1. OVERVIEW

Subject area	MACHINE LEARNING
Degree	Bachelor's Degree in Data Science
School/Faculty	FACULTY OF SCIENCE, ENGINEERING AND DESIGN
Year	3º
ECTS	9
Type	COMPULSORY
Language(s)	SPANISH
Delivery Mode	ON CAMPUS
Semester	5

2. INTRODUCTION

Machine Learning is a branch of artificial intelligence which uses different technology to give computers the ability to learn models. These can then be automated to either solve emerging problems or deal better with those which already exist.

Many researchers and businesses from a wide range of sectors are dedicating time to building systems which can adapt to their environment and learn from experience. These include the fields of IT, engineering, maths, physics and neuroscience. In a short space of time, research and new developments have provided a large variety of learning technology which is having a huge impact on fields of industry and science.

The exponential increase in available memory and computer performance as well as the decreasing cost of producing this technology has made it easy to apply these learning algorithms to problems which barely ten years ago were impossible to solve.

There are currently many applications of learning technology spanning several domains. In the world of commerce, for example, spoken and written words can now be recognised, consumer behaviour analysed and people's credit risk predicted.

The implementation of learning technology is taking place at a frenzied pace, with huge expectations as to the amount of hitherto complex problems which may now be solved in a growing number of knowledge areas.

The main aim of this subject is to give students a global vision of the most important learning technology and algorithms used today.

3. SKILLS AND LEARNING OUTCOMES

Basic skills (CB, by the acronym in Spanish):

- CB1 - Students have shown their knowledge and understanding of a study area originating from general secondary school education, and are usually at the level where, with the support of more advanced textbooks, they may also demonstrate awareness of the latest developments in their field of study.
- CB2 - Students can apply their knowledge to their work or vocation in a professional manner and possess the skills which are usually evident through the forming and defending of opinions and resolving problems within their study area.
- CB3 - Students must have the ability to gather and interpret relevant data (usually within their study area) to form opinions which include reflecting on relevant social, scientific or ethical matters.

Cross-curricular skills (CT, by the acronym in Spanish):

- CT3 - Teamwork: ability to integrate and collaborate actively with other people, areas and/or organisations to reach common goals.
- CT5 - Analysis and problem-solving: be able to critically assess information, break down complex situations, identify patterns and consider different alternatives, approaches and perspectives in order to find the best solutions and effective negotiations.
- CT08 - Entrepreneurial spirit: ability to take on and carry out activities that generate new opportunities, foresee problems or lead to improvements.

Specific skills (CE, by the acronym in Spanish):

- CE10 - Ability to apply Big Data methods, architecture and techniques to manage data effectively.
- CE11 - Ability to apply computational learning techniques in order to design and implement applications and systems that use them, including those dedicated to the automatic extraction of information and knowledge from large volumes of data.
- CE12 - Understanding of system interoperability techniques and data integration and aggregation.
- CE13 - Ability to design efficient interfaces in the context of Big Data that guarantee accessibility and usability, using graphic and analytical representation techniques.

Learning outcomes (RA, by the acronym in Spanish):

- Use methods, architecture and techniques to store and manage large volume databases to solve practical cases.
- Interpret and apply models and standards in the field of big data systems to practical cases.
- Describe automated learning techniques, choosing the most suitable and using them to come up with a solution to any given problem.
- Implement computer applications which use large-volume databases. This includes the use of machine learning technology to obtain models and how to interpret them.

The following table shows how the skills developed in the subject area match up with the intended learning outcomes:

Skills	Learning outcomes
CE10	Use methods, architecture and techniques to store and manage large volume databases to solve practical cases.
CE11	Interpret and apply models and standards in the field of big data systems to practical cases.
CE11, CE13	Describe automated learning techniques, choosing the most suitable and using them to come up with a solution to any given problem.
CE12	Implement computer applications which use large-volume databases. This includes the use of machine learning technology to obtain models and how to interpret them.
CE10	Use methods, architecture and techniques to store and manage large volume databases to solve practical cases.

