COURSE OUTLINE

(1) GENERAL

SCHOOL	Science and Technology		
ACADEMIC UNIT	Science and Technology		
PROGRAMME OF STUDIES	MSc in Data Science		
LEVEL OF STUDIES	Postgraduate		
COURSE CODE	DSC04	SEMESTER	1
COURSE TITLE	Machine Learning Principles and Concepts		
COURSE TYPE *Elective, compulsory*	Compulsory		
INSTRUCTOR(S)	Theory: Prof. Panayiotis Bozanis Lab: Dr. Leonidas Akritidis		

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
	4,2	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

TEACHING ACTIVITIES BREAKDOWN	WEEKLY HOURS
Theory	2,3
Recitation	0,7
Lab	1,2

Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background
PREREQUISITE COURSES:	-
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	English
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	https://elearn-ucips.ihu.gr/

(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*

On completing the course, the student will be able to:

- Develop an appreciation for what is involved in learning from data.

- Explain a wide variety of learning algorithms.
- Understand how to apply a variety of learning algorithms to datasets.
- Know how to perform evaluation of learning algorithms and model selection.

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	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*……*
Production of new research ideas	*Others…*
	…….

- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Decision Making
- Teamwork
- Production of free, creative, and inductive thinking

(3) SYLLABUS

The course introduces fundamental concepts and tools of Machine Learning. The student is exposed to the necessary mathematical/algorithmic background and coding with the Python programming language. The topics covered include:

- Optimization Techniques.
- Linear Regression.
- Linear 2- and multi-class classification.
- Feature Engineering.
- Kernel Methods.
- Fully Connected Neural Networks.
- Tree-Based Learners.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Hybrid: Face to face and synchronous distance learning
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	**Use of ICT in Teaching** During the educational process, various machine learning and programming tools are used, along with the material available at the e-learning platform. The hybrid teaching method involves synchronous learning with the support of the videoconferencing tool Zoom. Students are taught a variety of tools related to the course content and material. **Use of ICT in Communication with students** • The course material (slides, scientific articles, exercises, etc.) is posted on the course page at the e-learn platform (Moodle). • Use of Moodle Forums announcements. • Live video meetings via Zoom/Teams. • Contact via email.
TEACHING METHODS	*Activity* | *Semester workload*

The manner and methods of teaching are described in detail.
Lectures, recitation, 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

Lectures	30 hrs.
Recitation	9 hrs.
Lab	15 hrs.
Project	8 hrs.
Exams	2 hrs.
Non-Directed Study	86 hrs.
Course total	***150 hrs.***

COURSE MATERIAL ARRANGEMENT

Theory/Recitation

Introduction to Machine Learning	1 hr.
Zero & First Order Optimization Techniques	5 hrs.
Linear Regression	4 hrs.
Linear 2-Class Classification	5 hrs.
Linear Multi-Class Classification	3 hrs.
Linear Unsupervised Learning	3 hrs.
Feature Engineering and Selection	3 hrs.
Principles of Nonlinear Feature Engineering	3 hrs.
Principles of Feature Learning	4 hrs.
Kernel Methods	2 hrs.
Fully Connected Neural Networks	3 hrs.
Tree-Based Learners	3 hrs.

Lab

Introduction to Python and NumPy	3 hrs.
Gradient Descent, Linear and Logistic Regression	3 hrs.
Perceptron, Linear SVM, K-means Clustering	3 hrs.
Preprocessing, BOW, PCA	3 hrs.
Fully Connected NNs, Decision Trees, Random Forests	3 hrs.

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

Language of Evaluation: English

Evaluation Procedure:

- Written Exams (80%). Methods of evaluation:
  - Open-ended questions
  - Problem solving
  - Multiple choice questions (on lab material)
- Group project (20%):
  - Training and evaluation of various ML models
  - The students should achieve a passing grade to participate in the written exams.

The evaluation procedure is announced to the students during the first lecture and is also accessible at the e-learn platform throughout the entire semester.

STUDENT OBLIGATIONS

Compulsory attendance of lectures, labs, recitations, compulsory participation in midterms, exams, compulsory delivery of homework, projects, etc.

- Compulsory attendance of lectures
- Compulsory attendance of recitation
- Compulsory attendance of labs
- Compulsory participation in the exams
- Compulsory delivery of project

(5) ATTACHED BIBLIOGRAPHY

- Suggested Textbooks

1. Watt J., Borhani, R., Katsaggelos A.K., Machine Learning Refined: Foundations,Algorithms, and Applications, Cambridge University Press, 2020.
2. Zaki, M.J., Meira W., Jr, Data Mining and Machine Learning: Fundamental Concepts and Algorithms, Cambridge University Press, 2020.
3. Lee W.-M.., Python® Machine Learning, Wiley, 2019.

- *Additional Bibliography:*

1. Géron, A., Hands-On Machine Learning with Scikit-Learn, Keras, and Tensorflow: Concepts, Tools, and Techniques to Build Intelligent Systems, O'Reilly Media, 2019.
2. Burkov, A., The Hundred-Page Machine Learning Book, Andriy Burkov, 2019.
3. Garrity, T.A., All the Math You Missed (But need to know for graduate school), 2nd ed., Cambridge University Press, 2021.