ADVANCED TOPICS IN MACHINE LEARNING (EMaCS-03-07)				
DEGREE PROGRAM:		Master in Computer Science for the Human-Centric and Sustainable Industry		
SEMESTER: Third	**TYPE:** Basic	**CREDITS:** 7.5 ECTS	**WORKLOAD:** 187.5 hours	**MENTORING:** 4 hours/week
LANGUAGE: English				

OBJECTIVES	
General	This unit explores advanced concepts of machine learning, essentially learning mechanisms with deep neural networks, generative systems and evolutionary computing paradigms.
Specific	• Gain knowledge of the field of deep learning. • Understand and apply advanced data analysis techniques. • Understand and apply deep reinforcement learning to real-world problems.

SUSTAINABILITY

The course "Advanced Topics in Machine Learning" significantly contributes to sustainability by addressing key topics related to the efficiency and environmental impact of artificial intelligence (AI) solutions. By considering applications in areas such as finance, computational biology, and natural language processing (NLP), students can explore how machine learning technologies can optimize processes and reduce resource consumption. Furthermore, by introducing concepts of responsible AI, the course encourages the ethical and social consideration of AI implications, promoting sustainable practices in the development and implementation of machine learning models.

RESILIENCE AND HUMAN-CENTRIC DEVELOPMENT

Resilience and human-centric development are essential elements in the focus of this course. By exploring topics such as reinforcement learning and evolutionary computing, students acquire skills to develop machine learning models that adapt and evolve in changing environments. The application of advanced data analysis techniques and understanding how models can be applied in various areas, including computational biology, reinforces students' ability to develop solutions centred on human needs and resilience in real-world scenarios. Additionally, by addressing "Responsible AI," the course highlights the importance of developing solutions that benefit society and mitigate potential negative impacts. This supports a human-centric approach and the construction of machine learning systems that are ethical and socially responsible.

SUBJECT MATTER

1. Representation learning;
2. Auto-encoders;
3. Graph Neural Networks;
4. Reinforcement Learning;
5. Recurrent units and transformers;
6. Evolutionary Computing;
7. Responsible AI;
8. Applications: NLP, computational biology, finance.

COMPETENCES

C3 MANAGING AND EVALUATING DATA, INFORMATION AND DIGITAL CONTENT
C5. PROGRAMMING
C6 USING MACHINE LEARNING AND A.I. TECHNIQUES
C8. PROTECTING HEALTH AND WELL-BEING
C10 EXPLORATORY AND CRITICAL THINKING
C12 IDENTIFYING NEEDS AND TECHNOLOGICAL RESPONSES
C13. CREATIVELY USING DIGITAL TECHNOLOGIES

LEARNING OUTCOMES

Knowledge	• Know about the main paradigms of computational intelligence.
Skills	• Acquire ability to correctly apply deep learning to successfully complete data science projects.
Attitudes/values	• Develop the capacity to organise and manage teams for data science projects.
TEACHING METHODS	
The unit consists of lectures, practical classes and invited talks. • Theoretical classes will present the methodologies and examples of applications to case studies. • The practical classes focus on the practical implementation of algorithms and the supervision of the project and research work. • Invited talks from the industrial and academic community.	
EVALUATION	
Students will be assessed on two components, theoretical (30%) and practical (70%). • The theoretical component will be assessed by a written examination. • The practical component will be assessed by one Project (40%) and a research paper (30%).	
PRECONDITIONS	
None	
DEPARTMENT	Department of Informatics Engineering and Systems
LECTURERS	Carlos Pereira
LITERATURE	• Aurélien Géron; Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow; O'Reilly Media 2019; ISBN-13 : 978-1492032649 • Müller, A. C., & Guido, S. (2016). Introduction to machine learning with Python: a guide for data scientists. ” O’Reilly Media, Inc.” • Online resources, namely sk-learn, tensorflow, and keras.