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

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Learning time: 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>
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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

<table>
<thead>
<tr>
<th>Characterization data using attributes</th>
<th>Learning time: 16h</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 4h</td>
</tr>
<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, null 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
- Practice 14: clustering in Weka

<table>
<thead>
<tr>
<th>Learning time:</th>
<th>30h</th>
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<tbody>
<tr>
<td>Theory classes:</td>
<td>4h</td>
</tr>
<tr>
<td>Laboratory classes:</td>
<td>6h</td>
</tr>
<tr>
<td>Other activities:</td>
<td>10h</td>
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<tr>
<td>Self study:</td>
<td>10h</td>
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# Optimization

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

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

<table>
<thead>
<tr>
<th>Learning time:</th>
<th>26h</th>
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<tbody>
<tr>
<td>Theory classes:</td>
<td>4h</td>
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<tr>
<td>Laboratory classes:</td>
<td>4h</td>
</tr>
<tr>
<td>Other activities:</td>
<td>10h</td>
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<tr>
<td>Self study:</td>
<td>8h</td>
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</table>
## Classification

<table>
<thead>
<tr>
<th>Learning time: 46h</th>
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</thead>
<tbody>
<tr>
<td>Theory classes: 8h</td>
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<tr>
<td>Laboratory classes: 10h</td>
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<tr>
<td>Other activities: 10h</td>
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<tr>
<td>Self study: 18h</td>
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**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
- Practice 15: classification in Weka

## Theory of statistical estimation

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