



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

93000942 - Data science foundations and applications

DEGREE PROGRAMME

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

ACADEMIC YEAR & SEMESTER

2018/19 - Semester 1

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### Learning guide

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DRAFT VERSION

## 1. Description

### 1.1. Subject details

|                                       |  |
|---------------------------------------|--|
| <b>Name of the subject</b>            | 93000942 - Data science foundations and applications               |
| <b>No of credits</b>                  | 2 ECTS   |
| <b>Type</b>                           | Optional   |
| <b>Academic year of the programme</b> | First year   |
| <b>Semester of tuition</b>            | Semester 1   |
| <b>Tuition period</b>                 | September-January  |
| <b>Tuition languages</b>              | English  |
| <b>Degree programme</b>               | 09AT - Master universitario en teoria de la señal y comunicaciones |
| <b>Centre</b>                         | 09 - Escuela Tecnica Superior de Ingenieros de Telecomunicacion    |
| <b>Academic year</b>                  | 2018-19  |

## 2. Faculty

### 2.1. Faculty members with subject teaching role

| <b>Name and surname</b>                          | <b>Office/Room</b> | <b>Email</b>                     | <b>Tutoring hours *</b>                          |
|--|--------------------|----------------------------------|--|
| Federico Alvarez Garcia<br>(Subject coordinator) | D103               | federico.alvarez@upm.es          | Sin horario.<br>Appointment<br>arranged by email |
| Luis Alfonso Hernandez<br>Gomez                  | C-330              | luisalfonso.hernandez@upm.<br>es | Sin horario.<br>Appointment<br>arranged by email |

|                          |       |                           |  |
|--------------------------|-------|---------------------------|--|
| Eduardo Lopez Gonzalo    | C-330 | eduardo.lopez@upm.es      | Sin horario.<br>Appointment<br>arranged by email |
| Jose Luis Blanco Murillo |       | jl.blanco@upm.es          | Sin horario.<br>Appointment<br>arranged by email |
| Guillermo Cisneros Perez |       | guillermo.cisneros@upm.es | Sin horario.<br>Appointment<br>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

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

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

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

### 3.2. Learning outcomes

RA2 - Capacidad para planificar, diseñar y realizar aplicaciones que integren técnicas de tratamiento de señal, análisis estadístico y aprendizaje automático sobre datos masivos.

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.

## 4. Brief description of the subject and syllabus

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### 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 opportunities
  - 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 | Face-to-face classroom activities   | Face-to-face laboratory activities | Other face-to-face activities | Assessment activities |
|------|---|------------------------------------|-------------------------------|-----------------------|
| 1    | <b>Introduction and case studies</b><br>Duration: 00:30<br>Lecture<br><br><b>Presentation and introduction to applications with AI: Machine Learning, Deep Learning and Reinforced Learning</b><br>Duration: 01:30<br>Lecture |                                    |                               |                       |
| 2    | <b>Lab 1: introduction to BigData and Machine Learning programming</b><br>Duration: 02:00<br>Cooperative activities   |                                    |                               |                       |
| 3    | <b>Lab 1 (continuation): introduction to BigData and Machine Learning programming</b><br>Duration: 02:00<br>Cooperative activities  |                                    |                               |                       |
| 4    | <b>Lab 1 (continuation): introduction to BigData and Machine Learning programming</b><br>Duration: 02:00<br>Cooperative activities  |                                    |                               |                       |
| 5    |   |                                    |                               |                       |
| 6    | <b>Conference / seminar 4</b><br>Duration: 01:30<br>Cooperative activities  |                                    |                               |                       |
| 7    |   |                                    |                               |                       |
| 8    | <b>Conference / seminar 5</b><br>Duration: 01:30<br>Cooperative activities  |                                    |                               |                       |
| 9    |   |                                    |                               |                       |
| 10   |   |                                    |                               |                       |
| 11   | <b>Data Science Foundations</b><br>Duration: 02:00<br>Lecture   |                                    |                               |                       |
| 12   | <b>Data Science Applications</b><br>Duration: 02:00<br>Lecture  |                                    |                               |                       |
| 13   | <b>Data Science Frameworks</b><br>Duration: 02:00<br>Lecture  |                                    |                               |                       |



|    |   |  |  |  |
|----|---|--|--|--|
| 14 | <b>Analysis of case studies and trends</b><br>Duration: 01:30<br>Cooperative activities |  |  |  |
| 15 |   |  |  |  |
| 16 |   |  |  |  |
| 17 |   |  |  | exam on the contents of the conferences<br>and lectures, and presentation of<br>individual homeworks.<br>Other assessment<br>Continuous assessment and final<br>examination<br>Duration: 02:00 |

The independent study hours are training activities during which students should spend time on individual study or individual assignments.