4. CONTENTS

This subject deals with the following topics:

- SUMMARY: Principles of ML and DM
- BLOCK 1: Advanced models of data mining
  - Supervised learning techniques
  - Unsupervised learning techniques
- BLOCK 2: Neural networks
  - ANNs
  - CNNs
  - RNNs
  - Autoencoders
  - GANs
- BLOCK 3: Evolutionary computation
- BLOCK 4: Bayesian analysis of large data sets
- BLOCK 7: Semantic analysis and natural language processing
- BLOCK 8: Anonymisation techniques and solving problems through search

5. TEACHING/LEARNING METHODS

The types of teaching/learning methods are as follows:

- Master lecture
- Problem-based learning
- Project-based learning
- Service learning
- Gamification
- Flipped-Classroom
- Practical seminars
- Debates
- Tutorials

6. LEARNING ACTIVITIES

The types of learning activities, plus the amount of time spent on each activity, are as follows:

On campus:

Learning activity	Number of hours
Master lectures	65 h
Problem-solving and case studies (directed activities)	15 h
Practical seminars, debates/discussions and undirected activities	10 h
Challenge Learning Projects	12 h
Learning contract (definition of interests, needs and objectives)	10 h
Autonomous learning	105 h
Tutorials	8 h
TOTAL	225 h

7. ASSESSMENT

The assessment methods, plus their weighting in the final grade for the subject area, are as follows:

On campus:

Assessment system	Weighting
On campus tests to evaluate objectives of theory/practical learning (exam-type objective tests, written compositions, spoken presentations, case studies/problem solving, debates, simulation tests)	40%
On campus practical tests	15%

Off-site tests to assess theory/practical learning of school-based education projects (PECs in Spanish)	20%
Student performance in class	5%
Self- and co-assessment (challenges league).	10%
Research project	10%

On the Virtual Campus, when you open the subject area, you can see all the details of your assessment activities and the deadlines and assessment procedures for each activity. Please note there may be a specific assessment procedure for each activity and two activities are not necessarily weighted the same and/or the assessment criteria/rubric may be different.

The assessment criteria and the weightings will be specified for each activity included in the teaching block.

The assessment process is based on each student's own work and presumes authorship and originality of the work produced. Any issues with authorship or originality in assessed work resulting from copying or plagiarism are serious malpractice and may lead to academic and disciplinary measures.

Students can only pass this subject based on their continuous assessment. The weighted average of the continuous assessment marks from each teaching block will be the final mark for this subject area.

PLAGIARISM RULES

In accordance with the Disciplinary Regulations for Universidad Europea students:

• Plagiarism of all or part of any kind of intellectual work is considered to be a very serious offence.

• If any student commits the very serious offence of plagiarism or cheating to pass an assessment test, they will be disqualified from the corresponding exam, and their absence and the reason for this absence will be filed in their academic record.

8. BIBLIOGRAPHY

The recommended bibliography is as follows. Teaching staff will further add to this list in each of the modules.

Basic:

- Alpaydin, E (2020). Introduction to machine learning, The MIT Press, 2020:

- Theodoridis (2015). Machine Learning: a Bayesian and Optimization perspective. Elsevier
- D. Haroon (2017). Python Machine Learning Case Studies: Five Case Studies for the Data Scientist. Apress
- Bishop C.M, (2006). Pattern recognition and machine learning, Springer
- Cherkassky, V.; Mulier, F. (2007). Learning from data: concepts, theory, and methods, John Wiley, 2007.
- Haykin, S.S, (2009). Neural networks and learning machines. Prentice Hal, 2009. ISBN: 9780131471399
- T.; Tibshirani, R.; Friedman, J,. (2009). The elements of statistical learning: data mining, inference, and prediction. Hastie

Complementary:

- R. O. Duda, P. E. Hart, D. G. Stark (2016). Pattern classification, Third Edition, John Wiley & Sons Inc.
- C. M. Bishop (2016). Pattern Recognition and Machine Learning, Springer
- Géron, A, (2019). Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: concepts, tools, and techniques to build intelligent systems - O'Reilly Media, Inc.
- K. P. Murphy (2020). Machine Learning: a probabilistic perspective, Second Edition, The MIT Press.
- Hastie, R. Tibshirani, J. Friedman (2011) The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Second Edition, Springer (Series in Statistics)
- David V. (2017). Machine Learning with Python: The Basics. CreateSpace Independent Publishing Platform