COMILLAS
UNIVERSIDAD PONTIFICIA
ICAI ICADE CIHS

Syllabus
2025 - 2026

TECHNICAL SHEET OF THE SUBJECT

Data of the subject	
Subject name	Machine Learning III: Unsupervised Learning Techniques and Network Analysis
Subject code	FCEE-BA-422
Mainprogram	Grado en Análisis de Negocios/Business Analytics
Involved programs	Grado en Análisis de Negocios/Business Analytics y Grado en Relaciones Internacionales [Fifth year] Grado en Análisis de Negocios/Business Analytics y Grado en Derecho [Fourth year] Grado en Administración y Dirección de Empresas y Grado en Análisis de Negocios/Business Analytics [Fourth year] Grado en Ingeniería en Tecnologías de Telecom. y Grado en Análisis de Negocios/Business Analytics [Fifth year]
Level	Reglada Grado Europeo
Quarter	Semestral
Credits	3,0 ECTS
Type	Obligatoria (Grado)
Department	Departamento de Métodos Cuantitativos
Coordinator	Lucía Barcos Redín
Office hours	Request an appointment. Tutoring schedules will be available when the timetables are finalized.

Teacher Information	
Teacher	
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SPECIFIC DATA OF THE SUBJECT

Contextualization of the subject

Contribution to the professional profile of the degree

Machine Learning provides techniques that help extract relevant information from data. With this information, companies can make decisions and carry out actions to improve different aspects of the business. This course deals with a part of Machine Learning, specifically unsupervised learning.

In addition, and given that most of the data available today comes in the form of text, we will study sombe tools needed to represent and analyze text, gaining insights from it.

Furthermore, social networks are currently a very important source of information. Therefore, this course will also examine basic network analysis techniques.

Prerequisites

Fundamentals of statistical data analysis

Algebra Basics

Programming Fundamentals

Business Analytics Fundamentals

Competencies - Objectives

Competences

GENERALES

CG02	Capacidad de análisis de datos masivos procedentes de diversas fuentes: texto, audio, numérica e imagen	
CG03	Resolución de problemas y toma de decisiones en un entorno de datos masivos tanto cuantitativos como cualitativos	
	RA1	Saber seleccionar para cada problema la técnica o técnicas de análisis de datos más adecuada para poder convertir los datos ¿en bruto¿ en información y ésta en conocimiento que ayude a la toma de decisiones y a mejorar la gestión.
CG04	Capacidad para elaborar proyectos e informes de manera oral y escrita, difundiendo estas ideas a través de canales digitales	
	RA1	Ser capaz de resumir, sintetizar y comunicar de una forma atractiva y eficaz los resultados de la aplicación de las técnicas de análisis de datos, incluso de las más sofisticadas, de manera que resulten comprensibles a destinatarios no técnicos y ayuden de forma eficiente a la toma de decisiones empresariales.

CG09	Compromiso ético en la sociedad de la información	
	RA1	Persigue la excelencia en las actuaciones profesionales
	RA2	Se preocupa por las consecuencias que su actividad y su conducta pueden tener para los demás
	RA3	Incorpora en su discurso y en sus propuestas de actuaciones, las consecuencias que las mismas pueden tener para los distintos stakeholders de una organización global
ESPECÍFICAS		
CE19	Conocer los fundamentos de las principales técnicas tanto de la estadística clásica (descriptiva e inferencial) como del data mining	
	RA4	Conocer los fundamentos de las principales técnicas de data mining NO supervisado
CE20	Saber modelizar un problema empresarial real que precise análisis de datos y seleccionar críticamente la técnica o combinación de técnicas más adecuada	
	RA3	Saber modelizar un problema de aprendizaje no supervisado
	RA4	Conocer las ventajas y limitaciones de los procedimientos de data mining y saber cómo enfocar un problema desde diferentes técnicas complementarias
CE21	Saber interpretar, evaluar y comunicar resultados derivados de las técnicas de análisis de datos así como usarlos para la ayuda en la gestión y la toma de decisiones empresariales	
	RA3	Saber interpretar, evaluar y comunicar los resultados derivados de un análisis que emplee técnicas de data mining no supervisado
CE22	Saber aplicar las técnicas de análisis de datos (tanto las de la estadística clásica como las técnicas de data mining) a un conjunto de datos reales, mediante el empleo de algún software apropiado para tal fin	
	RA1	Saber realizar un análisis descriptivo básico a un conjunto de datos reales usando software apropiado para tal fin
	RA4	Saber aplicar técnicas de data mining de aprendizaje NO supervisado a un conjunto de datos reales usando software apropiado para tal fin.

THEMATIC BLOCKS AND CONTENTS

Contents - Thematic Blocks
Unit 1. Introduction to unsupervised learning, Text Mining and social network analysis. Review of programming fundamentals.
Unit 2: Dimension Reduction Techniques, Principal component analysis (PCA)

Unit 3. Clustering Techniques: K-means and hierarquical clustering
Unit 4. Association rules and Recommendation Systems
Unit 5. Text representation and Text mining.
Unit 6. Network Analysis.

