcia, techniki i narzędzia służące do tworzenia inteligentnych systemów, Aurélien Géron, Helion, 2018.

2. Python: uczenie maszynowe, Sebastian Raschka, Vahid Mirjalili ; tłumaczenie: Krzysztof Sawka, Helion, 2019.

3. Metody klasyfikacji obiektów w wizji komputerowej, Katarzyna Stąpor, PWN, 2011.

4. OpenCV 3: komputerowe rozpoznawanie obrazu w C++ przy użyciu biblioteki OpenCV, Adrian Kaehler, Gary Bradski, Helion, 2018.

Additional

1. Getting started with X-CUBE-AI Expansion Package for Artificial Intelligence (AI), STMicroelectronics, 2019.

2. Machine Learning in Computer Vision, N. SEBE, IRA COHEN, ASHUTOSH GARG, THOMAS S. HUANG, Springer, 2005.

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4
Classes requiring direct contact with the teacher	60	2,5
Student's own work (literature studies, preparation for project classes, preparation for tests, project preparation) [1]	40	1,5

[1] delete or add other activities as appropriate