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270222 - AA2 - Machine Learning 2

Coordinating unit: 270 - FIB - Barcelona School of Informatics

Teaching unit: 723 - CS - Department of Computer Science

Academic year: 2019

Degree: BACHELOR'S DEGREE IN DATA SCIENCE AND ENGINEERING (Syllabus 2017). (Teaching unit Compulsory)

ECTS credits: 6 Teaching languages: Catalan

Degree competences to which the subject contributes

Specific:

CE1. Skillfully use mathematical concepts and methods that underlie the problems of science and data engineering.

CE2. To be able to program solutions to engineering problems: Design efficient algorithmic solutions to a given computational problem, implement them in the form of a robust, structured and maintainable program, and check the validity of the solution.

CE3. Analyze complex phenomena through probability and statistics, and propose models of these types in specific situations. Formulate and solve mathematical optimization problems.

CE4. Use current computer systems, including high performance systems, for the process of large volumes of data from the knowledge of its structure, operation and particularities.

CE5. Design and apply techniques of signal processing, choosing between different technological tools, including those of Artificial vision, speech recognition and multimedia data processing.

CE6. Build or use systems of processing and comprehension of written language, integrating it into other systems driven by the data. Design systems for searching textual or hypertextual information and analysis of social networks.

CE8. Ability to choose and employ techniques of statistical modeling and data analysis, evaluating the quality of the models, validating and interpreting them.

CE9. Ability to choose and employ a variety of automatic learning techniques and build systems that use them for decision making, even autonomously.

Generical:

CG1. To design computer systems that integrate data of provenances and very diverse forms, create with them mathematical models, reason on these models and act accordingly, learning from experience.

CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.

CG3. Work in multidisciplinary teams and projects related to the processing and exploitation of complex data, interacting fluently with engineers and professionals from other disciplines.

CG4. Identify opportunities for innovative data-driven applications in evolving technological environments.

CG5. To be able to draw on fundamental knowledge and sound work methodologies acquired during the studies to adapt to the new technological scenarios of the future.

Transversal:

CT3. Efficient oral and written communication. Communicate in an oral and written way with other people about the results of learning, thinking and decision making; Participate in debates on topics of the specialty itself.

CT5. Solvent use of information resources. Manage the acquisition, structuring, analysis and visualization of data and information in the field of specialty and critically evaluate the results of such management.

CT7. Third language. Know a third language, preferably English, with an adequate oral and written level and in line with the needs of graduates.

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Teaching methodology

The theory classes introduce all the knowledge, techniques, concepts and results necessary to reach a well-founded level. These concepts are put into practice in the laboratory classes, in which the student learns to develop machine learning solutions to real problems of a certain complexity.

In the problem classes we will delve deeper to understand the theory by problem solving or by extending the concepts already seen.

In the laboratory classes, code is provided in various computing environments that allow solving a problem completely with the technique or techniques corresponding to the current topic. This laboratory also serves as a guide for the corresponding part of the practical works developed by the students.

Learning objectives of the subject

1.Organize the flow of solution of a machine learning problem, analyzing the possible options and elegint the mismatches to the problem
2.Decide, defend and criticise a solution for a machine learning problem, arguing the strong and weak points of appropriation.
3.Know and know how to apply advanced techniques to solve non-supervised learning problems, especially clustering.
4.Know how to apply deep feed-forward multilayer neuronal network techniques to solve complex supervised learning problems.
5.Know and apply advanced techniques of learning methods based on kernel functions, for the resolution of learning problems, both supervised and unsupervised.
6.To know and to know how to apply the advanced techniques for the resolution of learning problems by reinforcement, and its relation with techniques of deep learning.
7.Know how to identify problems involving signal processing, such as data in the form of audio, image or video, or a combination of you, and solve them with advanced computer learning techniques.
8.Know how to identify problems involving human or non-human speech processing, such as data in the form of audio or text, or a combination thereof, and solve them with advanced computational learning techniques

Study load

Total learning time: 150h	Hours large group:	30h	20.00%
	Hours small group:	30h	20.00%
	Guided activities:	0h	0.00%
	Self study:	90h	60.00%

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Content

Introduction to Machine learning

Degree competences to which the content contributes:

Description:
Description and approach of the problems attacked by machine learning. Identification of modern areas and problems (data, scalability, heterogeneity, etc). Introduction to modern and advanced techniques covered in progress. Advanced application examples.

