



POLITÉCNICA

INTERNATIONAL
CAMPUS OF
EXCELLENCE

COORDINATION PROCESS OF
LEARNING ACTIVITIES
PR/CL/001



E.T.S. de Ingenieros de
Telecomunicación

ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

93000949 - Application Projects

DEGREE PROGRAMME

09AT - Master Universitario En Teoria De La Señal Y Comunicaciones

ACADEMIC YEAR & SEMESTER

2022/23 - Semester 2

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1. Description

1.1. Subject details

Name of the subject	93000949 - Application Projects
No of credits	4 ECTS
Type	Optional
Academic year of the programme	First year
Semester of tuition	Semester 2
Tuition period	February-June
Tuition languages	English
Degree programme	09AT - Master Universitario en Teoría de la Señal y Comunicaciones
Centre	09 - Escuela Técnica Superior De Ingenieros De Telecomunicacion
Academic year	2022-23

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Juan Parras Moral	C-301	j.parras@upm.es	Sin horario. Appointment arranged by email
Luis Alfonso Hernandez Gomez (Subject coordinator)	C-330	luisalfonso.hernandez@upm.es	Sin horario. Appointment arranged by email

Santiago Zazo Bello	C-326	santiago.zazo@upm.es	Sin horario. Appointment arranged by email
Carlos Roberto Del Blanco Adan	C-306	carlosrob.delblanco@upm.es	Sin horario. Appointment arranged by email
Jose Luis Blanco Murillo	C303	jl.blanco@upm.es	Sin horario. Appointment arranged by email
Mateo Jose Camara Largo	C-301	mateo.camara@upm.es	Sin horario. Appointment arranged by email
Juan Ignacio Godino Llorente	C-312	ignacio.godino@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. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

- Aprendizaje Predictivo Y Descriptivo
- Técnicas De OptimizaciÓn Para Análisis De Datos Masivos
- Series Temporales
- Laboratorio De Técnicas De Aprendizaje Automático

3.2. Other recommended learning outcomes

- Previous exposure to a programming language, such as MATLAB, R or Python
- Previous basic knowledge of Machine Learning, Deep Learning and Artificial Intelligence

4. Skills and learning outcomes *

4.1. Skills to be learned

CB06 - 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

CB07 - 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

CB08 - Que los estudiantes sean capaces de integrar conocimientos y enfrentarse a la complejidad de formular juicios a partir de una información que, siendo incompleta o limitada, incluya reflexiones sobre las responsabilidades sociales y éticas vinculadas a la aplicación de sus conocimientos y juicios

CB09 - 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

CB10 - 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

CE02 - Evaluar y sintetizar los resultados de un trabajo en equipo en proyectos relacionados con la teoría de la señal y las comunicaciones, en un entorno internacional.

CE03 - Valorar y contrastar la utilización de las diferentes técnicas disponibles para la resolución de problemas reales dentro del área de teoría de la señal y comunicaciones.

CT01 - Capacidad para comprender los contenidos de clases magistrales, conferencias y seminarios en lengua inglesa

CT03 - Capacidad para adoptar soluciones creativas que satisfagan adecuadamente las diferentes necesidades planteadas

CT04 - Capacidad para trabajar de forma efectiva como individuo, organizando y planificando su propio trabajo, de forma independiente o como miembro de un equipo

CT05 - Capacidad para gestionar la información, identificando las fuentes necesarias, los principales tipos de documentos técnicos y científicos, de una manera adecuada y eficiente

CT06 - Capacidad para emitir juicios sobre implicaciones económicas, administrativas, sociales, éticas y

medioambientales ligadas a la aplicación de sus conocimientos

4.2. Learning outcomes

RA34 - Capability to develop and evaluate machine-learning techniques and to design big data learning systems

RA22 - Knowing conduct a technical presentation before an audience of peers, describing the work and results clearly and well structured, on time, and using precise language

RA32 - Capability for planning, design and implement applications, incorporating signal processing, statistical analysis and machine learning

* 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.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

The main objective of this course is to acquire some basic skills required when developing data science, machine learning, deep learning or in general AI Projects and Applications. The course will cover from the discussion on Ethical issues when designing AI projects to an introduction to AI development environments using cloud platforms such as Google Cloud Platform, AWS or Azure. Course activities may be given as seminars, workshops or conferences provided by industrial and/or academic partners,

Activities may change every course but as an example of possible ones we give the following examples:

- Ethical issues that may arise when developing big data analysis, machine learning or Artificial Intelligence applications.
- Integration of Machine Learning and Artificial Intelligence into Big Data Platforms.
- Introduction to Google Cloud Platform, Spark, Databricks and Vertex AI
- Deploying Machine Learning models using AWS Sagemaker.
- Introduction to Azure Machine Learning Studio
- Explainable and Interpretable AI

- Data Analysis, Visualization and Geospatial Data Seminar.

