UAB
Universitat Autònoma de Barcelona

Operational research

Code: 100125
ECTS Credits: 6

2024/2025

Degree	Type	Year
2500149 Mathematics	OT	4

Contact

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Teaching groups languages

You can view this information at the end of this document.

Prerequisites

This course assumes that the student has obtained the knowledge taught in different courses on the following topics:

- Calculus in several variables.

- Probability.

- Linear models.

- Python programming.

Objectives and Contextualisation

This course aims to familiarize the student with different methods of machine learning by applying the point of view used when large amounts of data are available.

Competences

- Actively demonstrate high concern for quality when defending or presenting the conclusions of one's work.
- Effectively use bibliographies and electronic resources to obtain information.
- Recognise the presence of Mathematics in other disciplines.
- Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
- Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
- Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
- Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.

- Use computer applications for statistical analysis, numeric and symbolic calculus, graphic display, optimisation or other purposes to experiment with Mathematics and solve problems.
- When faced with real situations of a medium level of complexity, request and analyse relevant data and information, propose and validate models using the adequate mathematical tools in order to draw final conclusions

Learning Outcomes

1. Achieve mastery and security in the handling of specific scientific programs for problem-solving with real data and in order to perform simulations.
2. Actively demonstrate high concern for quality when defending or presenting the conclusions of one's work.
3. Distinguish, of a problem, which thing is important of expensive to the building of the mathematical model and his resolution of what is not it.
4. Dominate the basic concepts of the theory and be able to combine them and use them to resolve problems.
5. Draw adequate conclusions from the result of the model.
6. Effectively use bibliographies and electronic resources to obtain information.
7. Evaluate the difficulty to do a calculation of analytical probabilities in complex situations and know distinguish when can realise these calculations and when has to resort to the simulation stochastic.
8. Find models of scientific or topological reality in relation to a decision-making problem and express it using the mathematical language of optimisation problems with dynamic programming or stochastic queues.
9. Know generate and manipulate models of simulation of the reality to establish and check hypothesis in the study of problems or realities more complex.
10. Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
11. Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
12. Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
13. Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
14. Understand the rudiments of logistics and other fields in which operative research is applied to the technological and industrial fields

Content

- Introduction to machine learning.
- Regularized linear and logistic regression.
- Statistical learning.
- Support vector machines.
- K-nearest neighbors.
- Naive Bayes.
- Decision trees.
- Ensembles.
- Text mining.
- Graph analysis.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lab sessions	30	1.2	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
Type: Supervised			
Theory sessions	50	2	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
Type: Autonomous			
Personal study of the subject	46	1.84	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14

Teaching will combine classroom lessons by teachers and practical work for students with a computer.

In all aspects of teaching/learning activities, the best efforts will be made by teachers and students to avoid language and situations that can be interpreted as sexist.

To achieve continuous improvement in this subject, everyone should collaborate in highlighting them.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Exam	50%	4	0.16	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
Practical Project	50%	20	0.8	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14

Continuous grading

The grading for the course will be done in two parts: the theory part, NT, and the practice part, NP. The final grade for the course will be N = 0.5*NT + 0.5*NP.

The grading for the theory part will be based in two exams: a partial exam, NEP, and a final exam, NEF. The final grade for the theory part will be NT = max(NEF, 0.3*NEP + 0.7*NEF), as long as NEF is higher than 3,5, otherwise NT = NEF.

The grading for the practice part will have be based on deliverables during the course.

On the day of the second-chance exam only the grade for the theory part will be updated. If a student goes to the second-chance exam then the theory grade, NT, will be NT = min(5, NER), where NER is the grade for the second-chance exam.

In order for an activity to be taken into account in the final grade, the activity grade has to be a minimum of 3,5. If NT or NP are below 3,5, then the final grade for the course will be N = min(NT, NP).

The student who has submitted works for at least 50% of the subject will be considered evaluable. Otherwise, it will appear in the record as non-evaluable.

Single grading

The grading for a student who chooses to be evaluated with the single grading modality will be based on the final examn grade (50%) and the grade for a practical project (50%).

Bibliography

- Geron, A. (2019) Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow (O'Reilly)
- Hastie, T. et al (2008) The Elements of Statistical Learning: Data Mining, Inference, and Prediction

Software

Theory and practical exercises will be done using R

Language list

Name	Group	Language	Semester	Turn
(PLAB) Practical laboratories	1	Catalan	first semester	afternoon
(TE) Theory	1	Catalan	first semester	afternoon