Introduction to kernel based methods

Degree competences to which the content contributes:

Description:
Kernel ridge regression. Feature maps. Introducció als espais de Hilbert. Representer Theorem. Spectral clustering.

Non-standard kernel functions

Degree competences to which the content contributes:

Description:
Non-standard kernel functions: refresh and expand the kernel function definition. Learning in RKHS. Kernel functions for text analysis, graphs, biomedical data (-OMIC).

Advanced kerned methods

Degree competences to which the content contributes:

Description:
Advanced kernel methods: kPCA, KFDA, Relevance Vector Machines. Advanced applications.

Deep neural network methods (I)

Degree competences to which the content contributes:

Description:
Deep feed-forward neural networks: multilayer perceptron (MLP), convolutional neural networks (CNN) and their training algorithms.

Deep methods for neural netwroks (II)

Degree competences to which the content contributes:

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Description:
Recurrent LSTM deep networks and its training algorithmd

Deep Reinforcement Learning

Degree competences to which the content contributes:

Description:
Deep Reinforcement Learning. Aplicacions.

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Planning of activities

Development of subject 1	Hours: 3h Theory classes: 1h Practical classes: 0h Laboratory classes: 0h Guided activities: 0h Self study: 2h
Specific objectives: 1	

Development of subject 2	Hours: 18h Theory classes: 4h Practical classes: 0h Laboratory classes: 4h Guided activities: 0h Self study: 10h
Specific objectives: 3	

Development of subject 3	Hours: 18h Theory classes: 4h Practical classes: 0h Laboratory classes: 4h Guided activities: 0h Self study: 10h
Specific objectives: 5	

Development of subject 4	Hours: 27h Theory classes: 6h Practical classes: 0h Laboratory classes: 6h Guided activities: 0h Self study: 15h
Specific objectives: 2, 5, 7, 8	

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Development of subject 5	Hours: 27h Theory classes: 6h Practical classes: 0h Laboratory classes: 6h Guided activities: 0h Self study: 15h
Specific objectives: 2, 4, 7, 8	

Development of subject 6	Hours: 27h Theory classes: 6h Practical classes: 0h Laboratory classes: 6h Guided activities: 0h Self study: 15h
Specific objectives: 1, 2, 4, 7, 8	

Development of subject 7	Hours: 15h Theory classes: 3h Practical classes: 0h Laboratory classes: 4h Guided activities: 0h Self study: 8h
Specific objectives: 1, 2, 3, 6, 7, 8	

Practicum evaluatio	Hours: 2h Guided activities: 2h Self study: 0h
Specific objectives: 1, 2	

Practicum report	Hours: 3h Guided activities: 3h Self study: 0h
Specific objectives: 1, 2, 3, 4, 5, 6, 7, 8	

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Qualification system

The subject is evaluated through a partial exam, a final exam and practical work in which real problems are addressed, writing the corresponding reports.

The partial exam will correspond to the kernel-based methods part and will discard this part of the syllabus.

The final grade is calculated as:

Grade = 0,4 * Jobs + 0,6 * (Final + Partial) / 2

For the students who attend the re-evaluation, the re-evaluation exam note will include the two parts of the syllabus and will substitute 0.6 * (Final + Partial) / 2.

Bibliography

Basic:

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

Shawe-Taylor, J.; Cristianini, N. Kernel methods for pattern analysis. Cambridge: Cambridge University Press, 2004. ISBN 0521813972.

Goodfellow, I.; Bengio, Y.; Courville, A. Deep learning [on line]. Cambridge, Massachusetts: The MIT Press, 2016 [Consultation: 22/07/2019]. Available on: <http://www.deeplearningbook.org/>. ISBN 9780262035613.