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 subject schedule is based on a previous theoretical planning of the subject plan and might go through experience some unexpected changes along throughout the academic year.

## 6. Activities and assessment criteria

### 6.1. Assessment activities

#### 6.1.1. Continuous assessment

| Week | Description   | Modality         | Type         | Duration | Weight | Minimum grade | Evaluated skills   |
|------|---|------------------|--------------|----------|--------|---------------|--|
| 17   | exam on the contents of the conferences and lectures, and presentation of individual homeworks. | Other assessment | Face-to-face | 02:00    | 100%   | 5 / 10        | CB08<br>CB09<br>CT01<br>CB07<br>CT03<br>CB06<br>CT04<br>CE01<br>CT06<br>CE03<br>CT05<br>CB10 |

#### 6.1.2. Final examination

| Week | Description   | Modality         | Type         | Duration | Weight | Minimum grade | Evaluated skills   |
|------|---|------------------|--------------|----------|--------|---------------|--|
| 17   | exam on the contents of the conferences and lectures, and presentation of individual homeworks. | Other assessment | Face-to-face | 02:00    | 100%   | 5 / 10        | CB08<br>CB09<br>CT01<br>CB07<br>CT03<br>CB06<br>CT04<br>CE01<br>CT06<br>CE03<br>CT05<br>CB10 |

### 6.1.3. Referred (re-sit) examination

| Description   | Modality         | Type         | Duration | Weight | Minimum grade | Evaluated skills   |
|---|------------------|--------------|----------|--------|---------------|--|
| exam on the contents of the conferences and lectures, and presentation of individual homeworks. | Other assessment | Face-to-face | 02:00    | 100%   | 5 / 10        | CB08<br>CB09<br>CT01<br>CB07<br>CT03<br>CB06<br>CT04<br>CE01<br>CT06<br>CE03<br>CT05<br>CB10 |

### 6.2. Assessment criteria

Students will be qualified through continuous evaluation by default. According to the "Normativa de Evaluación del Aprendizaje de la Universidad Politécnica de Madrid", students willing to renounce to continuous evaluation must complete the Moodle task entitled "Renounce to continuous evaluation" before the end of the 4th week from the subject start date.

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.

Extraordinary examination will be carried out exclusively by the final examination method.

The continuous evaluation will be based on 3 elements, covered in the evaluation:

- 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 50%) - minimal mark 4/10
- 3.- Test / short questions on the theoretical content presented in the lectures (weight 30%) - minimal mark 3.5 / 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 a continuous assessment without attending the conferences and seminars, and the elaboration of the analysis requested.

Students opting out the continuous assessment should take part in the final exam which will consist of:

- 50% of the mark the assessment of the presentation of the analysis of one case study which will be done during the exam, under the same conditions of the students taking part in the continuous assessment (minimal mark 4 out of 10 in this part)
- 20% showing proof of the attendance to the conferences, or the student should carry out an oral exam on the conferences contents (minimal mark 5 out of 10 in this part)
- 30% Test / short questions on the theoretical content presented in the lectures - minimal mark 3.5 out of 10

Extraordinary exam:

- 50% of the mark: the assessment of the presentation of the analysis of one case study which will be done during the exam, under the same conditions of the students taking part in the continuous assessment (minimal mark 4 out of 10 in this part)

- 20% showing proof of the attendance to the conferences, or that the student have acquired the competences through oral exam on the contents (minimal mark 5 out of 10 in this part)
- 30% Test / short questions on the theoretical content presented in the lectures (minimal mark 3.5 out of 10)

## 7. Teaching resources

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### 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 |