COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Physics		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**10ΕΛΕ22**	**SEMESTER**	**8**
COURSE TITLE	**Pattern Recognition – Machine 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*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	4	6

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	General Knowledge
PREREQUISITE COURSES:	Knowledge of Probability Theory and Statistics
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	No
COURSE WEBSITE (URL)	https://eclass.uoa.gr/courses/DI499/

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course 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*

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

- Describe the fundamental concepts of pattern recognition and machine learning.
- Identify different categories of machine learning algorithms and their characteristics.
- Explain the mathematical principles and optimization mechanisms governing machine learning models.
- Describe basic neural network architectures and their training methods
- Design and implement supervised learning algorithms for classification and regression problems.
- Apply appropriate techniques for data representation and feature extraction from different types of data (images, audio, text).
- Develop and train neural network models using modern architectures.
- Implement machine learning algorithms in Python using appropriate libraries.

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 course 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
……
Others…
…….

- Search for, analysis and synthesis of data and information using necessary technologies.
- Decision making.
- Working independently.
- Project planning and management.
- Production of free, creative and inductive thinking.
- Exercise of criticism and self-criticism.

(3) SYLLABUS

- Introduction to pattern recognition and machine learning; data representation (images, audio, text), feature extraction and the statistical learning framework.
- Regression: loss functions, optimization algorithms, regularization and model evaluation (over-/under-fitting).
- Classical methods for data classification.
- Unsupervised learning: clustering, dimensionality reduction and feature selection.
- Local methods, kernel methods and support vector machines (SVMs).
- Neural networks and deep learning: building blocks, training algorithms and network architectures.

All units are accompanied by tutorials with hands-on implementations of the algorithms in Python (scikit-learn, PyTorch).

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>- Support of learning process through e-class platform
- Course description, provision of files/multimedia
- Announcements, Messages, Discussions
- Email communication</td></tr>
<tr><td>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</td><td><table><tr><th>Activity</th><th>Semester workload</th></tr><tr><td>Lectures</td><td>30</td></tr><tr><td>Tutorial exercises</td><td>26</td></tr><tr><td>Individual projects</td><td>50</td></tr><tr><td>Independent study</td><td>44</td></tr><tr><td>Course total</td><td>150</td></tr></table></td></tr>
<tr><td>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.</td><td><table><tr><th>Assessment</th><th>Number</th><th>Percentage</th></tr><tr><td>Written exams</td><td>1</td><td>60%</td></tr><tr><td>Individual project</td><td>2</td><td>40%</td></tr></table>
The course evaluation is conducted through a written examination that includes machine learning model design and analysis problems, as well as theory questions, critical thinking questions and short-answer questions related to statistical learning and neural network concepts. Written exam evaluation is based on correctness and completeness of answers, ability to analyze and design machine learning systems, understanding of fundamental concepts and principles, and ability to apply theoretical knowledge to practical problems. Additionally, students are evaluated through individual projects that include implementing machine learning algorithms in Python and developing complete applications using real data.</td></tr>
</table>

(5) ATTACHED BIBLIOGRAPHY

Recommended textbooks (Eudoxus):

- Christopher M. Bishop, "Pattern Recognition and Machine Learning", Foundas Publications
- Sergios Theodoridis, Konstantinos Koutroumbas, "Pattern Recognition", P.C. Paschalidis Medical Publications

Supplementary textbooks:

- Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer
- Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press

Related academic journals:

- IEEE Transactions on Pattern Analysis and Machine Intelligence
- Journal of Machine Learning Research
- IEEE Transactions on Neural Networks and Learning Systems