820055 - IAAE - Artificial Intelligence for Engineering

**Coordinating unit:** 295 - EEBE - Barcelona East School of Engineering

**Teaching unit:** 723 - CS - Department of Computer Science

**Academic year:** 2019

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

**ECTS credits:** 6

**Teaching languages:** Catalan, Spanish

**Teaching staff**

Coordinator: Gerard Escudero
Samir Kanaan

Others: Gerard Escudero
Samir Kanaan

**Opening hours**

**Timetable:** Check the bulletin board information departments.

**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.
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

Learning objectives of the subject

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 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%.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>0h</th>
<th>0.00%</th>
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<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Hours small group:</td>
<td>60h</td>
<td>40.00%</td>
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<tr>
<td></td>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
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## Content

### Introduction

<table>
<thead>
<tr>
<th></th>
<th>Learning time: 16h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 6h</td>
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<tr>
<td></td>
<td>Self study : 8h</td>
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**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

### Characterization data using attributes

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<th>Learning time: 16h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 4h</td>
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<tr>
<td></td>
<td>Laboratory classes: 4h</td>
</tr>
<tr>
<td></td>
<td>Self study : 8h</td>
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**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
### Clustering

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

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

**Learning 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

**Learning time:** 26h
- Theory classes: 4h
- Laboratory classes: 4h
- Other activities: 10h
- Self study: 8h
## Classification

**Learning time:** 46h  
Theory classes: 18h  
Laboratory classes: 10h  
Self study: 18h

**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

## Theory of statistical estimation

**Learning time:** 8h  
Theory classes: 4h  
Self study: 4h

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

**Related activities:**  
Lecture

## Other problems in the pattern analysis

**Learning time:** 8h  
Theory classes: 4h  
Self study: 4h

**Description:**  
Regression, anomaly detection, projections...

**Related activities:**  
Lecture
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%).

**Bibliography**

**Basic:**


**Complementary:**


**Others resources:**

Documentation uploaded to Athena by teachers.