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Eunice EUROPEAN UNIVERSITY

EUROPEAN UNIVERSITY FOR CUSTOMISED EDUCATION

STUDY GUIDE

Fundamentals of machine learning and its practical application

Organised by

Poznan University of Technology [PUT]

b-tu Brandenburg University of Technology Cottbus - Senftenberg
UC Universidad de Cantabria
Università di Catania
Université Polytechnique HAUTS-DE-FRANCE
UMONS University of Mons
University of the Peloponnese
Vaasan yliopisto University of Vaasa
Politécnico de Viseu

1. IDENTIFYING DATA.	
· Course Name.	Fundamentals of machine learning and its practical application
· Coordinating University.	Poznan University of Technology
· Partner Universities Involved.	Not applicable
· Course Field(s).	Electrical Engineering
· Related Study Programme.	Electronics and Electrical Engineering, Laboratory of Power Electronics and Microprocessor Technology
· ISCED Code.	07 – Engineering, manufacturing and construction
· SDG.	Goal 4: Quality education, Goal 09: Industry, innovation and infrastructure
· Study Level.	Bachelor (B), Master (M)
· EUNICE Key Competencies	[Indicate the Key Competencies required for the course.] • Green – strongly • Orange- moderately • Red – partially • Blank cell - not at all

Problem solving	STRONGLY
Teamworking	PARTIALLY
Communication	MODERATELY
Self-management	MODERATELY
Cognitive flexibility	MODERATELY
Digital competence	STRONGLY
Technical competence	STRONGLY

	Global intercultural competence	NOT AT ALL

· Number of ECTS credits allocated.	1
· Mode of Delivery.	Online live + Self-study
· Language of Instruction.	English
· Course Dates.	01.03.2026 – 31.03.2026
· Precise Schedule of the Lectures.	Part 1. Introduction to deep learning Part 2. How to train a neural network using microcontrollers with a GPU module. Part 3. Convolutional neural networks and how to apply them to mobile devices Part 4. Augmenting and implementing new data using digital cameras and microcontrollers Part 5. Pre-trained models and how to use them for NVIDIA Jetson microcontrollers Part 6. Advanced architectures
· Key Words.	Microprocessor, NVIDIA Jetson, Edge AI, Electronics, Smart Vision System, ML models, Python, Linux
· Catchy Phrase.	The course aims to familiarise students with the techniques of programming microprocessors with ML models.

· Prerequisites and co-requisites.	English B2 or higher level The student starting this course should have basic knowledge of the basics of programming, telecommunications and mathematics. He should also have the ability to obtain information from the indicated sources and be ready to cooperate as part of the team. Knowledge in the field of digital electronics and the ability to design numerical algorithms and programming microprocessor systems at the level of first-cycle studies.
· Number of EUNICE students that can attend the Course.	30
· Course inscription procedure(s).	Application through the EUNICE website

2. CONTACT DETAILS.	
· Department.	Faculty of Automatic Control, Robotics And Electrical Engineering
· Name of Lecturer.	mgr inż. Amadeusz Gąsiorek, PUT
· E-mail.	Amadeusz.Gasiorek@put.poznan.pl
· Other Lecturers.	-

3. COURSE CONTENT.

During the course, different models for deep learning will be presented. These will allow students to handle different models of their own learned neural network and, later in the course, have the opportunity to support already prepared and learned networks. The first module will be aimed at teaching our own network to detect given numerical values. The next models the student will be exposed to are American Sign Language. Subsequent stages increase the complexity of the first models and thus, in subsequent exercises, students can take full advantage of detecting different things depicted in real-time images (e.g. distinguishing between animals and people). With the neural network, we can use it for our own purposes, e.g. detecting a person as e.g. a house owner, etc. The next step is real-time detection of people and other elements in the video or camcorder footage. In addition, a method will be presented on how to easily export our own learned network for use in off-the-shelf devices such as the NVIDIA Jetson microcontroller. The final stage of the course aims to show that the models that have been written in the course can be easily and effectively used in microcontrollers for research or your own projects.

