Course guide
240646 - 240646 - Artificial Intelligence Applied to Engineering

Last modified: 16/05/2023

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 723 - CS - Department of Computer Science.
Degree: BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Optional subject).
Academic year: 2023 ECTS Credits: 4.5 Languages: English

LECTURER

Coordinating lecturer: SAMIR KANAAN IZQUIERDO
Others: GERARD ESCUDERO BAKX

PRIOR SKILLS

The student should have a robust computer programming background, preferably in Python language.

REQUIREMENTS

Fundamentals of informatics (S1), Informatics (S3)

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Transversal:
07 AAT. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.
03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

TEACHING METHODOLOGY

The course has three hours per week of laboratory sessions: one hour and a half are theory presentations combined with guided exercises to be done with the computer, and the other half are laboratory works.
The students have to do a non presential work addressed to apply the techniques studied to a problem of the area (degree).
This comprises different methodologies: expositive (theory) 10%, problem-based 10%, group work in the laboratory 20%, individual non presential work 27% and group non presential work 33%.

LEARNING OBJECTIVES OF THE SUBJECT

The course wants the student to:
- Know the basic concepts of artificial intelligence, machine learning and pattern recognition
- Be able to use artificial intelligence tools that are useful to solve engineering problems
- Use the right data analysis methodology on each case
- Use model evaluation methodologies to check the applicability of such models to real-world problems
- Know the trends and latest advancements in the area to be able to apply them in future projects
STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours medium group</td>
<td>45,0</td>
<td>40.00</td>
</tr>
<tr>
<td>Self study</td>
<td>67,5</td>
<td>60.00</td>
</tr>
</tbody>
</table>

Total learning time: 112.5 h

CONTENTS

Introduction. Data representation

Description:
- Machine learning from the point of view of artificial intelligence
- Applications to engineering and technology
- Data representation
- Processing absent values and normalization
- Distance measures

Related activities:
- Theory sessions
- Laboratory sessions
- Practice 1: data preparation

Full-or-part-time: 10h 30m
- Practical classes: 4h 30m
- Laboratory classes: 1h 30m
- Self study: 4h 30m

Dimensionality reduction

Description:
- Principal components analysis (PCA)
- Non-negative matrix factorization (NMF)
- Independent component analysis (ICA)

Related activities:
- Theory sessions
- Laboratory sessions
- Practice 1: dimensionality reduction

Full-or-part-time: 15h
- Practical classes: 4h 30m
- Laboratory classes: 1h 30m
- Self study: 9h
## Data clustering

**Description:**
- K-means
- DB-Scan
- Hierarchical clustering. Dendrograms
- Clustering evaluation

**Related activities:**
- Theory sessions
- Laboratory sessions
- Practice 1: clustering

**Full-or-part-time:** 10h 30m
- Practical classes: 3h
- Laboratory classes: 1h 30m
- Self study: 6h

## Neural networks. Deep learning

**Description:**
- Basic neural networks: perceptron
- Multilayer perceptron
- Convolutional networks
- Autoencoders
- Learning improvement
- Other architectures

**Related activities:**
- Theory sessions
- Laboratory sessions
- Practice 2: neural networks

**Full-or-part-time:** 24h
- Practical classes: 6h
- Laboratory classes: 3h
- Self study: 15h

## Classification

**Description:**
- Distance-based: k Nearest Neighbours, linear, supervised k-means
- Probability-based: Naïve Bayes, introduction to Maximum Entropy
- Rule-based: decision trees, AdaBoost
- Linear classifier, linear with kernel, support vector machines (SVM)

**Related activities:**
- Theory sessions
- Practice 3: distance-based classifiers
- Practice 4: probability-based classifiers
- Practice 5: rule-based classifiers
- Practice 6: SVMs

**Full-or-part-time:** 22h 30m
- Practical classes: 4h 30m
- Laboratory classes: 3h
- Self study: 15h
**Statistical estimation theory**

**Description:**
- Bias and variance
- Test protocols: simple validation, cross validation
- Statistical tests
- Evaluation metrics

**Related activities:**
- Theory sessions
- Practice 3: distance-based classifiers
- Practice 4: probability-based classifiers
- Practice 5: rule-based classifiers
- Practice 6: SVMs

**Full-or-part-time:** 16h 30m
- Practical classes: 4h 30m
- Laboratory classes: 3h
- Self study: 9h

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**Further machine learning techniques**

**Description:**
- Regression
- Anomaly detection
- Recommenders

**Related activities:**
- Theory sessions
- Laboratory sessions
- Practice 7: regression

**Full-or-part-time:** 13h 30m
- Practical classes: 3h
- Laboratory classes: 1h 30m
- Self study: 9h

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**GRADING SYSTEM**

The evaluation of the course comprises the assessment by the professors of the laboratory works and reports (50%) and the non presential works (the other 50%).

During the spring semester of course 2019-2020, as a consequence of the Covid19 public health crisis:
- the oral defenses of the non presential works (projects) are cancelled, the work reports will be evaluated instead.

**EXAMINATION RULES.**

The laboratory and non presential reports must be delivered as executed Jupyter Notebook, with the name of all the members of the group if it is a group work.
BIBLIOGRAPHY

Basic:

Complementary:

RESOURCES

Other resources:
Documents prepared by the professors, posted to Atenea