- Seminar on Deep Generative Models: Variational Autoencoders, Normalizing Flows, Generative adversarial networks (GANs)
- Seminars where students starting their Master Theses can present and debate with other students about the topic, methodology, machine learning development strategies, etc.
- Seminars or conferences from different companies or academia. These activities will be mainly directed to learn from real use-cases the value of Data Analysis and Visualization or the role of Machine Learning in different application areas.
- Meet-up with former Master students to learn from first-hand current job opportunities and possibilities for professional development.

5.2. Syllabus

1. Issues when developing Machine Learning and Artificial Intelligence
 - 1.1. Major problems in Data Science: Bias, Privacy
 - 1.2. Ethical Issues
2. Developing Machine Learning and AI projects on Cloud Platforms
 - 2.1. Google Cloud, Spark, Databricks twitter streaming analytics case study
 - 2.2. Developing AI projects in Google Cloud Vertex AI
 - 2.3. Developing ML applications in AWS Sagemaker
 - 2.4. ML workflow on Azure Machine Learning Studio
3. Data Analysis, Visualization and Geospatial Data
 - 3.1. Introduction to visualization and tools
 - 3.2. Practical use cases
4. Advanced Deep Learning techniques
 - 4.1. Deep Generative Models: Variational Autoencoders, Normalizing Flows, Generative adversarial networks (GANs)
 - 4.2. Differentiable Digital Signal Processing
5. Seminars on projects and applications using ML, DL and AI
 - 5.1. Developing Interpretable and Explainable AI
 - 5.2. Telecommunication applications
 - 5.3. Internet-of-Things

5.4. Robotics

5.5. Smart Grids

5.6. Predictive maintenance and preventive maintenance

5.7. Financial Trading Systems

6. Schedule

6.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	Course introduction Duration: 03:00 Lecture			
2	Ethical issues when developing Machine Learning and Artificial Intelligence Duration: 03:00 Lecture			
3	Students' presentations and debate Duration: 03:00 Cooperative activities			
4	Developing Machine Learning and AI projects on Cloud Platforms Duration: 03:00 Lecture			
5		Google Cloud, Spark, Databricks twitter streaming analytics case study Duration: 03:00 Laboratory assignments		
6		Developing AI projects in Google Cloud Vertex AI Duration: 03:00 Laboratory assignments		
7		Developing ML applications in AWS Sagemaker Duration: 03:00 Laboratory assignments		
8		ML workflow on Azure Machine Learning Studio Duration: 03:00 Laboratory assignments		
9	Seminar: Data Analysis and Visualization Duration: 03:00 Lecture			
10		Seminar: Geospatial Data analysis and visualization Duration: 03:00 Laboratory assignments		
11	Visualization data: Students' presentations Duration: 03:00 Cooperative activities			

12	Seminar: Advanced Deep Learning Duration: 03:00 Lecture			
13		Seminar: Advanced Deep Learning Duration: 03:00 Laboratory assignments		
14	Conferences: debating the role of Machine Learning in different application areas Duration: 03:00 Cooperative activities			
15				
16				
17				Final Evaluation: reporting course activities Individual work Continuous assessment Not Presential Duration: 00:00 Final Evaluation: report on the development of AI Projects and Applications Individual work Final examination Not Presential Duration: 00:00 Written test on the development of AI Projects and Applications Written test Final examination Presential Duration: 01:30

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.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Final Evaluation: reporting course activities	Individual work	No Presential	00:00	100%	5 / 10	CT01 CB07 CT03 CB06 CE02 CT04 CT06 CB08 CB09 CE03 CT05 CB10

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Final Evaluation: report on the development of AI Projects and Applications	Individual work	No Presential	00:00	70%	5 / 10	CB08 CB09 CT01 CB07 CT03 CB06 CE02 CT04 CT06 CE03 CT05 CB10
17	Written test on the development of AI Projects and Applications	Written test	Face-to-face	01:30	30%	3.5 / 10	CT01 CB08 CB09 CB07 CT03 CB06 CE02 CT04 CT06 CE03 CT05

CB10

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Report on the development of AI Projects and Applications	Individual work	Face-to-face	00:00	70%	5 / 10	CB08 CB09 CT01 CB07 CT03 CB06 CE02 CT04 CT06 CE03 CT05 CB10
Written test on the development of AI Projects and Applications	Written test	Face-to-face	01:30	30%	3.5 / 10	CB08 CB09 CT01 CB07 CT03 CB06 CE02 CT04 CT06 CE03 CT05 CB10

7.2. Assessment criteria

Evaluation will assess if students have acquired all the competences of the subject. Thus, evaluation through extraordinary assessment will be carried out considering all the evaluation techniques used in ordinary evaluation (EX, ET, TG, etc.).

