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
DEEP LEARNING FOR ROBOTIC VISION, LEARNING AND CONTROL

Course

Proposed by Discipline

Automation, electronics,

electrical engineering

and space technologies

Type of studies

Doctoral School

Form of study

full-time

Year/Semester

II/4

Course offered in

English

Requirements

elective

Number of hours

Lecture	Tutorials	Projects/seminars
8		

Number of credit points
2

Lecturers

Responsible for the course/lecturer:

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Responsible for the course/lecturer:

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Prerequisites

Knowledge: The student starting this module should have basic knowledge of linear algebra, digital signal processing and neurocomputing.

Skills: He/she should have skills to solve basic problems related to using of sensory information in control and the ability to acquire information from given sources. The student should understand the necessity of extending his/her competences.

Social Competencies: Furthermore, regarding social skills, the student should demonstrate qualities such as honesty, responsibility, perseverance, curiosity, creativity, good manners, respect for others, and the ability to collaborate effectively in research teams.

Course objective

1) Provide students with knowledge of image processing and analysis techniques in the field of image preprocessing, segmentation, deep learning for recognition and interpretation of visual information for use in control.

2) Provide students with knowledge of elements of machine vision systems and deep learning, their structure and possible applications in robotics vision learning and control.

3) Develop students' skills to select the appropriate image processing methods and deep learning CNNs depending on the given tasks and the ability to use computer vision for path planning, tracking and visual feedback for the robot nonlinear control or neurocontrol.

Course-related learning outcomes

Knowledge
A PhD student who graduated from doctoral school knows and understands:

1) global achievements, covering theoretical foundations as well as general and selected specific issues that are relevant to scientific disciplines studied at the Doctoral School, to the extent that enables revision of existing paradigms [P8S_WG/SzD_W01],
2) key developmental trends of disciplines of science in which education at the Doctoral School takes place [P8S_WG/SzD_W02],
3) scientific research methodology in disciplines represented at the Doctoral School [P8S_WG/SzD_W03],
4) principles of disseminating results of scientific activity, also in an open access mode [P8S_WG/SzD_W04].

Skills
A PhD student who graduated from doctoral school can:

1) use knowledge from different branches of science to creatively identify, formulate and innovatively solve complex problems or to perform research tasks such as: - define the aim and subject of scientific research, form a research hypothesis, - develop research methods, techniques and tools and use them creatively, - draw conclusions on the basis of research results, [P8S_UW/SzD_U01],
2) critically analyze and assess scientific research results, work of experts and other creative activities

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together with their contribution into knowledge development, [P8S_UW/SzD_U02],

3) transfer the results of scientific activity to the economic and social sphere, [P8S_UW/SzD_U03],

4) communicate on specialist issues on the level that allows active participation in the international scientific community, [P8S_UK/SzD_U04],

5) share results of scientific activity also in a popular form, [P8S_UK/SzD_U05],

6) initiate debates, [P8S_UK/SzD_U06],

7) take part in scientific discourse, [P8S_UK/SzD_U07],

8) use the English language on at least B2 level, according to the Common European Framework of Reference for Languages (CEFR), to a degree which allows active participation in the international scientific and professional community, [P8S_UK/SzD_U08],

9) plan and implement individual and team research projects, also in the international community, [P8S_UK/SzD_U09],

10) independently plan and act for their self-development as well as inspire and organize development of others, [P8S_UK/SzD_U10],

11) plan classes and groups of classes and conduct them with the use of up-todate methods and tools [P8S_UK/SzD_U11],

Social competencies

A PhD student who graduated from doctoral school is ready to:

1) critically assess achievements within a given scientific discipline, [P8S_KK/SzD_K01],

2) critically evaluate their own contribution to development of a given scientific discipline, [P8S_KK/SzD_K02],

3) acknowledge the importance of knowledge in solving cognitive and practical problems, [P8S_KK/SzD_K03],

4) fulfilling the social obligations of researchers and creators, [P8S_KO/SzD_K04],

5) initiate actions in the public interests, [P8S_KO/SzD_K05],

6) think and act in an entrepreneurial manner, [P8S_KO/SzD_K06],

7) maintain and develop the ethos of research and creative communities, including: - conducting independent scientific activity, - respecting the principle of public ownership of the results of scientific activities, including the principles of intellectual property protection, [P8S_KR/SzD_K07].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Verification of assumed learning objectives related to lectures is performed based on evaluation of acquired knowledge based on the written exam in the test form with 25-30 questions (pass threshold 50%) and individual discussion on results of the exam.

In the scope of the final project, the objectives are verified based on an assessment of the current progress of the project, evaluation of student's knowledge and skills related to implementation, and evaluation of report connected with presentation of the project.

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PQF code	Methods for verification of learning outcomes	Assessment criteria
SzD_W01, SzD_W02 SzD_W03, SzD_W04	The objectives are verified based on an assessment of the current progress of the project, evaluation of student's knowledge and skills related to implementation, and evaluation of report connected with presentation of the project.	Written exam in the test form with 25-30 questions (pass threshold 50%) and individual discussion on results of the exam.
SzD_U01, SzD_U02 SzD_U03, SzD_U04 SzD_U05, SzD_U06 SzD_U07, SzD_U08 SzD_U09, SzD_U10 SzD_U11	Critically analyze and assess scientific research results, work of experts and other creative activities together with their contribution into knowledge development	Written exam in the test form with 25-30 questions (pass threshold 50%) and individual discussion on results of the exam.
SzD_K01, SzD_K02 SzD_K03, SzD_K04 SzD_K05, SzD_K06 SzD_K0	Critically evaluate their own contribution to development of a given scientific discipline, acknowledge the importance of knowledge in solving cognitive and practical problems	Written exam in the test form with 25-30 questions (pass threshold 50%) and individual discussion on results of the exam.

Programme content

The module program covers the following topics:
1. Foundations of Convolutional Neural Networks,
2. Signal and Image Processing using Deep Learning CNN,
3. 3D Object and Pose Recognition using CNNs,
4. Deep reinforcement learning for continuous robot control tasks,
5. Riemannian geometry and CNN for robot learning and adaptive control algorithms.

Course topics

Neurocomputing has been applied to problems in object recognition, speech recognition, speech synthesis, forecasting, scientific computing, control, robotics, and many more. The resulting applications are touching all of our lives in areas such as healthcare and medical research, human-computer interaction, robotics, communication, transport, conservation, manufacturing, and many other fields of human endeavour.

This course consists in four lectures covering following topics:

i. Train models in computer vision, natural language processing, tabular data, and collaborative filtering
ii. Learn the latest deep learning techniques that matter most in practice
iii. Improve accuracy, speed, and reliability by understanding how deep learning models work
iv. Discover how to turn your models into web applications
v. Implement deep learning algorithms from scratch

After taking the class, the students will be able to apply deep learning CNNs methods for the following:

- Object classification
- Object recognition and localization
- 3D Pose Object estimation
- Apply Recurrent CNN for signal and image processing

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- Deep reinforcement learning for continuous robot control tasks
- CNNs for Computer Vision, Control, Robotics and Medical Image Processing

Teaching methods

1) Lectures: multimedia presentation illustrated with examples using Matlab, Phyton and other demonstration showing specific image processing and deep learning methods and application for robot vision, learning and control.
2) Project: individual work solving project tasks.

Bibliography

Basic

Christopher M. Bishop, Hugh Bishop, Deep Learning: Foundations and Concepts, Springer, 2023

Additional

Jeremy Howard and Sylvain Gugger, Deep Learning for Coders with fastai and PyTorch: AI Applications Without a PhD, 1st Edition, O´Reilly, 2020

Rowel Atienza, Advanced Deep Learning with TensorFlow 2 and Keras, Packt Publishing Limited, 2020

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,0
Classes requiring direct contact with the teacher	8	0,0
Doctoral student's own work (literature studies, preparation for tutorials, project preparation)[1]	42	2,0

[1] delete or add other activities as appropriate