



Course guide

240787 - 240787 - Applied Machine Learning and Optimisation

Last modified: 12/06/2023

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: **Degree:** BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGIES AND ECONOMIC ANALYSIS (Syllabus 2018). (Optional subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: Pablo Martin Calvo
Fabrizio Germano

Others: Pablo Martin Calvo

PRIOR SKILLS

Knowledge of the following topics will help students better leverage this course, but is not strictly required:

- Basic programming, specially in data oriented languages such as Python or R.
- Operations research

REQUIREMENTS

The course assumes the student has covered all the Mathematics previous courses, as well as Probability & Statistics.

TEACHING METHODOLOGY

There will be 20 lecture classes and 6 practical seminars. Lecture classes will be used to present material to students as well as having discussions on the course contents. For the practical seminars, students will be divided into two groups with independent sessions to reduce the class size. The practical seminars will be used to deep-dive in the three mandatory case assignments that students will do throughout the course. The sessions will also be hands-on and students will work in the case together with the professor.

Students are expected to attend all the activities in the course. Beyond lectures and practical seminars, additional reading resources will be provided to students. For students that need to level up their Python skills, self-paced materials will be suggested.

LEARNING OBJECTIVES OF THE SUBJECT

The goal of this course is to provide an introduction to simulation, optimization and machine learning techniques to students with a background in social sciences, with an approach biased towards practical work. The expected outcome is that students that have passed this course know a variety of modern and useful techniques that can be applied in real-life business contexts. With this knowledge and experience, the students understand what are the right techniques for different problems, which are the main steps and requirements to apply each of these techniques and how to judge the successful application of them. This course aims to provide enough background so that the students from social sciences can successfully interact with engineering and technical profiles, which are usually taught the techniques focused in this course. Having said that, this course can also be a first introduction for students that are willing to pursue a more thorough learning of the techniques discussed in the course, after or during itself.

With the knowledge and skills obtained in this course, students become fit for tasks such as:

- Applying simulation, optimization and machine learning techniques to simple cases.
- Planning and designing simulation, optimization and machine learning initiatives.
- Leading simulation, optimization and machine learning projects from a managerial point of view.
- Acting as a liaison between management and technical profiles in business contexts.



CONTENTS

Applied Automatic Learning and Optimisation

Description:

- L1: Introduction and motivation of the course
- L2: Simulation, Optimization and Machine Learning in companies
- L3: Introduction to simulation: What is it, When do we use it, Types of simulation
- L4: Simulation examples in Python.
- L5: Simulation methodology.
- L6: Simulation-based optimization I. Challenges and issues with simulation.
- L7: Introduction to optimization
- L8: Modeling optimization problems
- L9: Taxonomy of optimization techniques
- L10: Simulation-based optimization II.
- L11: Challenges in real-world usage. Simulation vs Optimization
- L12: Introduction to Machine Learning
- L13: Supervised Machine Learning (SML)
- L14: Typical SML workflow
- L15: Algorithm deep dive: Decision trees
- L16: Feature Engineering and Model Evaluation
- L17: Deployment of Models
- L18: Stories from the trenches: applying all of this in the real world
- L19: Where to go from here: further learning and career advice
- L20: Final Q&A, exam preparation

Full-or-part-time: 39h

Theory classes: 30h

Practical classes: 9h

GRADING SYSTEM

The following items compose the final grade:

- Case assignments: 50% of the grade. There will be three assignments, each with the same weight.
- Final exam: 50% of the grade. There will be a final exam at the end of the course.

Students who fail the course, have followed the continuous assessment and took the final exam will get the chance to sit a retake exam. The grade they obtain in the retake exam will replace the grade they obtained in their first final exam. Their grades for the case assignments will remain the same and the final grade will be computed with the same formula.

BIBLIOGRAPHY

Basic:

- Gutttag, John V.. Introduction to Computation and Programming Using Python: With Application to Understanding Data [on line]. 3rd ed. Cambridge, Massachusetts: MIT Press, 2021 [Consultation: 12/01/2024]. Available on: <https://renoir.upc.edu/login/tipus.php?url=https%3A%2F%2Fsearch.ebscohost.com%2Flogin.aspx%3FAN%3D2518027%26direct%3Dtrue%26site%3Dehost-live%26db%3Dnlebk%26scope%3Dsite&logup=false>. ISBN 026236343.