ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

93001071 - Data Science Foundations And Applications

DEGREE PROGRAMME

09AQ - Master Universitario En Ingenieria De Telecomunicacion

ACADEMIC YEAR & SEMESTER

2023/24 - Semester 1

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1. Description

1.1. Subject details

Name of the subject	93001071 - Data Science Foundations And Applications
No of credits	2 ECTS
Type	Optional
Academic year ot the programme	Second year
Semester of tuition	Semester 3
Tuition period	September-January
Tuition languages	English
Degree programme	09AQ - Master Universitario en Ingenieria de Telecomunicacion
Centre	09 - Escuela Tecnica Superior De Ingenieros De Telecomunicacion
Academic year	2023-24

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Federico Alvarez Garcia (Subject coordinator)	D103	federico.alvarez@upm.es	Sin horario. Appointment arranged by email
Eduardo Lopez Gonzalo	C-330	eduardo.lopez@upm.es	Sin horario. Appointment arranged by email

Luis Alfonso Hernandez Gomez	C-330	luisalfonso.hernandez@upm.es	Sin horario. Appointment arranged by email
Jose Luis Blanco Murillo		jl.blanco@upm.es	Sin horario. Appointment arranged by email

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

3. Skills and learning outcomes *

3.1. Skills to be learned

CE1 - Capacidad para aplicar métodos de la teoría de la información, la modulación adaptativa y codificación de canal, así como técnicas avanzadas de procesado digital de señal a los sistemas de comunicaciones y audiovisuales.

CG1 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación.

CG2 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.

CG4 - Que los estudiantes sepan comunicar sus conclusiones ?y los conocimientos y razones últimas que las sustentan? a públicos especializados y no especializados de un modo claro y sin ambigüedades.

CG5 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

CT1 - Capacidad para comprender los contenidos de clases magistrales, conferencias y seminarios en lengua inglesa.

CT3 - Capacidad para adoptar soluciones creativas que satisfagan adecuadamente las diferentes necesidades planteadas.

CT4 - Capacidad para trabajar de forma efectiva como individuo, organizando y planificando su propio trabajo, de forma independiente o como miembro de un equipo.

CT5 - Capacidad para gestionar la información, identificando las fuentes necesarias, los principales tipos de documentos técnicos y científicos, de una manera adecuada y eficiente.

3.2. Learning outcomes

RA305 - Capability to design, develop and evaluate machine-learning techniques for a wide range of application areas

RA315 - capacility to understand the data science foundations and most relevant applications

RA194 - Conocer y aplicar técnicas de análsis de datos

RA10 - Saber realizar una presentación de carácter técnico, ante una audiencia de pares, que describa el trabajo realizado y sus resultados, de forma clara y bien estructurada, en el tiempo establecido, y usando un lenguaje preciso

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

4. Brief description of the subject and syllabus

4.1. Brief description of the subject

The course provides an overview of the scientific foundations and major technological challenges when extracting knowledge from the rich variety of signals and data provided by current and future communication systems. A main focus is placed on large, diverse, distributed and heterogeneous data sets that can be described by the Big Data paradigm. The course also presents application scenarios covering a wide range of industrial sectors: Cognitive Radio, Cognitive Networks, Future Internet Services, Social Networks and Multimedia Analytics, Internet-of-Things, Machine-to-Machine, Smart Cities, Smart Grids, Biomedical Applications, Biometrics and Forensics, Financial Services, Robotic systems through Case studies and debates which are addressed over a set of conferences bringing together leading experts in different sectors. Seminars are devoted to special topics such as Privacy and Big Data, Big Data Project Management or the connections between Next-Generation Communications, Internet-of-Things, Big Data Platforms and Cognitive and Knowledge-based Services.

The main outcome of the course will be to reinforce the applicability of the contents acquired during the MSc to the market, follow the trends and real cases from the big data applications market and increase the contact of the student with professionals from the sector. This will enhance their skills for developing their future professional carriers.

A basic outcome of this course will be to help students to have a global perspective on contents, complementarity and practical values of the different courses in this Track.

Another important course outcome will be to prepare students to critically assess the value of scientific and technological approaches to derive knowledge from data in real-world applications.

