Last update: 04-07-2019

230625 - MLEARN - Machine Learning From Data

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering

Teaching unit: 739 - TSC - Department of Signal Theory and Communications

Academic year: 2019

Degree: MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Teaching unit Compulsory)
MASTER'S DEGREE IN INFORMATION AND COMMUNICATION TECHNOLOGIES (Syllabus 2009). (Teaching unit Optional)
MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Teaching unit Optional)

ECTS credits: 5 Teaching languages: English

Teaching staff

Coordinator: 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

Total learning time: 125h	Hours large group:	39h	31.20%
	Hours medium group:	0h	0.00%
	Hours small group:	0h	0.00%
	Guided activities:	0h	0.00%
	Self study:	86h	68.80%

Content

Introduction to the techniques of machine learning	Learning time: 33h Theory classes: 8h Self study : 25h

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

Bayesian Framework	Learning time: 18h Theory classes: 6h Self study : 12h

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

Linear Discriminant Functions and lineal regression	Learning time: 7h Theory classes: 2h Self study : 5h

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

Multilayer perceptron and radial basis functions	Learning time: 21h Theory classes: 7h Self study : 14h

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

Exploratory Data analysis	Learning time: 3h Theory classes: 1h Self study : 2h

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

Advanced methods for machine learning	Learning time: 39h Theory classes: 13h Self study : 26h

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

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Planning of activities

EXTENDED ANSWER TEST (FINAL EXAMINATION)

Weekly deliverables	Hours: 2h Theory classes: 2h

Description:
weekly essay + lab practice at home

Qualification 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:

Hastie, T.; Tibshirani, R.; Friedman, J. The elements of statistical learning: data mining, inference, and prediction. 2nd ed. New York: Springer, 2009. ISBN 9780387848570.

Bishop, C.M. Neural networks for pattern recognition. Oxford: Clarendon Press, 1995. ISBN 0198538642.

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.

Bishop, C.M. Pattern recognition and machine learning. New York: Springer, 2006. ISBN 0387310738.

Duda, R.O.; Hart, P-E.; Stork, D.G. Pattern classification. 2nd ed. New York: John Wiley & Sons, 2001. ISBN 0471056693.

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.