Syllabus
2024 - 2025

TECHNICAL SHEET OF THE SUBJECT

Data of the subject

Subject name	Automated Learning
Subject code	DTC-IMAT-221
Mainprogram	Bachelor's Degree in Mathematical Engineering and Artificial Intelligence
Involved programs	Grado en Ingeniería Matemática e Inteligencia Artificial [Second year]
Credits	6,0 ECTS
Type	Obligatoria (Grado)
Department	Department of Telematics and Computer Sciencies

Teacher Information

Teacher

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Teacher

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SPECIFIC DATA OF THE SUBJECT

Contextualization of the subject

Contribution to the professional profile of the degree

This is the first subject of data analysis and machine learning. Here we will cover the basic concepts in supervised and unsupervised learning, as well as some initial advanced concepts. The subject is designed to set the mathematical base of many machine learning techniques without losing the applied part of this field of research.

Prerequisites

Python programming, Algebra and Calculus (in one and multiple variables). Basic inference and statistics knowledge.

Competencies - Objectives

Competences

GENERALES

CG02	Capacidad de razonamiento abstracto y sentido crítico, así como de cálculo, modelado, simulación, optimización y predicción, para dar respuesta a los problemas planteados por la ciencia, la tecnología y la sociedad en general.
CG08	Capacidad para identificar, analizar y definir los elementos significativos que constituyen un problema vinculado a la explotación de datos e inteligencia artificial aplicada a las actividades empresariales para resolverlo con criterio y de forma efectiva
ESPECÍFICAS	
CE01	Capacidad para la resolución de los problemas matemáticos que puedan plantearse en la ingeniería, aplicando con aptitud los conocimientos sobre: álgebra lineal y multilineal, geometría, cálculo diferencial e integral, ecuaciones diferenciales, métodos numéricos, estadística y optimización.
CE22	Capacidad para analizar los datos mediante la aplicación de métodos y técnicas estadísticas, trabajando con datos cualitativos y cuantitativos.
CE24	Capacidad para identificar los modelos estadísticos y de investigación operativa más adecuados para la toma de decisiones
CE25	Conocimiento y capacidad para aplicar técnicas de inteligencia artificial, aprendizaje automático, aprendizaje profundo y aprendizaje por refuerzo que permiten extraer conocimiento de grandes volúmenes de datos.
CE27	Capacidad para diseñar programas que usen software estadístico y de investigación operativa conociendo su alcance y limitaciones

Learning outcomes	
RA1	Conocer los principios básicos del aprendizaje automático
RA2	Conocer, comprender y manejar el análisis de regresión como técnica para analizar dependencias entre variables
RA3	Conocer, comprender y manejar las técnicas de clasificación para analizar dependencias entre variables
RA4	Conocer, comprender y manejar las técnicas de reducción de la dimensión para analizar la interdependencia entre variables y simplificar problemas de aprendizaje
RA5	Conocer, comprender y manejar el análisis de conglomerados para estudiar la interdependencia en los datos bajo estudio
RA6	Ser capaz de seleccionar la técnica de aprendizaje automático más apropiada en función del problema a resolver
RA7	Conocer las técnicas evolutivas en inteligencia artificial
RA8	Conocer y manejar software estadístico para analizar un conjunto de datos multivariante utilizando técnicas de aprendizaje automático y extraer sus propias conclusiones

THEMATIC BLOCKS AND CONTENTS

Contents - Thematic Blocks

1. Foundations of machine learning.
2. Classification techniques.
3. Regression techniques.
4. Dimensionality reduction techniques.
5. Clustering.
6. Metaheuristics in machine learning. Genetic algorithms.

TEACHING METHODOLOGY

General methodological aspects of the subject

In-class Methodology: Activities

The training activities will be: **Expository and participatory master classes:** • The teacher will combine exposition of the theoretical contents with practical examples, both mathematical and programming. • The student will have some practical examples of code, generated inside and outside the classroom by the teacher. • Short tests will be proposed to evaluate the follow-up of the contents, making an impact on those parts with the greatest difficulties. **Practical exercises and problem solving:** • The student will solve problems posed by the teacher in person during the second weekly class session, promoting cooperative work dynamics. • Punctually, students (individually or in groups) will present their resolution of exercises in class and they will work on said resolution to improve it or discuss details of it. **Practical sessions using software:** • Practical sessions will be dedicated to solving doubts about the weekly exercises, where students will have time to work in the problems. • The practices will be graduated by difficulty, and students will implement them in a step-by-step basis with evaluating milestones. **Continuous performance evaluation activities:** • Tests will be carried out, they will develop complementary practices to the weekly ones and gamified challenges.	CG02, CG08, CE01, CE22, CE24, CE25, CE27

Non-Presential Methodology: Activities

The training activities will be: **Practical exercises and problem solving:** • The student will have specific problems focused on assimilating the theoretical concepts explained in the previous theory session to develop remotely. • The solution of problems will be uploaded to the platform the following week or exposed in class.	