4.2. Syllabus

1. Presentation and study of several case studies and basic frameworks and languages

    1.1. Computation frameworks for BigData

    1.2. Programming BigData: practical cases, languages and basic tools. Lab.

    1.3. Applications of BigData for telecom operators

    1.4. Applications of BigData for fintech

    1.5. BigData business oportunities

    1.6. BigData in retail

    1.7. BigData next steps

2. Analysis of case studies and state of play

5. Schedule

5.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	**Introduction and case studies** Duration: 00:30 Lecture **Presentation and introduction to applications with AI: Machine Learning, Deep Learning and Reinforced Learning** Duration: 01:30 Lecture			
2	**Presentation and introduction to applications with AI: Machine Learning, Deep Learning and Reinforced Learning (continuation)** Duration: 02:00 Lecture			
3	**Lab 1: introduction to BigData and Machine Learning programming** Duration: 02:00 Cooperative activities			
4	**Lab 1 (continuation): introduction to BigData and Machine Learning programming** Duration: 02:00 Cooperative activities			
5				
6	**Conference / seminar 1** Duration: 01:30 Cooperative activities			**Conferences** Other assessment Continuous assessment Not Presential Duration: 01:00 **Conferences** Problem-solving test Final examination Presential Duration: 02:00
7				
8	**Conference / seminar 2** Duration: 01:30 Cooperative activities			
9				**Conferences** Other assessment Continuous assessment Not Presential Duration: 01:00

10				
11	**Data Science Applications** Duration: 02:00 Lecture			
12	**Data Science Frameworks** Duration: 02:00 Lecture			
13	**Analysis of case studies and trends** Duration: 01:30 Cooperative activities			
14	**Presentation of study cases** Duration: 02:00 Cooperative activities			**Elaboration of the analysis of one/several case studies** Individual presentation Continuous assessment Presential Duration: 00:20 **Elaboration of of the analysis of one or several cases** Individual presentation Final examination Presential Duration: 01:00
15				
16				
17				**Test / short questions on the theoretical content presented in the lectures and conferences** Written test Continuous assessment Presential Duration: 02:00 **Test / short questions on the theoretical content presented in the lectures and conferences** Written test Final examination Presential Duration: 02:00

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

* The schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution.

6. Activities and assessment criteria

6.1. Assessment activities

6.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
6	Conferences	Other assessment	No Presential	01:00	10%	5 / 10	CG4 CT1
9	Conferences	Other assessment	No Presential	01:00	10%	5 / 10	CG4 CT1
14	Elaboration of the analysis of one/several case studies	Individual presentation	Face-to-face	00:20	40%	4 / 10	CG4 CT4 CG2 CG1
17	Test / short questions on the theoretical content presented in the lectures and conferences	Written test	Face-to-face	02:00	40%	4 / 10	CT3 CT4 CT1 CT5 CG2 CG4 CG5 CG1 CE1

6.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
6	Conferences	Problem-solving test	Face-to-face	02:00	20%	5 / 10	CG4 CT4 CG1
14	Elaboration of of the analysis of one or several cases	Individual presentation	Face-to-face	01:00	40%	4 / 10	CG4 CT4 CG2 CG1
17	Test / short questions on the theoretical content presented in the lectures and conferences	Written test	Face-to-face	02:00	40%	4 / 10	CT3 CT4 CT1 CT5 CG2 CG5 CG1 CE1

6.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Conferences proof or equivalent work request	Other assessment	Face-to-face	02:00	20%	5 / 10	CG4 CT1
Recovering: Elaboration of the analysis of one/several case studies	Group work	Face-to-face	00:20	40%	4 / 10	CG4 CT4 CG2 CG1
Test / short questions on the theoretical content presented in the lectures and conferences	Written test	Face-to-face	02:00	40%	4 / 10	CG4 CT3 CT4 CT1 CT5 CG2 CG5 CG1 CE1

6.2. Assessment criteria

Evaluation will assess if students have acquired all the competences of the subject. Evaluation activities that assess learning outcomes that cannot be evaluated through a single exam can be carried out along the semester (conferences and work in pairs).

Extraordinary examination will be carried out with the same approach.

The evaluation will be based on 3 elements:

1.- Conferences and seminars attendance (weight 20%) Note: the attendance to the 85% of the conferences is mandatory to get the minimal mark 5/10

2.- Elaboration of the analysis of one/several case studies (written) and presentation in the classroom to the rest of students (weight 40%) - minimal mark 4/10

3.- Test / short questions on the theoretical content presented in the lectures, seminar and conferences (weight 40%) - minimal mark 4 / 10

According to the nature of this subject, the evaluation will be done following the scheme presented above. This subject does not include the possibility to carry out an assessment without attending the conferences and seminars, and the elaboration of the analysis requested.

Extraordinary examination:

- Same approach, but the activities should be carried out during the ordinary period (conferences can only take place in the indicated times and cannot carried out again in the extraordinary exam period, therefore extra activity to cover the conferences will be requested) to be carried out again for the extraordinary exam if the minimal mark is not reached.

7. Teaching resources

7.1. Teaching resources for the subject

Name	Type	Notes
Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners	Bibliography	This book provides a view into BigData with the overview of big data and its notable characteristics; high performance computing architectures for analytics; comprehensive coverage of data mining, text analytics; and machine learning predictive modeling

8. Other information

8.1. Other information about the subject

In this subject we allign with the the Sustainable Development Goals (SDG) 4, 5 and 9.

Especifically this subject will support in the activities to be carried out:

4.4 By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship

5.B Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women

9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending