



POLITÉCNICA

INTERNATIONAL
CAMPUS OF
EXCELLENCE

COORDINATION PROCESS OF
LEARNING ACTIVITIES
PR/CL/001



E.T.S. de Ingenieros de
Telecomunicacion

ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

93000944 - Large-scale Media Analytics

DEGREE PROGRAMME

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

ACADEMIC YEAR & SEMESTER

2023/24 - Semester 2

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1. Description

1.1. Subject details

Name of the subject	93000944 - Large-Scale Media Analytics
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	2023-24

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Alberto Belmonte Hernandez (Subject coordinator)	D-112.2	alberto.belmonte@upm.es	Sin horario. Appointment arranged by email
Federico Alvarez Garcia	D-103	federico.alvarez@upm.es	Sin horario. Appointment arranged by email

Jose Manuel Menendez Garcia	C-300	jm.menendez@upm.es	Sin horario. Appointment arranged by email
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* 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

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

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

CE01 - Analizar y aplicar técnicas para el diseño y desarrollo avanzado de equipos y sistemas, basándose en la teoría de la señal y las comunicaciones, en un entorno internacional

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.

CT05 - 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

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

RA43 - Ability to develop basic applications in relevant current use cases in the media industry (media search, content recommendation, etc.)

RA42 - knowledge on Big Data technologies and their application to multimedia content

RA41 - Ability to select and apply adequate machine learning techniques to large-scale multimedia datasets and evaluate their performance

* 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

Current data analysis applications require the management of extremely large collections of heterogeneous multimedia data. The extraction of knowledge from these huge datasets is a difficult problem with a broad scope.

This subject aims at presenting the most relevant techniques and methodologies for large scale multimedia analysis.

In particular, we will discuss the application of widely used feature extraction and machine learning techniques (dimensionality reduction, classification, clustering) to text, image, audio, spatio-temporal and tabular data. Heterogeneous information networks and suitable data mining techniques will also be described.

Big data technologies will be introduced, including efficient acquisition, storage and processing of huge amounts of heterogeneous data. Some of the described techniques will be applied to relevant use cases, such as content search, summarization, content recommendation...

Practical sessions will be proposed in which students will apply these tools to real datasets and become familiar with powerful analysis frameworks. Finally a final project will be developed by students applying the techniques reviewed in the lessons over a selected dataset.

4.2. Syllabus

1. Exploratory Data Analysis

- 1.1. Analytic graphics and techniques for exploratory data analysis
- 1.2. Data transformation and dimensionality reduction, clustering and outliers detection
- 1.3. Algorithms analysis, hyperparameters, evaluation metrics
- 1.4. Explainable AI
- 1.5. Lab session: EDA and analysis applied to a dataset

2. Image and Audio Feature Extraction

- 2.1. Computer vision and image descriptors: Histograms, Texture, Spatio-Temporal
- 2.2. Image/Video Movement
- 2.3. Deep Learning for image feature extraction
- 2.4. Audio signal and audio descriptors
- 2.5. Deep Learning for audio analysis
- 2.6. Lab session: Image/audio search and classification

3. Recommender Systems

- 3.1. Simple recommenders
- 3.2. Content-based recommenders
- 3.3. Collaborative filtering
- 3.4. Hybrid recommenders
- 3.5. Lab session: Simple, content-based and collaborative filtering recommenders

4. Text analysis

- 4.1. Text mining and cleaning
- 4.2. Vector space models
- 4.3. Keywords extraction and summarization
- 4.4. Text clustering, classification and recommendation

- 4.5. Lab session: Text analytics
- 5. Machine/Deep Learning Applications with multimedia content
 - 5.1. Advanced techniques for multimedia content
 - 5.2. Recent deep learning architectures for multimedia content
- 6. Project development in pairs or individually
 - 6.1. Project guidance
 - 6.2. Project results and presentation

5. Schedule

5.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	Chapter 1 - EDA and data understanding Duration: 03:00 Lecture			
2		Lab 1 - EDA and data understanding Duration: 03:00 Laboratory assignments		
3	Chapter 2 - Image feature extraction Duration: 03:00 Lecture			
4	Chapter 2 - Image/Video and audio feature extraction Duration: 03:00 Lecture			
5		Lab 2 - Image/Video/Audio feature extraction Duration: 03:00 Laboratory assignments		
6	Chapter 3 - Recommender systems Duration: 03:00 Lecture			
7		Lab 3 - Recommender systems Duration: 03:00 Laboratory assignments		
8	Chapter 4 - Text feature extraction Duration: 03:00 Laboratory assignments			
9		Lab 4 - Text feature extraction Duration: 03:00 Laboratory assignments		
10	Chapter 5 - Advanced techniques Duration: 03:00 Lecture			
11		Project session: Project proposal and dataset used Duration: 03:00 Laboratory assignments		Lab sessions report Problem-solving test Continuous assessment Not Presential Duration: 00:00
12		Project session: Feature extraction techniques Duration: 03:00 Laboratory assignments		

