UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Course guide
205239 - NT - Numerical Tools in Machine Learning for Aeronautical Engineering

Last modified: 02/04/2024

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 748 - FIS - Department of Physics.

Degree: BACHELOR'S DEGREE IN AEROSPACE TECHNOLOGY ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN AEROSPACE VEHICLE ENGINEERING (Syllabus 2010). (Optional subject).

Academic year: 2024 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Alex Ferrer Ferré

Others:

TEACHING METHODOLOGY

Each session consists in a theoretical part of 1 hour and a practical part of 1.5 hour. In the practical part, a set of small exercises will be solved and discussed in class to fix the main ideas and concepts of the session, and the take-home assignments will be discussed.

LEARNING OBJECTIVES OF THE SUBJECT

This course is an introduction to Machine Learning. The main objective is to learn several numerical techniques used in this field.
After learning some basics in optimization and statistics, the course will focus on understanding the numerical algorithms used for solving some of the most important problems in Machine Learning: linear regression, logistic regression, clustering, k-means, support vector machine, principal component analysis, EM, neuronal networks and others.
Finally, the techniques learned during the course will be applied to some problems that appear in Aeronautical engineering.

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	40.00
Self study	45,0	60.00

Total learning time: 75 h

CONTENTS

Module 1: Introduction to Machine Learning

Description:
1. Introduction to Machine Learning. Basics in Optimization. Basics in Statistics.
2. Basics in Python and Jupyter.

Full-or-part-time: 15h
Theory classes: 8h
Self study : 7h

Module 2: Supervised learning

Description:
Introduction. Linear regression. Classification and logistic regression. Naive Bayes. Neural networks. Support vector machine and kernel trick. K-nearest neighbors. Bayes learning: MAP and MLE.

Full-or-part-time: 25h
Theory classes: 10h
Self study : 15h

Module 3: Unsupervised learning

Description:
Introduction. Clustering. K-means algorithm. Principal component analysis. EM algorithm. Kernel density estimation. Non-negative matrix factorization. Autoencoders.

Full-or-part-time: 25h
Theory classes: 10h
Self study : 15h

Module 4: Application to Aeronautical Engineering

Description:
Aeronautical engineering problems solved by Machine learning algorithms

Full-or-part-time: 10h
Theory classes: 2h
Self study : 8h

GRADING SYSTEM

3 or 4 take-home assignments (50% of the final grade).
1 final project (50% of the final grade).

BIBLIOGRAPHY

Basic:
- Goodfelow, Ian, Bengio, Yoshua; Courville, Aaron. Deep learning : adaptive computation and machine learning series [on line]. Cambridge, Massachusetts: The MIT Press, 2016 [Consultation: 21/10/2024]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=6287197. ISBN 9780262035613.
- Boyd, Stephen P; Vandenberghe, Lieven. Convex optimization. Cambridge: Cambridge University Press, 2004. ISBN 9780521833783.
- Nocedal, Jorge; Wright, Stephen J. Numerical optimization [on line]. 2nd ed. Berlin: Springer, cop. 2006 [Consultation: 23/04/2024]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-0-387-40065-5. ISBN 0387303030.
- Allaire, G. Shape optimization by the homogenization method. New York [etc.]: Springer, cop. 2002. ISBN 0387952985.