TEACHING METHODOLOGY

General methodological aspects of the subject
The course offers a practical approach, aimed at demonstrating the application of different techniques to the analysis of real-world problems in business or social contexts. In class sessions, after introducing the main theoretical concepts of each technique, students will work with different datasets to illustrate their practical application, using programming as the primary tool. In general, the activities carried out in this course will encourage a responsible and critical use of generative artificial intelligence tools, such as ChatGPT or Copilot. Following the classification by Perkins et al. (2024), a level 3 integration is adopted, which means that students may use these tools as support for understanding concepts, generating ideas, exploring alternative approaches, identifying and addressing coding errors, reformulating explanations, or improving the formal quality of their reports (wording, grammar, and style). However, the final code, analyses, and interpretations must clearly reflect the personal work of the student or the group, demonstrating a process of critical review and individual contribution. In all cases, students must transparently declare the use made of such tools, specifying at which stages and for what purpose they were employed. In this way, AI can serve as a complement that stimulates reflection, reinforces learning, and fosters creativity, but never as a substitute for analytical ability, independent programming, or the academic reasoning that characterizes university-level work. In particular, the following activities will be developed to work on the concepts and competencies mentioned above.

In-class Methodology: Activities	
Presentation of the main theoretical concepts Resolution and discussion of different practical examples/cases (using some programming language) General tutoring of practical application work Evaluation activities	CG02, CG03, CG04, CG09, CE19, CE20, CE21, CE22

Non-Presential Methodology: Activities	
Personal study Resolution of practical cases using diferent data sets and a programming language	CG02, CG03, CG04, CG09, CE19, CE20, CE21, CE22

SUMMARY STUDENT WORKING HOURS

CLASSROOM HOURS	
Lecciones de Carácter expositivo	Ejercicios y resolución de casos y de problemas
15.00	15.00

NON-PRESENTIAL HOURS		
Ejercicios y resolución de casos y de problemas	Estudios individual y/o en grupo, y lectura organizada	Trabajos monográficos y de investigación, individuales o colectivos
15.00	15.00	15.00
		ECTS CREDITS: 3,0 (75,00 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
Final Exam	Scores rated from 0 to 10 It is necessary to obtain **a minimum grade of 4.5 points** in the final exam in order to be able to average it with the rest of the items and pass the course	50
Teamwork (final project with a practical aplication) A misuse or fraudulent use of generative artificial intelligence (such as ChatGPT) will be cause for sanction (see NOTE below)	Scores rated from 0 to 10 A minimum level of quality is required in order to pass the course (applicable to both, ordinary and extraordinary calls)	20
Intermediate tests and other items of continuous evaluation (weekly practices, kahoots, etc.)	Scores rated from 0 to 10	30

Ratings

For the evaluation of both calls, ordinary and extaordinary, the same grading system will be followed (same weightings as previously shown). The philosophy that continuous work is part of the learning of the subject underlies.

It is necessary to obtain **a minimum grade of 4.5 points** (out of 10) in the final exam in order to be able to average it with the rest of the items and pass the course (apllicable to both, ordinary and extraordinary calls).

It is necessary a minimum level of quality in the final project in order to pass the course (applicable to both, ordinary and extraordinary calls). The final project is a way of demonstrating that the student has acquired the skills to apply theoretical concepts to real data by means of the appropriate analysis techniques and the necessary programming skills.

EXTRAORDINARY CALL (2nd): the same grading system as for the ordinary call will be applied, with the same weightings. Students who

have not submit or have failed the final project will have to submit it again in this call.

THIRD AND SUBSEQUENT CALLS: it will be necessary to submit a final project (25% of the grade) and take a final exam (75%). The submission of the final project is mandatory.

EXCHANGE STUDENTS (IN): same regime as regular students.

EXCHANGE STUDENTS (OUT): same system as for third and subsequent calls.

NOTE ON THE MISUSE OF GENERATIVE ARTIFICIAL INTELLIGENCE IN ALL ASSESSMENT ACTIVITIES

The improper, uncritical, or abusive use of generative artificial intelligence tools, without providing review, personal reflection, or academic justification, may be considered a violation or fraud within the assessment system. Such conduct will negatively affect the grade and may lead to disciplinary action. See also "General methodological aspects of the subject" subsection.

It is hereby reminded that, according to the University's General Regulations, Article 168.2.e, it is considered a serious offense to engage in "actions aimed at falsifying or defrauding the systems of academic performance assessment." The consequences of such conduct shall be "temporary expulsion of up to three months or the prohibition to sit examinations in the next examination period following the imposition of the sanction, in one or several courses in which the student is enrolled, [...] in addition to receiving a failing grade (0) in the respective course, [...] and the prohibition to sit examinations for that course the following examination period."

BIBLIOGRAPHY AND RESOURCES

Basic Bibliography

Material (presentations, code, etc.) availabe in Moodle Rooms

Shmueli, G., Bruce, G. , Yahav, I., Patel, N.R., Lichtendahl, K. (2018). Data Mining for Business Analytics. Concepts, Techniques and Applications in R. John Wiley & Sons, Inc

James, G., Witten, D., Hastie, T., and Tibshirani, R. (2021) . An Introduction to Statistical Learning: with Applications in R. New York, Springer.

Complementary Bibliography

Provost, F., & Fawcett, T. (2013). Data Science for Business: What you need to know about data mining and data-analytic thinking. O'Reilly Media, Inc.

Aggarwal C.C. (2016) Recommender Systems. The textbook. Springer

Kassambara, A. (2017). Practical guide to cluster analysis in R . Published by STHDA

Perkins, M., Furze, L., Roe, J., & MacVaugh, J. (2024). *The Artificial Intelligence Assessment Scale (AIAS): A Framework for Ethical Integration of Generative AI in Educational Assessment.* Journal of University Teaching and Learning Practice, 21(6). https://doi.org/10.53761/q3azde36.