Practical sessions using software: • Once the weekly practice is released after the corresponding theory session, the student will work on it remotely. The student must arrive at the face-to-face practice session with the objectives proposed in the statement at 80%. • In the classroom, the statement will be extended incrementally and the proposed milestones will be covered progressively. **Personal at-home study:** • The main objective of the remote work is to understand and comprehend the theoretical concepts of the subject, as well as to be able to put this knowledge into practice to solve different types of problems. • After each theoretical explanation, the teacher will upload all the developed codes to the web and the student will have to review them and ask "Whatif" questions to better assimilate the theoretical concepts. • Texts will be proposed for reading at home one or two weeks before the practical session in which the topics are covered. When appropriate, a short session of questions about said reading will be prepared.	CG02, CG08, CE01, CE22, CE24, CE25, CE27

SUMMARY STUDENT WORKING HOURS

CLASSROOM HOURS				
Clases magistrales expositivas y participativas	Ejercicios prácticos y resolución de problemas	Sesiones prácticas con uso de software	Tutorías para resolución de dudas	Actividades de evaluación continua del rendimiento
30.00	18.00	10.00	5.00	2.00
NON-PRESENTIAL HOURS				
Estudio personal	Trabajos			
95.00	20.00			
ECTS CREDITS: 6,0 (180,00 hours)				

EVALUATION AND CRITERIA

Evaluation activities	Evaluation criteria	Weight
Points based on the final and the inter-semester exams.	Inter-semester exam: 25% Final exam: 45% Percentages in terms of the total value to the final subject score (inter-semester - 2.5 points out of 10, final - 4 points out of 10)	70
Colaborative work	The collaboration, participation and successful completion of the weekly practices and the challenges posed throughout the course, both in collaborative and individual sessions. It also includes	

At-home exercises Practices	short class tests, as well as defenses of practices in the classroom. Part of these weekly deliverables will be aimed at preparing the student for the final project delivery.	20 %
Final project	Individual final project that the student will turn in at the end of the course.	10 %

Ratings

The final grade in the ordinary and extraordinary call of the subject will depend on the evaluation of the following activities:

- Final Note = 25% Intersemester Test + 45% Final Exam + 20% Weekly Practices + 10% Final Project
- From the 20% destined to weekly practices, 10% will be reserved to practices that prepare the student for the final project delivery.
- To pass the subject, students must obtain at least 5 points out of 10 in the final exam of the subject and in the final practice, both in the ordinary and extraordinary sessions.
- In case a student fails the final project but passes the final exam, the possibility of conducting an extraordinary delivery of the project will be considered.
- Failure to attend 15% of class hours or more may result in the impossibility of taking ordinary and extraordinary calls.
- The final practice will be INDIVIDUAL. Copies or plagiarism could result in the impossibility of taking the ordinary and extraordinary calls.
- In class you can work in a group, but the delivery of the weekly practices is done individually unless explicitly indicated otherwise.
- The extraordinary exam groups the marks of the intersemester exam and the final (70% of the mark).

BIBLIOGRAPHY AND RESOURCES

Basic Bibliography

• C. Bishop (2007). *Pattern Recognition and Machine Learning*. Springer.

• T. Hastie, R. Tibshirani, J. Friedman (2017) *The Elements of Statistical Learning: Data Mining, Inference and Prediction*. Springer.

• A. Gelman, J. Carlin, H. Stern, D. Dunson, A. Vehtari, D. Rubin (2021). *Bayesian Data Analysis* (3rd edition).

• S. Russell, P. Norvig (2022), *Artificial Intellicente: A Modern Approach* (4th edition).

Complementary Bibliography

- E. Alpaydin (2014). *Introduction to Machine Learning.* 3rd Ed. MIT Press
- S. Marsland (2015), *Machine Learning: An Algorithmic Perspective*, 2nd Ed., Chapman & Hall/Crc Machine Learning & Pattern Recognition.
- T. Mitchell (1997). *Machine Learning.* McGraw-Hill.

- G. James, D. Witten, T. Hastie & R. Tibshirani (2013). *An Introduction to Statistical Learning with Applications in R*. Springer.