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 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.
820055 - IAAE - Artificial Intelligence for Engineering

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 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

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

<table>
<thead>
<tr>
<th>Introduction</th>
<th><strong>Learning time:</strong> 16h</th>
</tr>
</thead>
<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>
</tr>
</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 python

<table>
<thead>
<tr>
<th>Characterization data using attributes</th>
<th><strong>Learning time:</strong> 16h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 4h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 4h</td>
</tr>
<tr>
<td></td>
<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: 14h  
Laboratory classes: 6h  
Self study: 10h  

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

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

### 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>Learning time: 46h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 18h</td>
</tr>
<tr>
<td>Laboratory classes: 10h</td>
</tr>
<tr>
<td>Self study : 18h</td>
</tr>
</tbody>
</table>

**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

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

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

**Related activities:**
- Lecture

---

### Other problems in the pattern analysis

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

**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.