

Course guide

240646 - 240646 - Artificial Intelligence Applied to Engineering

Last modified: 13/03/2025

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: 2025 **ECTS Credits:** 4.5 **Languages:** English

LECTURER

Coordinating lecturer: LLUÍS TALAVERA

Others: LLUÍS TALAVERA

PRIOR SKILLS

The student should have a strong programming background, preferably in the Python language.

REQUIREMENTS

Computer Science (S1), Extended Computer Science (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 subject is based on a combination of lectures, exercise solving, and project-based learning. Students work in groups throughout the semester to carry out various assignments and a project aimed at applying the techniques studied. Classes are held in a laboratory classroom and consist of three hours per week divided into one and a half-hour sessions. The professor briefly introduces the theoretical concepts of the subject and then guides the students to explore further some of the subjects in a personalized manner according to each group's needs. Additionally, the professor monitors the groups' work and clarifies any doubts they each group encounters when developing their work.

LEARNING OBJECTIVES OF THE SUBJECT

Upon completing the course, the student should be able to:

- Apply artificial intelligence tools from the field of machine learning to any engineering problem with available data.
- Describe the characteristics, strengths, and weaknesses of the main machine learning techniques.
- Compare the performance of various learning models considering their characteristics.
- Follow a rigorous data analysis methodology that includes a systematic and reliable evaluation of learning models.
- Work effectively in teams to solve problems applying machine learning techniques following the established methodology.
- Utilize the internet to search for materials for studying machine learning techniques and to keep up with the latest advancements for application in future projects.

STUDY LOAD

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

Total learning time: 112.5 h

CONTENTS

Introduction. Basic concepts.

Description:

What is machine learning
Applications of machine learning
Types of machine learning
Classification and regression
Data representation and processing
Data preparation: missing values, scaling, coding categorical data.

Related activities:

Lectures
Lab sessions
Course project

Full-or-part-time: 25h

Theory classes: 2h 30m
Laboratory classes: 5h 30m
Guided activities: 3h
Self study : 14h

Model validation in supervised learning

Description:

Underfitting and overfitting

Bias/variance tradeoff

Validation strategies: hold-out, repeated hold-out, k-fold cross validation

Classification metrics

Regression metrics

Hyperparameter tuning

Related activities:

Lectures

Course project

Full-or-part-time: 8h 30m

Theory classes: 1h

Laboratory classes: 1h 30m

Guided activities: 1h 30m

Self study : 4h 30m

Classification and regression

Description:

Logistic regression

Linear regression

Polynomial regression

Naive Bayes

k-nearest neighbours

Decision trees

Support Vector Machines (SVM)

Ensemble learning

Related activities:

Lectures

Lab sessions

Course project

Full-or-part-time: 39h

Theory classes: 3h

Laboratory classes: 6h

Guided activities: 8h

Self study : 22h

Neural networks and deep learning

Description:

Introduction to neural networks

The perceptron

Multilayer perceptron (MLP)

Deep learning

Convolutional Neural Networks (CNN)

Related activities:

Lectures

Lab sessions

Assignment

Course project

Full-or-part-time: 14h

Theory classes: 1h

Laboratory classes: 2h 30m

Guided activities: 1h 30m

Self study : 9h

Unsupervised learning

Description:

Clustering

k-means, hierarchical clustering, DBSCAN

Clustering metrics

Dimensionality reduction

Principal Component Analysis (PCA)

T-distributed Stochastic Neighbor Embedding (t-SNE)

Related activities:

Lectures

Lab sessions

Assignment

Full-or-part-time: 14h

Theory classes: 1h

Laboratory classes: 2h

Guided activities: 2h

Self study : 9h

Time series

Description:

Time series decomposition

Stationarity, autocorrelation

The ARIMA model

Machine learning modeling: lag features

Full-or-part-time: 12h

Theory classes: 0h 30m

Laboratory classes: 1h

Guided activities: 1h 30m

Self study : 9h



GRADING SYSTEM

The grading for the subject will be based on the following concepts:

- Group project (45%)
- Completion of various practical assignments in groups (45%)
- Quizzes: Conducted individually during class time and consisting of questions on theoretical concepts of the course (10%)

BIBLIOGRAPHY

Basic:

- Benítez, Raúl. Inteligencia artificial avanzada. Barcelona: UOC, 2012. ISBN 9788490298879.
- 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.

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