Image classification:
- Using Anaconda Navigator and then at the very end a demonstration of ImageNet's capabilities on the Jetson platform
- Coding your own image recognition program (Python)
- Running a live camera recognition demonstration
- Multi-label classification for tagging images

Object detection:
- Detecting objects in images
- Running a live camera object detection demonstration
- Coding your own object detection program
- Using TAO detection models
- Tracking objects in video

Semantic segmentation:
- Segmenting images from the command line
- Running a live camera segmentation demonstration
- Estimating pose
- Action recognition
- Background removal

- Monocular depth

Training:

- Transfer Learning with PyTorch
- Classification/Recognition (ResNet-18)
- Re-training on the Cat/Dog dataset
- Re-training on the PlantCLEF dataset
- Collecting custom datasets for classification
- Object detection (SSD-Mobilenet)
- Re-training SSD-Mobilenet
- Collecting custom datasets for object detection

4. LEARNING OUTCOMES.

Knowledge:

1. Has knowledge of development trends, new achievements and dilemmas of modern engineering.

Skills:

1. Can obtain information from literature, databases and other sources, make their interpretation, evaluation, critical analysis and synthesis, as well as draw conclusions and formulate and exhaustively justify opinions.
2. Can formulate and test hypotheses related to engineering and simple research problems, develop detailed documentation of the results of the experiment, design tasks, interpret the obtained results and draw conclusions.

Social competences:

1. Recognizes the importance of knowledge in solving cognitive and practical problems and understands that in technology, knowledge and skills quickly become obsolete and therefore require constant replenishment.

5. OBJECTIVES.

Getting to know the architecture and applications of digital signal processors and embedded systems. Acquiring the ability to design real-time digital signal processing algorithms and using camera detection and motion sensors. Acquisition of programming skills for digital signal processors and microcontrollers NVIDIA Jetson - based on selected runtime environments.

6. COURSE ORGANISATION.

UNITS	
1.	Introduction to deep learning
2.	How to train a neural network using microcontrollers with a GPU module.

3.	Convolutional neural networks and how to apply them to mobile devices
4.	Augmenting and implementing new data using digital cameras and microcontrollers
5.	Pre-trained models and how to use them for NVIDIA Jetson microcontrollers
6.	Advanced architectures

LEARNING RESOURCES AND TOOLS.

PLANNED LEARNING ACTIVITIES AND TEACHING METHODS.
Multimedia presentation, presentation illustrated with examples given on the blackboard and carrying out the tasks given by the teacher - practical exercises.

7. ASSESSMENT METHODS, CRITERIA AND PERIOD.

Design
1. Continuous assessment, rewarding the increase in the ability to use the learned rules and methods.
2. Assessment of knowledge and skills related to the implementation of the project.
3. Obtaining additional points for activity during classes, especially for:
- proposing to discuss additional aspects of the issue,
- the effectiveness of applying the acquired knowledge while solving a given problem,
- the ability to cooperate as part of a team practically carrying out a detailed task in the laboratory,
- remarks related to the improvement of teaching materials.

OBSERVATIONS.
Teacher-Led Observations

8. BIBLIOGRAPHY AND TEACHING MATERIALS.

Basic:
1. A. Dąbrowski, Przetwarzanie sygnałów przy użyciu procesorów sygnałowych, Wydawnictwo Politechniki Poznańskiej, Poznań, 2000.
2. R. G. Lyons, Wprowadzenie do cyfrowego przetwarzania sygnałów, Wyd. II, WKŁ, W-wa, 2010.
3. T.P. Zieliński, Cyfrowe przetwarzanie sygnałów. Od teorii do zastosowań, Wyd. II, WKŁ, W-wa, 2014.
4. S. R. Ball, “Embedded Microprocessor Systems: Real World Design”, Elsevier Science, 2002.
5. Technical documentation of microcontrollers NVIDIA Jetsonand their application notes and educational materials - available on the websites of NVIDIA and GitHub.
6. Semantic Intelligent Computing and Applications, Walter de Gruyter GmbH, Berlin/Boston 2024
7. Deep Learning Research and Applications, Walter de Gruyter GmbH, Berlin/Boston 2020

8. Deep Learning for Cognitive Computing Systems Technological Advancements and Applications, Walter de Gruyter GmbH, Berlin/Boston 2023
9. Artificial Intelligence Machine Learning, Convolutional Neural Networks and Large Language Models, Walter de Gruyter GmbH, Berlin/Boston 2024
10. Magnus Ekman - Learning Deep Learning Theory and Practice of Neural Networks, Computer Vision, Natural Language Processing, and Transformers U (2021, Addison-Wesley Professional)

Additional:

1. Fitz M. P., Fundamentals of Communications Systems, 2007, McGraw-Hill
2. Hsu Hwei P., Schaum's Outlines of Theory and Problems of Signals and Systems, 1995, McGraw-Hill
3. W. Kester, The Data Conversion Handbook, Elsevier, 2005
4. Artificial Intelligence for Signal Processing and Wireless Communication, Walter de Gruyter GmbH, Berlin/Boston 2022