Course guides
230625 - MLEARN - Machine Learning From Data

Last modified: 10/05/2021

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 ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Compulsory subject).

Academic year: 2021 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: Primavera: ENRIC MONTE MORENO
Tardor: JOSEP VIDAL

Others: ENRIC MONTE MORENO
JOSEP VIDAL
VERONICA VILAPLANA

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

Type	Hours	Percentage
Self study	86,0	68.80
Hours large group	26,0	20.80
Hours small group	13,0	10.40

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 ie 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:
- Géron, A. Hands-on machine learning with scikit-learn and tensorflow: concepts, tools, and techniques to build intelligent systems [on line]. Sebastopol, CA: O'Reilly Media, Inc, 2017 [Consultation: 10/07/2019]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=4822582. ISBN 9781491962299.
- Duda, R.O.; Hart, P-E.; Stork, D.G. Pattern classification. 2nd ed. New York: John Wiley & Sons, 2001. ISBN 0471056693.
- Hastie, T.; Tibshirani, R.; Friedman, J. The elements of statistical learning: data mining, inference, and prediction [on line]. 2nd ed. New York: Springer, 2009 [Consultation: 21/05/2020]. Available on: http://dx.doi.org/10.1007/978-0-387-84858-7. ISBN 9780387848570.
- Bishop, C.M. Neural networks for pattern recognition. Oxford: Clarendon Press, 1995. ISBN 0198538642.
- Bishop, C.M. Pattern recognition and machine learning. New York: Springer, 2006. ISBN 0387310738.

Complementary:
- Cherkassky, V.; Mulier, F. Learning from data: concepts, theory and methods [on line]. 2nd ed. New York: John Wiley, 2007 [Consultation: 10/07/2019]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=313393. ISBN 0471681822.