820055 - IAAE - Artificial Intelligence for Engineering

<table>
<thead>
<tr>
<th>Coordinating unit:</th>
<th>295 - EEBE - Barcelona East School of Engineering</th>
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</thead>
<tbody>
<tr>
<td>Teaching unit:</td>
<td>723 - CS - Department of Computer Science</td>
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<tr>
<td>Academic year:</td>
<td>2018</td>
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<td>Degree:</td>
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<td>BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Teaching unit Optional)</td>
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<td>ECTS credits:</td>
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<td>Teaching languages:</td>
<td>Catalan, Spanish</td>
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</table>

**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

Total learning time: 150h

<table>
<thead>
<tr>
<th>Activity</th>
<th>Hours</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Hours large group:</td>
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<tr>
<td>Hours medium group:</td>
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<td>Hours small group:</td>
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<td>Guided activities:</td>
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<tr>
<td>Self study:</td>
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<td>60.00%</td>
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</table>
## 820055 - IAAE - Artificial Intelligence for Engineering

### Content

<table>
<thead>
<tr>
<th>Introduction</th>
<th><strong>Learning time:</strong> 16h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 6h</td>
</tr>
<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

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<tr>
<th>Characterization data using attributes</th>
<th><strong>Learning time:</strong> 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>
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<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  
**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  
**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  
**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.