Course guide  
230625 - MLEARN - Machine Learning From Data

Unit in charge: Barcelona School of Telecommunications Engineering  
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree:  
MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Optional subject).  
MASTER'S DEGREE IN AERONAUTICAL ENGINEERING (Syllabus 2014). (Optional subject).  
MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Compulsory subject).

Academic year: 2023  
ECTS Credits: 5.0  
Languages: English

LECTURER

Coordinating lecturer: Consultar aquí / See here:  
https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadores/responsables-assignatura

Others: Consultar aquí / See here:  
https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadores/professorat-assignat-idioma

PRIOR SKILLS

Calculus, algebra and signal processing

REQUIREMENTS

none

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:  
1. Ability to apply information theory methods, adaptive modulation and channel coding, as well as advanced techniques of digital signal processing to communication and audiovisual systems.

Transversal:  
2. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

3. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

4. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

TEACHING METHODOLOGY

Blackboard classes and deliverables
LEARNING OBJECTIVES OF THE SUBJECT

Learning objectives of the subject:
The objectives are to introduce students to the main algorithms for learning from data / machine learning, and for understanding how to make the algorithms work with real data.

Learning results of the subject:
- Ability to understand the general principles of the machine learning algorithms.
- Ability to distinguish the relevant properties of algorithms for a given problem.
- Knowledge of the main machine learning techniques

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours small group</td>
<td>13,0</td>
<td>10.40</td>
</tr>
<tr>
<td>Self study</td>
<td>86,0</td>
<td>68.80</td>
</tr>
<tr>
<td>Hours large group</td>
<td>26,0</td>
<td>20.80</td>
</tr>
</tbody>
</table>

Total learning time: 125 h

CONTENTS

**Introduction to the techniques of machine learning**

**Description:**
Description of the types of machine learning models based on data, emphasizing structure, geometry and the relationship with deep learning.

**Related activities:**
Individual Deliverable + individual practices

**Full-or-part-time:** 33h
Theory classes: 8h
Self study: 25h

**Bayesian Framework**

**Description:**
A classification model based on Bayes' formula is presented, its plausibility. From the general formula the typology of classification models obtained is explained. In parallel geometric interpretations are presented. The Bayesian framework is generalized to the approximation of functions and parametric regression.

**Related activities:**
Individual Deliverable + Individual practices

**Full-or-part-time:** 18h
Theory classes: 6h
Self study: 12h
### Linear Discriminant Functions and lineal regression

**Description:**
Based on the simplest model geometry, it is a hyperplane, the duality between classification and function approximation is presented. Geometric model is related to the Bayesian framework and underlying assumptions are clarified. The various ways of calculating the model parameters are also presented.

**Related activities:**
Individual Deliverable + Individual practices

**Full-or-part-time:** 7h
- Theory classes: 2h
- Self study: 5h

### Multilayer perceptron and radial basis functions

**Description:**
The underlying geometry of the models of multilayer perceptron and radial basis functions is described. From the geometrical properties of the models and the types of problems that can be solved with these models are derived. Then are presented the algorithms to estimate the parameters. Also the conditions under which they can function properly. A Bayesian interpretation of the geometry associated with the two models is given. The techniques that make deep learning work are described.

**Related activities:**
Individual Deliverable + Individual practices

**Full-or-part-time:** 21h
- Theory classes: 7h
- Self study: 14h

### Exploratory Data analysis

**Description:**
Different techniques are presented to study how the data are distributed in order to choose the technique of 'machine learning' more suitable for the data type.

**Related activities:**
Individual Deliverable

**Full-or-part-time:** 3h
- Theory classes: 1h
- Self study: 2h

### Advanced methods for machine learning

**Description:**
Advanced SVM methodologies, unsupervised techniques, k-nearest neighbours, decision trees, random forests and boosting are described.

**Related activities:**
Weekly essay and ML practical application

**Full-or-part-time:** 39h
- Theory classes: 13h
- Self study: 26h
ACTIVITIES

EXTENDED ANSWER TEST (FINAL EXAMINATION)

Weekly deliverables

Description:
weekly essay + lab practice at home

Full-or-part-time: 2h
Theory classes: 2h

GRADING SYSTEM

Autumn term: Lab work : 25% . Delivery of homework :20%. Participation in the proposed ML challenge :15%. Final exam:40%

Spring term: Max of ((40% deliverables, 60% final exam), (100% final exam))

BIBLIOGRAPHY

Basic:

Complementary: