# 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:** 2017

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

**ECTS credits:** 6  
**Teaching languages:** Catalan, Spanish

## Teaching staff

**Coordinator:** Gerard Escudero  
**Others:** Gerard Escudero  
Samir Kanaan

## Opening hours

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

## Prior skills

There are no previous capacities.

## 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%.
# 820055 - IAAE - Artificial Intelligence for Engineering

## 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

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

### Introduction

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

**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 R
- Practice 13: introduction to Weka

### Characterization data using attributes

<table>
<thead>
<tr>
<th><strong>Learning time:</strong> 16h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 4h</td>
</tr>
<tr>
<td>Laboratory classes: 4h</td>
</tr>
<tr>
<td>Self study : 8h</td>
</tr>
</tbody>
</table>

**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

**Learning time:** 30h

- Theory classes: 4h
- Laboratory classes: 6h
- Other activities: 10h
- Self study: 10h

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

**Related activities:**
- Lectures
- Practice 5: kmeans and PAM
- Practice 6: dendrogram
- Practice 14: clustering in Weka

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# Optimization

**Learning time:** 26h

- Theory classes: 4h
- Laboratory classes: 4h
- Other activities: 10h
- Self study: 8h

**Description:**
- Simulated annealing and gradient descent
- Genetic Algorithms

**Related activities:**
- Lectures
- Practice 7: simulated annealing and gradient descent
- Practice 8: genetic algorithms
## Classification

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 46h</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Based on distances: k Nearest Neighbours, linear classifier and supervised k-means</td>
<td></td>
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<tr>
<td>- Based on probabilities: Naïve Bayes and introduction to Maximum Entropy</td>
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<tr>
<td>- Based on rules: Decision Trees (splitting and entropy) and an introduction to AdaBoost</td>
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<tr>
<td>- Linear classifier with kernels and Support Vector Machines (SVMs)</td>
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<tr>
<td>Related activities:</td>
<td></td>
</tr>
<tr>
<td>- Lectures</td>
<td></td>
</tr>
<tr>
<td>- Practice 9: classifiers based on distances</td>
<td></td>
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<tr>
<td>- Practice 10: classifiers based on probabilities</td>
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<tr>
<td>- Practice 11: rule-based classifiers</td>
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<tr>
<td>- Practice 12: SVMs</td>
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<tr>
<td>- Practice 15: classification in Weka</td>
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</tbody>
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## Theory of statistical estimation

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 8h</th>
</tr>
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<tbody>
<tr>
<td>- Bias and variance</td>
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<tr>
<td>- Test Protocols: single and cross-validation</td>
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<tr>
<td>- Statistical tests</td>
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<tr>
<td>- Measures of evaluation</td>
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</tr>
<tr>
<td>Related activities:</td>
<td></td>
</tr>
<tr>
<td>- Lecture</td>
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</table>

## Other problems in the pattern analysis

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 8h</th>
</tr>
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<tbody>
<tr>
<td>- Regression, anomaly detection, projections...</td>
<td></td>
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<tr>
<td>Related activities:</td>
<td></td>
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<tr>
<td>- Lecture</td>
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</table>
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.