13		Project session: Preliminary results Duration: 03:00 Laboratory assignments		
14		Project session: Final projects ideas Duration: 00:00 Laboratory assignments		
15				Project development and presentation Group work Continuous assessment Presential Duration: 00:30
16				
17				Exam: Test / Short Questions Written test Continuous assessment Presential Duration: 01:30 Final exam Written test Final examination Presential Duration: 01:30 Lab sessions report Problem-solving test Final examination Not Presential Duration: 00:00

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
11	Lab sessions report	Problem-solving test	No Presential	00:00	25%	4 / 10	CB07 CT05
15	Project development and presentation	Group work	Face-to-face	00:30	35%	5 / 10	CB06 CB07 CB09 CB10 CT05 CE01 CE02
17	Exam: Test / Short Questions	Written test	Face-to-face	01:30	40%	4 / 10	CB07 CB09 CB10 CT05 CE01

6.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Final exam	Written test	Face-to-face	01:30	75%	5 / 10	CB06 CB07 CB09 CB10 CT05 CE01 CE02
17	Lab sessions report	Problem-solving test	No Presential	00:00	25%	5 / 10	CB07 CT05

6.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
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Extraordinary assessment	Written test	Face-to-face	01:30	75%	5 / 10	CB06 CB07 CB09 CB10 CT05 CE01 CE02
Lab sessions report	Problem-solving test	Face-to-face	00:00	25%	5 / 10	CB07 CT05

6.2. Assessment criteria

Students will be qualified through progressive evaluation. Evaluation will assess if students have acquired all the competences of the subject. Thus, evaluation through final assessment will be carried out considering all the evaluation techniques used in continuous evaluation (EX, ET, TG, etc.), and will be celebrated in the exam period approved by Junta de Escuela for the current academic semester and year. Evaluation activities that assess learning outcomes that cannot be evaluated through a single exam can be carried out along the semester.

The **progressive evaluation** will be based on the following elements:

- Attend and follow the theory and practical sessions. 4 laboratory sessions will be held. Each lab will incorporate some questions that need to be solved during the session. After the laboratory sessions a homework over a different dataset need to be done (mandatory practices).
- Develop a final project in pairs or individually and present the results to the classroom. This activity includes the reading and extracting of the main ideas from relevant papers in the field. Project will include a report and the performance of a presentation to the group (15 minutes plus 5 minutes discussion) by each pair/individual of students. During the project, a presentation of the actual results will be carry out to the rest of the class (project follow up) every week.
- Individual exam: questions on the theoretical content of the course, selected papers and code.

All parts are required to pass the subject.

The weight of such activities, **all mandatory** are:

- Lab sessions (individual) 25% - minimal threshold 4/10
- Project (pairs/individual) 35% - minimal threshold 5/10
- Exam [Test / Short questions] (individual) 40% - minimal threshold of 4/10

In the event that a student does not pass Lab sessions or/and Project, the student will be **evaluated a final exam** with the requirement of delivering the laboratory practices tasks (homework). In this case the percentages for the evaluations are the following:

- Lab sessions (individual) 25% - minimal threshold 5/10
- Exam [Test / Short questions] (individual) 75% - minimal threshold of 5/10

Extraordinary examination will be carried out by a final exam and the requirement of completing the laboratory practices tasks (homework). The minimum percentages to pass the subject in this case are:

- Lab sessions (individual) 25% - minimal threshold 5/10
- Exam [Test / Short questions] (individual) 75% - minimal threshold of 5/10

7. Teaching resources

7.1. Teaching resources for the subject

Name	Type	Notes
Pentreath, N. (2015). Machine Learning with Spark. Packt Publishing Ltd.	Bibliography	Machine Learning with Spark
Segaran, T. (2007). Programming collective intelligence: building smart web 2.0 applications. " O'Reilly Media, Inc."	Bibliography	Programming collective intelligence: building smart web 2.0 applications
Aggarwal, C. C., & Zhai, C. (2012). Mining text data. Springer Science & Business Media.	Bibliography	Mining text data. Springer Science & Business Media.
Python Data Science Handbook - Jake VanderPlas	Bibliography	Data analysis
Python for Data Analysis, Data Wrangling with Pandas, NumPy, and IPython - Wes Mckinney	Bibliography	Data analysis

Hands On Machine Learning with Scikit Learn and TensorFlow - Aurelien Geron	Bibliography	Machine Learning and Deep Learning
Data Analysis and Visualization Using Python Analyze Data to Create Visualizations for BI Systems - Dr. Ossama Embarak	Bibliography	Data analysis and visualization
Introduction to Machine Learning with Python: A Guide for Data Scientists - Sarah Guido	Bibliography	Artificial intelligence

8. Other information

8.1. Other information about the subject

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

Especially 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.