Universitat Autònoma de Barcelona

2020/2021

Optimisation

Code: 104396
ECTS Credits: 6

Degree	Type	Year	Semester
2503740 Computational Mathematics and Data Analytics	OB	2	2

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Other comments on languages

This document is an unsupervised translation. In case of discrepancy, the Catalan version shall prevail.

Teachers

Rosa Camps Camprubí

External teachers

Aureli Alabert

Prerequisites

Pre-taught knowledge will be used in the subjects of Linear Algebra, Calculation in a Variable, Computation in Several Variables, Initiation in Programming, Numerical Calculation, and Algorithmism and Combining in Graphs.

Objectives and Contextualisation

Learn to model decision-making problems in terms of linear and non-linear programs. Understand the mechanism of the simplex method. Solve linear programs, by hand and with addient software. Program non-linear programming algorithms, and use existing libraries. Introduce yourself in the field of combinatorial optimization, through selected examples.

Competences

- Apply a critical spirit and rigour for the validation or rejection of your own arguments and those of others.

- Demonstrate a high capacity for abstraction and translation of phenomena and behaviors to mathematical formulations.
- Formulate hypotheses and think up strategies to confirm or refute them.
- Make effective use of bibliographical resources and electronic resources to obtain information.
- 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 be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
- 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, numerical and symbolic computation, graphic visualisation, optimisation and other to experiment and solve problems.
- Work cooperatively in a multidisciplinary context assuming and respecting the role of the different members of the team.

Learning Outcomes

1. "Mathematically identify and describe a problem; structure available information; select a suitable model."
2. Apply a critical spirit and rigour for the validation or rejection of your own arguments and those of others.
3. Contrast the solution obtained, after resolving the model, in terms of its adjustment to real phenomenon.
4. Contrast, if possible, the use of calculation with the use of abstraction in solving a problem.
5. Evaluate the advantages and disadvantages of using calculation and abstraction.
6. Extract appropriate conclusions from the model result.
7. Find models of scientific or technological reality relating to a decision-making problem and express this with the mathematical language of optimisation problems with dynamic programming or stochastic queues.
8. Handle specific scientific software to solve problems with real data and to carry out simulations.
9. Make effective use of bibliographical resources and electronic resources to obtain information.
10. Master the basics of theory and be able to combine these and use them to solve problems.
11. 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.
12. 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.
13. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
14. Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
15. 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.
16. Understand the rudiments of logistics and other fields in which operational research is applied within technological and industrial ambits.
17. Work cooperatively in a multidisciplinary context, taking on and respecting the role of the distinct members in the team.

Content

1- Nonlinear Programming: Theory of extremes. Optimization without restrictions. Optimization with restrictions.

2- Linear Programming: Modeling in terms of linear programs. The simplex algorithm. Full Linear

Programming. Linear flows over networks.

3- Combinatorial optimization: classical problems. Heuristic methods Computational complexity.

Methodology

The efficient learning of the optimization must combine three activities: The study of the mathematical theory, the modeling of real problems, and the effective resolution of academic and real problems. All within the eminently practical character of the degree. The real optimization problems are very complex. When we talk about "real problems" here, we refer to simplifications of real situations that can be attacked within a reasonable time in the development of the course, which at the same time give a good image of the transversality of the fields of application of the optimization

The study of the theory will be done through recommended readings and master class lessons. It will tend to apply the methodology of the reversed classroom: Students must work the subject on their own and prepare the classes through recommended previous readings; In class the remarkable aspects are discussed, the issues raised by the students are resolved and additional aspects of interest are incorporated.

It will be practiced with specific modeling software, where possible, and with function libraries in a general programming language (C / C ++ or Python) appropriate to the student's previous training. Free and / or free software will always be used. The student will also program complete basic algorithms and solve specific problems with them.

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. In order to achieve continuous improvement in this topic, everyone should collaborate to show the deviations that you observe regarding this objective.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Classroom lectures (theoretical and practical)	56	2.24	
Type: Autonomous			
Problem solving by means of programming	60	2.4	
Theoretical problem solving	28	1.12	

Assessment

The evaluation of the subject will be based on:

Delivery of work for each of the three parts of the course. (30% of the final grade)
Examination of each of the three parts of the course. (70% of the final grade)

To pass the course, you must:

Obtain an overall average of 5 out of 10. (Notes starting at 4.8 will be assessed on a case by case basis).
Obtain a minimum of 4 out of 10 in each of the three parts of the course, both in the works and in the exams.

From each one of the examinations there will be a second call to recover / improve the note. The delivery of this second exam will automatically annul the note of the first call. The works are NOT recoverable. In the same call, the examinations of the different parties do not necessarily have to be on different days.

The student who has submitted works or exams for a total of at least 50% of the subject will be considered evaluable, according to the weight that appears in the following table of Evaluation activities. Otherwise, it will appear in the Minutes as Non-Valuable.

The notes of the second call will not be taken into account for the allocation of Honor Matriculations.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Assignments Combinatorial Optimisation	Ten percent	0	0	2, 5, 3, 4, 16, 6, 1, 8, 14, 13, 11, 12
Assignments Linear Programming	Ten percent	0	0	2, 5, 3, 4, 16, 6, 1, 8, 14, 13, 11, 12
Assignments NonLinear Programming	Ten percent	0	0	2, 5, 3, 4, 16, 6, 1, 8, 14, 13, 11, 12
Exam Combinatorial Optimisation	Fifteen percent	2	0.08	3, 16, 10, 6, 1, 15, 14, 11, 17, 7, 9
Exam Linear Programming	Twenty five percent	2	0.08	3, 16, 10, 6, 1, 15, 14, 11, 17, 7, 9
Exam NonLinear Programming	Twenty five percent	2	0.08	3, 16, 10, 6, 1, 15, 14, 11, 17, 7, 9

Bibliography

During the course the essential material will be provided to follow it. Bibliographical references and other resources will be suggested at the opportune moment of the course.