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	DSE02	SEMESTER	2
COURSE TITLE	Advanced Machine Learning		
COURSE TYPE *Elective, compulsory*	Compulsory		
INSTRUCTOR(S)	Theory: Prof. Konstantinos Diamantaras		

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
	3	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	-
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*

Upon successful completion of the course the student will be able to:

- Know a wide range of machine learning methods including the latest and most advanced methods as well as their scope.

- Understand the types of problems solved and the methods that correspond to them.
- Analyze a problem that requires the use of machine learning and apply the appropriate method to it.
- Produce solutions to machine learning problems by applying the most modern software tools

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 aim of the course is to provide the student with a comprehensive, up-to-date and in-depth knowledge of the field of machine learning by studying the main modern models, methods and types of learning. Also, basic elements of learning theory are established and the most modern software tools are described. The subject of the course is analyzed in the following sections:

- Support vector machines.
- Deep Learning.
- Deep learning applications
- Bayes modeling and inference
- Ensemble models.
- Probabilistic graphical models.
- Recurrent neural networks.
- Reinforcement Learning.
- Application of Keras/Tensorflow to solve machine learning problems

(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 teaching process, the Keras/Tensorflow software tool is presented and used, which is suitable for the implementation of deep learning methods. Training materials, examples and videos are provided on the e-learning platform. The hybrid teaching method is realized through modern lectures with the support of the Zoom videoconferencing tool. Students are taught a variety of tools / python libraries that are necessary for the implementation of the project and are directly related to the course material. **Use of ICT in Communication with students**

- The course material (slides, videos, demos, exercises, etc.) is posted on the course page at the e-learn platform (Moodle).
- Use of Moodle Forums announcements.
- Live video meetings via Zoom.
- Contact via email.

TEACHING METHODS

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

Activity	*Semester workload*
Lectures	30 hrs.
Recitation	9 hrs.
Lab	-
Project	20 hrs.
Exams	2 hrs.
Non-Directed Study	89 hrs.
Course total	***150 hrs.***

COURSE MATERIAL ARRANGEMENT

Theory/Recitation

Support Vector Machines	1 hr.
Support Vector Regression	5 hrs.
Bayesian modeling and inference	4 hrs.
Mixture models	5 hrs.
The EM algorithm	3 hrs.
Ensemble models	3 hrs.
Mixture of Experts	3 hrs.
Recurrent Neural Networks	3 hrs.
Application demo of recurrent models	2 hrs.
Probabilistic Graphical Models	3 hrs.
Bayesian networks	3 hrs.
Deep Neural Networks	
Restricted Bolzmann Machines	
Deep Belief Networks	
Auto-encoders	
Convolutional Neural Networks	
Application of deep learning to image recognition	
Introduction to Keras /Tensorflow	
Demo of deep learning apps using Keras/Tensorflow	
Reinforcement Learning	
The k-armed bandit problem	
Markov Decision Processes	
Q-learning	
Monte Carlo methods	
Deep reinforcement learning	

Lab

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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

Language of Evaluation: English

Evaluation Procedure:

- Written Exams (70%). Methods of evaluation:
  - Open-ended questions
  - Problem solving
  - Multiple choice questions
- Group project (30%):
  - Participation in a machine learning competition

work, clinical examination of patient, art interpretation, other *Specifically-defined evaluation criteria are given, and if and where they are accessible to students*	○ Training and evaluation of Deep Learning 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 participation in the exams ● Compulsory delivery of project

(5) ATTACHED BIBLIOGRAPHY

- Suggested Textbooks

1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, "Deep Learning", MIT Press, 2016 http://www.deeplearningbook.org/
2. Sergios Theodoridis. "Machine learning: a Bayesian and optimization perspective". Academic Press, 2015.
3. Richard G. Sutton and Andrew G. Barto, "Reinforcement Learning: An Introduction", MIT Press (second edition 2017)
4. Bishop, Christopher M., "Pattern Recognition and Machine Learning", Springer, 2006.