

COURSE OUTLINE

(1) GENERAL INFORMATION

SCHOOL	SCHOOL OF APPLIED MATHEMATICAL AND PHYSICAL SCIENCES		
LEVEL OF STUDIES	POSTGRADUATE		
INTERDEPARTMENTAL PROGRAM	Mathematical Modeling in Modern Technologies and Financial Engineering		
COURSE CODE		SEMESTER	2
COURSE TITLE	AI Hands On		
INDEPENDENT TEACHING ACTIVITIES <i>In case credit units are awarded separately for different parts of the course, e.g. Lectures, Laboratory Exercises, etc., specify them. If credit units are awarded as a whole for the course, indicate the weekly teaching hours and the total credits.</i>		Weekly Teaching Hours	Credits (ECTS)
Lectures – Exercises		2	ECTS 8
Laboratory		1	
Assignments		3	
COURSE TYPE <i>General background, specialized background, specialization, general knowledge, skill development</i>	General background		
PRE- and CO-REQUISITES:	-		
LANGUAGE OF INSTRUCTION AND ASSESSMENT:	ENGLISH and GREEK		
COURSE OFFERED TO ERASMUS STUDENTS: <i>(If yes what is the type of course, e.g. reading course)</i>	YES in ENGLISH language		
COURSE WEBSITE (URL):	-		

(2) LEARNING OUTCOMES

Learning Outcomes

Here are described the learning outcomes of the course, including the specific knowledge, skills, and competencies that students will acquire upon successful completion (according to the skills and competencies framework of the European higher education chart).

Upon successful completion of the course, students will be able to:

- **Understand** AI programming foundations, data structures, SQL, and best practices.
- **Explain** core AI tasks including supervised, unsupervised, and self-supervised learning.
- **Apply** feature engineering, data preprocessing, and storage techniques.
- **Analyze** AI models such as clustering, regression, and classification techniques.
- **Develop** practical AI applications, including retrieval-augmented generation (RAG), agent-based systems, and AI-powered customer ranking.
- **Evaluate** the trade-offs between different AI techniques such as dimensionality reduction, transformers, and neural radiance fields (NeRF).
- **Implement** AI solutions using Python, Docker, and cloud-based AI tools.

General Competencies

Considering the general competencies expected from a graduate (as these are specified in the Diploma Supplement) which of these does the course aim to develop?

Search, analysis, and synthesis of data and information, using necessary technologies

Adaptation to new situations

Decision-making

Independent work

Teamwork

Working in an international environment

Working in an interdisciplinary environment

Producing new research ideas

Project planning and management

Respect for diversity and multiculturalism

Environmental awareness

Demonstration of social, professional, and ethical responsibility and sensitivity to gender issues

Exercise of critical and self-critical thinking

Promotion of free, creative, and inductive thinking

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Others

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General Competencies:

- **Problem-solving & decision-making** in AI-driven applications.
- **Independent & team-based AI development.**
- **Interdisciplinary collaboration** in AI and data science projects.
- **Critical thinking** in evaluating AI model performance and ethical considerations.
- **Creative AI system design** with ethical considerations.
- **Project management** in AI-related research and applications.

(3) COURSE CONTENT

COURSE CONTENT	
Module 1: AI Programming Foundations - Data structures and libraries (NumPy, Pandas, Matplotlib) - SQL fundamentals - Object-oriented & functional programming for AI - Best coding practices - Dockerization techniques for AI applications Module 2: Data Fundamentals for AI - Data types: Structured, unstructured, and semi-structured - Data preprocessing & feature engineering - Hot and cold data storage (SQL, NoSQL, Big Data) Module 3: AI Core Tasks - Unsupervised learning: Clustering, dimensionality reduction - Self-supervised learning: Reinforcement learning, contrastive learning, masked language modeling - Supervised learning: Classification, regression, ranking, and generative models (text, image, sound, video)	Module 4: Modeling - Classical ML algorithms: PCA, k-Means, SVM, Decision Trees, etc. - Learning to rank - Neural networks: CNNs, RNNs, Transformers, LLMs - Advanced AI techniques: Graph neural networks (GNNs), NeRF, computer vision models Module 5: AI Applications - Customer ranking in marketing - Retrieval-augmented generation (RAG) - Retail market product retrieval - Virtual Try-On & Virtual Try-Off - Time series forecasting - Agentic text-to-SQL and function calling - Ethical AI and fairness considerations

(4) TEACHING AND LEARNING METHODS – STUDENT EVALUATION

TEACHING METHODS AND TOOLS <i>Face-to-face, distance learning, etc.</i>	Distance learning
USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT) <i>Use of ICT in teaching, lab training, communication with students</i>	Online coding platforms (e.g., Jupyter Notebooks, Google Colab) Cloud-based AI services (e.g., Azure OpenAI, LangChain) Data analysis and visualization tools

COURSE ORGANIZATION <i>The teaching methods and approaches are detailed here</i> <i>Possible activities include:</i> Lectures Seminars Laboratory Exercises Fieldwork Study & literature analysis Tutorials Practical Training Clinical Training Artistic Workshop Interactive Teaching Study Project Report Writing Artistic Creation Educational Visits ... <i>Indicate the hours of study for every learning activity as well as the hours of non guided study according to the principles of ECTS</i>	Activity Semester Workload Lectures: 26 Study: 26 Homework: 3 Laboratory: 13 Project Work/Presentation: Yes Educational Visits: No Total Course Load (in hrs): 65
STUDENT EVALUATION <i>Language of Evaluation</i> <i>Evaluation Methods: Formative or Summative</i> Multiple Choice Test Short Answer Questions Essay Questions Problem Solving Written Assignment Report/Presentation Oral Exam Public Presentation Laboratory Work Artistic Performance Other <i>Explicitly define the evaluation criteria and their availability to students</i>	Evaluation Language: Greek and English (for Erasmus students) Evaluation Type Percentage (%) 1st assignment: 25% 2nd assignment: 25% Final assignment: 50% Evaluation Criteria: • Problem-solving and AI application development. • Accuracy and efficiency of code implementation. • Creativity and innovation in AI model design. • Ethical considerations in AI applications. Students are required to complete and pass all three assignments in order to successfully pass the course. Failure to pass any of the assignments will result in failing the course.

(5) RECOMMENDED BIBLIOGRAPHY

Charu C. Aggarwal – Neural Networks and Deep Learning: A Textbook.

Ian Goodfellow, Yoshua Bengio, Aaron Courville – Deep Learning.

David L. Poole & Alan K. Mackworth – Artificial Intelligence: Foundations of Computational Agents.

Magnus Ekman – Efficient Transformers and Quantization Techniques.

Thomas Kipf & Max Welling – Graph Convolutional Networks and Beyond.

MIT OpenCourseWare – Free Course Materials on Neural Networks & AI Systems.

OpenAI Community Documentation – LangGraph & AI Agent Frameworks.

Journal of Machine Learning Research (JMLR)

- Focus: Covers a wide range of machine learning topics, including deep learning, reinforcement learning, and AI applications.
- Website: <https://www.jmlr.org>

Artificial Intelligence Journal (AIJ)

- Focus: Publishes research on AI methodologies, algorithms, and applications, including neural networks, NLP, and ethical AI considerations.
- Website: <https://www.journals.elsevier.com/artificial-intelligence>

IEEE Transactions on Neural Networks and Learning Systems (TNNLS)

- Focus: A leading journal publishing cutting-edge research in neural networks, deep learning, and AI methodologies.
- Website: <https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=5962385>