

APPLIED MACHINE LEARNING

COURSE OUTLINE

1. GENERAL			
SCHOOL	School of Music and Optoacoustic Technologies		
ACADEMIC UNIT	Department of Music Technology and Acoustics		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	0807.8.004.1	SEMESTER	2nd
COURSE TITLE	Applied Machine Learning		
INDEPENDENT TEACHING ACTIVITIES if credits are awarded for separate components of the course	WEEKLY TEACHING HOURS	CREDITS	
	0	6	
Total	0	6	
COURSE TYPE general background, special background, specialised general knowledge, skills development			
PREREQUISITE COURSES	None		
LANGUAGE OF INSTRUCTION and EXAMINATIONS	English		
OFFERED TO ERASMUS STUDENTS	Yes (in English)		
COURSE WEBSITE (URL)	https://eclass.hmu.gr/courses/SMOT225/		
2. LEARNING OUTCOMES			
Learning outcomes			
Machine learning has become a fundamental component of numerous commercial and research applications. Using the Python programming language and libraries such as PyTorch, it is possible to rapidly develop sophisticated applications in areas including audio-based human-computer interaction (e.g., natural language dialogue systems), music information retrieval, and many others. With this in mind, the course aims to introduce students to the field of machine learning. Within this framework, students will study the principles underlying the various stages involved in implementing data-driven knowledge discovery systems, using both classical machine learning techniques and state-of-the-art methods. The course also covers the latest approaches to natural language interaction based on large language models. Lectures will address the complete machine learning workflow, including data collection, feature extraction, model training, and performance evaluation. In addition to providing the necessary theoretical background, the course makes extensive use of Python libraries that are widely employed in both research and commercial applications for the development of automatic pattern recognition systems in domains such as natural language processing, audio signal processing, and related fields.			
General Competences			
Upon successful completion of the course, students will be able to: Understand the fundamental concepts and applications of machine learning. Evaluate the advantages and limitations of widely used machine learning algorithms. Design datasets and construct reliable training and evaluation sets for data-driven knowledge discovery. Apply advanced model evaluation techniques and hyperparameter optimization methods. Demonstrate proficiency in the use of popular Python-based machine learning libraries and frameworks. Employ trained large language models to develop natural language human-computer interaction systems.			

3. SYLLABUS

The following topics will be covered in the Applied Machine Learning course.

Theory

Introduction to machine learning: linear regression and logistic classification

Handwritten digit classification from images: introduction to neural networks

Convolutional neural networks for image and audio processing; transposed (deconvolutional) neural networks

Autoencoders, Variational Autoencoders (VAEs), and Generative Adversarial Networks (GANs)

Semantic embedding methods for time-series data

Time-series modeling and processing using Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) networks

Transformers and Large Language Models (LLMs)

Large Language Models for tool use, Retrieval-Augmented Generation (RAG), and Agentic AI

Laboratory Exercises

Forward propagation in neural networks

Handwritten digit classification

Convolutional neural networks for image and audio processing

Variational Autoencoders for audio applications

Semantic word embedding exercises for natural language

Using LSTM networks for music emotion recognition

Using Large Language Models for natural language interaction

Using Large Language Models and external tools for music analysis

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY

Face-to-face, Distance learning, etc.

Face-to-face

USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY

Use of ICT in teaching, laboratory education, communication with students

Google colab, eclass

TEACHING METHODS

The manner and methods of teaching are described in detail.

Activity

Semester workload

Course total

STUDENT PERFORMANCE EVALUATION

Description of the evaluation procedure

Intermediate exercises and final project.

5. ATTACHED BIBLIOGRAPHY

- [1] C. M. Bishop, Αναγνώριση Προτύπων και Μηχανική Μάθηση, ΕΚΔ. Γρηγόριος Χρυσοστόμου Φούντας, 2019 (ISBN 9789603307907 – Κωδικός στο Εύδοξο: 86053413)
- [2] J. Grus, Επιστήμη Δεδομένων: Βασικές Αρχές και Εφαρμογές με Python, 2η έκδοση, ΕΚΔ. Α. ΠΑΠΑΣΩΤΗΡΙΟΥ & ΣΙΑ Ι.Κ.Ε., 2020 (ISBN: 978-960-491-144-8 - Κωδικός στον Εύδοξο: 94690736)
- [3] A. Geiron, Hands-on machine learning with Scikit-Learn, Keras and TensorFlow: concepts, tools, and techniques to build intelligent systems (2nd ed.). O'Reilly. 2019
- [4] D. Foster, Generative deep learning: Teaching machines to paint, write, compose, and play. O'Reilly Media Company.
- [5] Ian H. Witten; Eibe Frank; Mark A. Hall, Data Mining: Practical machine learning tools and techniques, 3rd Edition, Morgan Kaufmann, San Francisco. 2011.
- [6] D. MacKay, Information Theory, Inference, and Learning Algorithms, Cambridge University Press, 2003.
- [7] T. Mitchell, Machine Learning, McGraw Hill, 1997
- [8] S. Guido and A. Muller, Introduction to Machine Learning with Python, O'Reilly Media, 2016.

