

Course guides

270651 - ML - Machine Learning

Last modified: 16/02/2022

Unit in charge:	Barcelona School of Informatics		
Teaching unit:	723 - CS - Department of Computer Science.		
Degree:	MASTER'S DEGREE IN INNOVATION AND RESEARCH IN INFORMATICS (Syllabus 2012). (Optional subject).		
Academic year: 2021	ECTS Credits: 6.0	Languages: English	

LECTURER

Coordinating lecturer:	MARTA ARIAS VICENTE
Others:	Segon quadrimestre: MARTA ARIAS VICENTE - 11 MARIO MARTÍN MUÑOZ - 11 RAQUEL LEANDRA PÉREZ ARNAL - 11

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

CEC1. Ability to apply scientific methodologies in the study and analysis of phenomena and systems in any field of Information Technology as well as in the conception, design and implementation of innovative and original computing solutions.

CEC2. Capacity for mathematical modelling, calculation and experimental design in engineering technology centres and business, particularly in research and innovation in all areas of Computer Science.

Generical:

CG1. Capability to apply the scientific method to study and analyse of phenomena and systems in any area of Computer Science, and in the conception, design and implementation of innovative and original solutions.

CG3. Capacity for mathematical modeling, calculation and experimental designing in technology and companies engineering centers, particularly in research and innovation in all areas of Computer Science.

CG5. Capability to apply innovative solutions and make progress in the knowledge to exploit the new paradigms of computing, particularly in distributed environments.

Transversal:

CTR6. REASONING: Capacity for critical, logical and mathematical reasoning. Capability to solve problems in their area of study. Capacity for abstraction: the capability to create and use models that reflect real situations. Capability to design and implement simple experiments, and analyze and interpret their results. Capacity for analysis, synthesis and evaluation.

Basic:

CB6. Ability to apply the acquired knowledge and capacity for solving problems in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study.

TEACHING METHODOLOGY

The course introduces the most important concepts in machine learning and its most relevant techniques with a solid foundation in math. All the theory and concepts are illustrated and accompanied by real-world examples and code using open source libraries.

The theory is introduced in lectures where the teacher exposes the concepts, and during the lab sessions students will see many examples on how to apply the methods and theory learned, as well as code their own solutions to exercises proposed by the teacher.

Students have to work on a course project using a real-world dataset.

LEARNING OBJECTIVES OF THE SUBJECT

1. Formulate the problem of (machine) learning from data, and know the different machine learning tasks, goals and tools.
2. Organize the workflow for solving a machine learning problem, analyzing the possible options and choosing the most appropriate to the problem at hand
3. Ability to decide, defend and criticize a solution to a machine learning problem, arguing the strengths and weaknesses of the approach. Additionally, ability to compare, judge and interpret a set of results after making a hypothesis about a machine learning problem
4. Understand and know how to apply least squares techniques for solving supervised learning problems
5. Understand and know how to apply techniques for single and multilayer neural networks for solving supervised learning problems
6. Understand and know how to apply support vector machines for solving supervised learning problems
7. Understand and formulate different theoretical tools for the analysis, study and description of machine learning systems
8. Understand and know how to apply the basic techniques for solving unsupervised learning problems

STUDY LOAD

Type	Hours	Percentage
Laboratory classes	27,0	18.00
Theory classes	27,0	18.00
Self study	96,0	64.00

Total learning time: 150 h

CONTENTS

Introduction to Machine Learning

Description:

General information and basic concepts. Overview to the problems tackled by machine learning techniques. Supervised learning (classification and regression), unsupervised learning (clustering and density estimation) and semi-supervised learning (reinforcement and transductive). Examples.

Supervised machine learning theory

Description:

The supervised Machine Learning problem setup. Classification and regression problems. Bias-variance tradeoff. Regularization. Overfitting and underfitting. Model selection and resampling methods.

Linear methods for regression

Description:

Error functions for regression. Least squares: analytical and iterative methods. Regularized least squares. The Delta rule. Examples.

Linear methods for classification

Description:

Error functions for classification. The perceptron algorithm. Novikoff's theorem. Separations with maximum margin. Generative learning algorithms and Gaussian discriminant analysis. Naive Bayes. Logistic regression. Multinomial regression.



Artificial neural networks

Description:

Artificial neural networks: multilayer perceptron and radial basis functions network. Application to classification and to regression problems.

Kernel functions and support vector machines

Description:

Definition and properties of Kernel functions. Support vector machines for classification and regression problems.

Unsupervised machine learning

Description:

Unsupervised machine learning techniques. Clustering algorithms: EM algorithm and k-means algorithm.

Ensemble methods

Description:

Bagging and boosting methods, with an emphasis on Random Forests

ACTIVITIES

Theory lectures

Specific objectives:

1, 3

Full-or-part-time: 47h

Theory classes: 27h

Self study: 20h

Lab lectures

Specific objectives:

2, 3

Full-or-part-time: 54h

Laboratory classes: 27h

Self study: 27h



Mid-term exam (test)

Specific objectives:

1, 2, 3

Full-or-part-time: 9h 30m

Guided activities: 1h 30m

Self study: 8h

Final exam

Specific objectives:

1, 2, 3, 4, 5, 6, 7, 8

Full-or-part-time: 18h

Guided activities: 2h

Self study: 16h

Course project

Specific objectives:

1, 2, 3, 4, 5, 6, 7, 8

Full-or-part-time: 25h

Self study: 25h

GRADING SYSTEM

The course is graded as follows:

P = Grade of mid-term test-type exam

F = Score of the final exam

L = Score for the practical work

final grade = 20% P + 40% F + 40% L

BIBLIOGRAPHY

Basic:

- Bishop, C.M. Pattern recognition and machine learning. New York: Springer, 2006. ISBN 0387310738.
- Cherkassky, V.S.; Mulier, F. Learning from data: concepts, theory, and methods. 2nd ed. New York: John Wiley, 2007. ISBN 0471681822.
- Alpaydin, E. Introduction to machine learning. 3th ed. Cambridge, Massachusetts ; London: The MIT Press, 2014. ISBN 9780262028189.
- Murphy, K.P. Machine learning: a probabilistic perspective. Cambridge, Mass.: MIT Press, 2012. ISBN 9780262018029.

Complementary:

- Haykin, S.S. Neural networks and learning machines. 3rd ed. Upper Saddle River: Prentice Hall, 2009. ISBN 9780131471399.
- Hastie, T.; Tibshirani, R.; Friedman, J. The elements of statistical learning: data mining, inference, and prediction. 2nd ed. New York: Springer, 2009. ISBN 9780387848570.
- Duda, R.O.; Hart, P.E.; Stork, D.G. Pattern classification. 2nd ed. New York: John Wiley & Sons, 2001. ISBN 0471056693.



RESOURCES

Hyperlink:

- <http://cran.r-project.org/>
- http://videlectures.net/Top/Computer_Science/Machine_Learning/
- <http://www.academicearth.org/courses/machine-learning>