



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

Type	Hours	Percentage
Hours medium group	45,0	40.00
Self study	67,5	60.00

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

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

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 Noteboosk, with the name of all the members of the group if it is a group work.



BIBLIOGRAPHY

Basic:

- Géron, A. Hands-on machine learning with Scikit-Learn & TensorFlow : concepts, tools, and techniques to build intelligent systems [on line]. 3th edition. Sebastopol, CA: O'Reilly, 2023 [Consultation: 24/03/2023]. Available on: <https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=30168989>. ISBN 9781098122461.
- Benítez, Raúl. Inteligencia artificial avanzada. Barcelona: UOC, 2012. ISBN 9788490298879.

Complementary:

- Duda, Richard O ; Peter E. Hart ; David G. Stork. Pattern classification [on line]. 2nd ed. New York [etc.]: John Wiley & Sons, cop. 2001 [Consultation: 29/06/2020]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=699526>. ISBN 0471056693.

RESOURCES

Other resources:

Documents prepared by the professors, posted to Atenea