DAMA610 Module Outline

1. GENERAL

SCHOOL	School of Science and Technology		
PROGRAMME	Data Science and Machine Learning		
LEVEL OF STUDIES	Level 7 of the Hellenic and European Qualifications Framework		
MODULE CODE	DAMA610	**SEMESTER**	3
MODULE TITLE	Deep Learning		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**HOURS**	**CREDITS**
Weekly workload: 32-33 hours x 13 weeks		420	15 ECTS
MODULE TYPE *Compulsory/Elective/ Mandatory Optional*	Compulsory		
PREREQUISITE MODULES	None		
LANGUAGE OF INSTRUCTION and EXAMINATIONS	English		
IS THE MODULE OFFERED TO ERASMUS STUDENTS	Yes		
MODULE WEBSITE (URL)	The Module has a dedicated space in HOU's digital learning platform (http://courses.eap.gr, http://study.eap.gr), which students and tutors can access using their credentials.		

2. LEARNING OUTCOMES

Learning outcomes

The learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the Module are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

Knowledge:

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

- Understand the concept of Supervised, Unsupervised, Self-Supervised and Reinforcement Learning.
- Understand Transfer Learning and utilize pre-trained models for relevant tasks.
- Understand the concept of Generative Models

Skills:

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

- Implement machine learning and deep learning models and perform hyperparameter tuning, using Jupyter notebooks, Scikit-learn, TensorFlow/Keras, or PyTorch.
- Use Recurrent Neural Networks (RNNs) and evaluate their effectiveness.
- Apply Convolutional Neural Networks (CNNs) to specific data sets and describe their structure.
- Use Large Language Models (LLMs) for a collection of language tasks.
- Perform self-supervised learning by implementing autoencoders
- Generate images with Generative Adversarial Networks (GANs) and assess the output quality.
- Understand the concept of Diffusion Models and identify emerging use cases.
- Apply reinforcement learning to specific problems.

- Use Physics Informed Neural Networks (PINNs) in scientific applications
- Describe Boltzmann and restricted Boltzmann machines and their role in deep learning.

Competences:

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

- Evaluate the effectiveness of Artificial Neural Networks in different contexts.
- Assess the quality of outputs generated by GANs.
- Utilize pre-trained models for relevant tasks using Transfer Learning.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the Module aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology
Adapting to new situations
Decision-making
Working independently
Team work
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project planning and management
Respect for difference and multiculturalism
Respect for the natural environment
Showing social, professional and ethical responsibility and sensitivity to gender issues
Criticism and self-criticism
Production of free, creative and inductive thinking

The general skills that the students will acquire are:

- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Adapting to new situations
- Decision-making
- Working independently
- Team work
- Project planning and management
- Showing social, professional and ethical responsibility and sensitivity to gender issues
- Production of free, creative and inductive thinking

3. SYLLABUS

Purpose of Module

The students will be able to implement deep machine learning methods in Jupyter notebooks, use Scikit-Learn, TensorFlow/Keras and PyTorch, write and execute python code. The students are expected to be familiar with linear and nonlinear regression, support vector machines, perform model regularization, implement decision trees and ensemble learning in the form of random forests. They are also expected to know how to perform dimensionality reduction and use principal component analysis. The module focuses on neural network methods and deep learning including fully connected deep networks, convolutional neural networks, pre-trained models, large language models, autoencoders and generative models. Use of recurrent neural networks, physics informed neural networks and restricted Boltzmann machines completes the material of the module. DAMA-610 builds heavily on DAMA-510 and after its completion the students will be able to use the mathematical tools acquired in the latter in real world data problems.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	- Distance teaching and learning with three (3) Group Counseling Meetings (GCMs) of 4-hour duration during the academic semester on weekends. - Personal communication and feedback (advisory role of Adjunct Faculty).
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	During GCMs and teaching the following are used: - Remote meetings tools (webex, Teams), - Presentation software (PowerPoint, educational video - animations etc.), - Specialized software/databases for the subjects under study.

	In addition, students use office automation tools, web browsers and e-reader for digital books. Communication with the students is supported by: - The digital platform of HOU ((https://courses.eap.gr/login/index.php / https://study.eap.gr/login/index.php) (course information, educational material posts, announcements, messages, examination results, user groups, discussion forums etc.). - e-mail and messaging.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	<table><tr><th>*Activity*</th><th>*Semester Workload*</th></tr><tr><td>3 GCMs (x 4 hours)</td><td>12</td></tr><tr><td>5 Educational Activities (x 4 hours)</td><td>20</td></tr><tr><td>2 Semester Assignments (x 30 hours)</td><td>60</td></tr><tr><td>Individual Study time (25 hours x 13 weeks)</td><td>325</td></tr><tr><td>Final examination</td><td>3</td></tr><tr><td>***Total Workload***</td><td>420</td></tr></table>
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	**Students' evaluation – Grade assessment of a Module:** a. Five (5) multiple-choice (quiz) Educational Activities (Q), which contribute equally to the final grade with a value of 2% each. b. Two (2) Semester Assignments (A) which contribute equally to the final grade with a value of 10% each. The scoring of educational activities and assignments is activated only if the student succeeds an overall score equal to or above the base (≥50%) in the final or repeat exams. c. Final or repeat exams (E) contribute to the final grade of the module by 70%. The Final Grade of the module is calculated as follows (with 10 being the maximum Grade): Final Grade = (Q1 x 2%) + (Q2 x 2%) + (Q3 x 2%) + (Q4 x 2%) + (Q5 x 2%) + (A1 x 10%) + (A2 x 10%) + (E x 70%) **Language of evaluation**: English

5. INDICATIVE BIBLIOGRAPHY

- Recommended bibliography:

- A. Geron (2022). Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 3rd Edition, 3rd edition, O' Reilly Media.
- I. Goodfellow and Y. Bengio and A. Courville (2016). Deep Learning. MIT Press.
- G. Tsironis, Artificial Intelligence and Complex Dynamical Systems, Springer (2025)

Additional digital (and multimedia) material will be made available online.

- Related scientific Journals:

- Journal of Machine Learning Research (http://www.jmlr.org)
- Machine Learning (https://www.springer.com/journal/10994)
- Neural Computing and Applications, Springer (https://link.springer.com/journal/521)