Syllabus
2025 - 2026

TECHNICAL SHEET OF THE SUBJECT

Data of the subject	
Subject name	Deep learning
Subject code	DTC-IMAT-321
Mainprogram	Bachelor's Degree in Mathematical Engineering and Artificial Intelligence
Involved programs	Grado en Ingeniería Matemática e Inteligencia Artificial [Third year]
Credits	4,5 ECTS
Type	Obligatoria (Grado)
Department	Department of Telematics and Computer Sciencies
Coordinator	Óscar Llorente González

Teacher Information	
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SPECIFIC DATA OF THE SUBJECT

Contextualization of the subject

Contribution to the professional profile of the degree

This subject is foundational for the sequence of subjects Natural Language Processing I and II and Reinforcement Learning.

Prerequisites

Having passed a course on Machine Learning.

Competencies - Objectives

Competences

GENERALES	
CG04	Conocimientos básicos sobre el uso y programación de los ordenadores, sistemas operativos, bases de datos y programas informáticos con aplicación en ingeniería.

ESPECÍFICAS	
CE09	Capacidad para analizar, diseñar y resolver problemas reales a través de técnicas algorítmicas mediante un lenguaje de programación
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.
CE29	Capacidad para realizar el tratamiento y análisis de información de visión por ordenador, así como la extracción de características a partir de dicha información.
CE31	Capacidad para especificar, diseñar e implementar las técnicas de aprendizaje automático y profundo para la resolución de problemas complejos.

Learning outcomes

RA1	Entender la diferencia conceptual entre los modelos de aprendizaje automático y profundo
RA2	Ser capaz de establecer paralelismos y relaciones entre los modelos de aprendizaje profundo y las técnicas de inteligencia artificial clásicas, especialmente con aquellas relacionadas con la visión por ordenador
RA3	Entender el proceso de entrenamiento de las redes neuronales profundas y el efecto de los hiperparámetros
RA4	Ser capaz de seleccionar el modelo de aprendizaje profundo más adecuado para cada tipo de problema
RA5	Saber desarrollar modelos de aprendizaje profundo con las librerías open source más utilizadas y la forma de paralelizar el entrenamiento en hardware específico (GPU y TPU)

THEMATIC BLOCKS AND CONTENTS

Contents - Thematic Blocks

1. Deep Learning Frameworks
2. Foundations of Neural Networks
3. Convolutional Neural Networks (CNNs)
4. Optimization and Regularization
5. Recurrent Neural Networks (RNNs)
6. Unsupervised Deep Learning
7. Generative Adversarial Networks (GANs)

TEACHING METHODOLOGY

General methodological aspects of the subject

In-class Methodology: Activities

Training activities will include: **Explanatory and participatory lectures:** • The teacher will combine exposition of theoretical content with practical examples, both mathematical and programming. • Students will have practical code examples generated by the teacher inside and outside the classroom. • Short tests will be given to assess the understanding of the content, focusing on challenging parts. **Practical exercises and problem-solving:** • Students will solve problems presented by the teacher in person during the second weekly class session, fostering cooperative work dynamics. • Occasionally, students (individually or in groups) will present their exercise solutions in class, and discussions will focus on improving or clarifying details. **Practical sessions using software:** • Practical sessions will address questions about the weekly practice, allowing students to complete their tasks. • The difficulty of the practices will be graded, and students will implement them as they complete each milestone. **Continuous performance assessment activities:** • Tests will be conducted, complementary practices to the weekly ones will be developed, and gamified challenges will be introduced.	CG04, CE09, CE25, CE31, CE29

Non-Presential Methodology: Activities

The educational activities will be: **Practical exercises and problem solving:** • The student will have specific problems aimed at assimilating the theoretical concepts explained in the previous theory session to be developed in a non-presential manner. • The solution to the problems will be uploaded to the platform the following week or presented in class. **Practical sessions using software:** • Once the weekly practice is released after the corresponding theory session, the student will work on it in a non-presential manner. • The student must achieve 80% of the proposed objectives in the statement before the practical session.	CG04, CE09, CE25, CE31,

In the classroom, the statement will be expanded incrementally and the proposed milestones will be covered progressively. • Personal study: • The main objective of non-presential work is to understand and comprehend the theoretical concepts of the subject, as well as to be able to put these knowledge into practice to solve different types of problems. • After each theoretical explanation, the teacher will upload all developed codes to the website and the student must review them and pose "What if" questions to better assimilate the theoretical concepts. Texts will be assigned for reading at home one or two weeks before the practical session in which the topics are addressed. When appropriate, a short session of questions about the reading will be prepared.	CE29

SUMMARY STUDENT WORKING HOURS

CLASSROOM HOURS		
Clases magistrales expositivas y participativas	Tutorías para resolución de dudas	Actividades de evaluación continua del rendimiento
28.00	5.00	2.00
NON-PRESENTIAL HOURS		
Sesiones prácticas con uso de software	Estudio personal	Ejercicios prácticos y resolución de problemas
45.00	40.00	15.00
		ECTS CREDITS: 4,5 (135,00 hours)

EVALUATION AND CRITERIA

The use of AI to produce full assignments or substantial parts thereof, without proper citation of the source or tool used, or without explicit permission in the assignment instructions, will be considered plagiarism and therefore subject to the University's General Regulations.

Evaluation activities	Evaluation criteria	Weight
Midterm and final exam	• Mid-term Exam – 20% (50% theory & 50% practice) • Final Exam – 30% - (50% theory & 50% practice) Must have at least a grade of 4/10 in each part	50
Practice	• Mid-term Exam – 20% (50% theory & 50% practice) • Final Exam – 30% - (50% theory & 50% practice) Must have at least a grade of 4/10 in each part	50

Ratings

- Individual Projects – 20%
- Group project – 30%
- Mid-term Exam – 20% (50% theory & 50% practice)
- Final Exam – 30% - (50% theory & 50% practice) Must have at least a grade of 4/10 in each part

BIBLIOGRAPHY AND RESOURCES

Basic Bibliography

- Ian Goodfellow, Yoshua Bengio, & Aaron Courville (2016). *Deep Learning*. MIT Press.
- Stevens, E., Antiga, L.,, Viehmann, T. (2020). *Deep Learning with PyTorch*.