Course guide
820055 - IAAE - Artificial Intelligence for Engineering

Last modified: 14/06/2023

Unit in charge: Barcelona East School of Engineering
Teaching unit: 723 - CS - Department of Computer Science.

Degree: BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Optional subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: GERARD ESCUDERO BAKX

Others: Primer quadrimestre:
GERARD ESCUDERO BAKX - Grup: M11
RAMON SANGÜESA SOLE - Grup: M11

Segon quadrimestre:
GERARD ESCUDERO BAKX - Grup: M10
RAMON SANGÜESA SOLE - Grup: M10

PRIOR SKILLS

Computer Science course (Python) or equivalent.

REQUIREMENTS

There are no previous requirements.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Transversal:
1. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

TEACHING METHODOLOGY

The course consists of four classroom hours per week in lab: two correspond to theoretical expositions combined with guided exercises performed with a computer and two of laboratory practice.
Should carry out a non-contact techniques are applied to a problem studied for the degree.
The course uses the narrative approach (theory) by 10%, a problem-based by 10%, attendance group work (laboratory) by 20%, non-contact individual work by 27% and non-contact work group by 33%.

LEARNING OBJECTIVES OF THE SUBJECT

The course aims:
- To familiarize students with basic concepts in the fields of Machine Learning and Pattern Analysis
- To provide tools of Artificial Intelligence that will be useful to apply them to engineering problems

STUDY LOAD

Type	Hours	Percentage
Hours small group	60,0	40.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Introduction

Description:
Patterns analysis from the standpoint of artificial intelligence
Applications in the fields of engineering and technology

Related activities:
Lecture
Practices 1 and 2: introduction to python

Full-or-part-time: 16h
Theory classes: 2h
Laboratory classes: 6h
Self study : 8h

Characterization data using attributes

Description:
Data representation
Treatment of missing values and normalization
Distance measures
Feature extraction: principal component analysis (PCA), independent component analysis (ICA)

Related activities:
lectures
Practice 3: representation, normalization, nul values, covariances, correlations, binarization, distance matrices, similarities, etc.
Practice 4: PCA + ICA

Full-or-part-time: 16h
Theory classes: 4h
Laboratory classes: 4h
Self study : 8h

Clustering

Description:
k-means, PAM
Dendrograms
Introduction to Spectral Clustering

Related activities:
Lectures
Practice 5: kmeans and PAM
Practice 6: dendrogram

Full-or-part-time: 30h
Theory classes: 14h
Laboratory classes: 6h
Self study : 10h

Optimization

Description:
Simulated annealing and gradient descent
Genetic Algorithms

Related activities:
Lectures
Practice 7: simulated annealing and gradient descent
Practice 8: genetic algorithms

Full-or-part-time: 26h
Theory classes: 4h
Laboratory classes: 4h
Other activities: 10h
Self study : 8h

Classification

Description:
Based on distances: k Nearest Neighbours, linear classifier and supervised k-means
Based on probabilities: Naïve Bayes and introduction to Maximum Entropy
Based on rules: Decision Trees (splitting and entropy) and an introduction to AdaBoost
Linear classifier with kernels and Support Vector Machines (SVMs)

Related activities:
Lectures
Practice 9: classifiers based on distances
Practice 10: classifiers based on probabilities
Practice 11: rule-based classifiers
Practice 12: SVMs

Full-or-part-time: 46h
Theory classes: 18h
Laboratory classes: 10h
Self study : 18h

Theory of statistical estimation

Description:
Bias and variance
Test Protocols: single and cross-validation
Statistical tests
Measures of evaluation

Related activities:
Lecture

Full-or-part-time: 8h
Theory classes: 4h
Self study : 4h

Other problems in the pattern analysis

Description:
Regression, anomaly detection, projections...

Related activities:
Lecture

Full-or-part-time: 8h
Theory classes: 4h
Self study : 4h

GRADING SYSTEM

The evaluation will be conducted through the assessment by teachers of different laboratory practice (which will mean 50%) and class work (which will represent the other 50%).
This subject has neither exams nor reevaluation.

BIBLIOGRAPHY

Basic:
- Géron, Aurélien. Hands-on machine learning with Scikit-Learn and TensorFlow : concepts, tools, and techniques to build intelligent systems [on line]. Sebastopol: O'Reilly, 2017 [Consultation: 29/05/2020]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=4822582. ISBN 9781491962299.
- Benítez, Raúl ... [et al.]. Inteligencia artificial avanzada. Barcelona: UOC, 2012. ISBN 9788490298879.

Complementary:
- Shawe-Taylor, J.; Cristianini, Nello. Kernel methods for pattern analysis. Cambridge: Cambridge University Press, 2004.
- Duda, Richard O.; Hart, Peter E.; Stork, David G. Pattern classification. 2nd. New York [etc.]: John Wiley & Sons, cop. 2001. ISBN 0471056693.

RESOURCES

Other resources:
Documentation uploaded to Athena by teachers.