Progressive evaluation will be the preferred assessment method as it will be suited to the optimum learning process along the course. Progressive evaluation will require a minimum of 75% class attendance. It will consist of a Course Report with a detailed presentation of the learning outcomes from all the activities along the course. Course Report will represent 100% of final grade and it must be due by the final exam date.

This Report that must also include every achievement, new skill or knowledge derived from seminars and conferences. All the activities must be clearly supported by detailed descriptions, and, when applicable, including generated materials (student's presentations, programs, notebooks, dashboards, etc.).

The Course Report will be worked on and continuously supervised during the course through several course assignments that will be announced in Moodle. In that way students will receive updated feedback on their progress and continuous effort along the course. Students will be required to attend to specific presentations and final presentations to defend their work as it is going to be developed in their Report.

Global or final evaluation should be followed by those students that cannot attend regularly to class and cannot guaranty a minimum of 75% class attendance. Final evaluation will consist of:

- The generation of a detailed Report to demonstrate students' skills to develop Machine Learning, Deep Learning and, in general Artificial Intelligence for different Projects and Applications. The evaluation of this Report will represent 70% of final grade and it must be due by the final exam date, although students can submit draft versions before that date can they can receive feedback on their work.
- A written test scheduled on the final exam date. In this test, students will be evaluate on their fundamental skills on data analysis and visualization tools, cloud platforms and technologies etc. for developing different Projects and Applications using Machine Learning, Deep Learning and Artificial Intelligence. The result of this test will represent 30% of final grade.

Evaluation through extraordinary assessment will consist of:

- A Report to demonstrate students' develop Machine Learning, Deep Learning and, in general Artificial Intelligence for different Projects and Applications (70% of final grade)
- A written test on fundamental skills on data analysis and visualization tools, cloud platforms and technologies etc. for developing different Projects and Applications using Machine Learning, Deep Learning

and Artificial Intelligence (30% of final grade).

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Weapons of Math Destruction	Bibliography	O. Neill, C. (2016). Weapons of Math Destruction. How Big Data Increases Inequality and Threatens Democracy.
Ethics for robots: How to design a moral algorithm	Bibliography	Leben, Derek. Routledge, 2018.
Deep Learning	Bibliography	Deep Learning. An MIT Press book. Ian Goodfellow and Yoshua Bengio and Aaron Courville
Unsupervised Feature Learning and Deep Learning	Web resource	http://ufldl.stanford.edu/tutorial/
Master the art of data science	Web resource	https://datascience.ibm.com/
Python for data analysis	Bibliography	McKinney, Wes. Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. " O'Reilly Media, Inc.", 2012.
Introducing Tableau	Web resource	https://www.tableau.com
Google Cloud Tutorials	Web resource	https://cloud.google.com/gcp/getting-started
Google Cloud AI Fast, large scale and easy to use AI services	Web resource	https://cloud.google.com/products/machine-learning/
Databricks Unified Analytics	Web resource	https://databricks.com/
Aprendizaje automático en AWS	Web resource	https://aws.amazon.com/es/machine-learning/

AWS Sagemaker	Web resource	https://aws.amazon.com/es/sagemaker/
Azure ML Studio	Web resource	https://azure.microsoft.com/en-us/free/machine-learning/

9. Other information

9.1. Other information about the subject

This course will contribute to Goal 4.4 in Sustainable Development Goals (SDGs) 2030 United Nations Agenda providing our students to have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship.

This course will also help students to learn the crucial role of including ethical principles in the development of data analysis projects. This will contribute to learn how to design data projects to contribute to several SDGs goals: end poverty (Goal 1), promote well-being (Goal 2), and promote sustainable management of water, energy, economic growth and industrialization (Goals 5, 6, 7, and 8) as well as to reduce inequality among countries (Goal 10).

Due to the value of data in developing future applications in a broad range of areas, the course will also contribute to SDG Goal 17 Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development, in particular working on systemic issues on Data monitoring and accountability (17.18 and 17.19)