Universitat Autònoma de Barcelona

2023/2024

Optimisation

Code: 104396
ECTS Credits: 6

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

Contact

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Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject. Please note that this information is provisional until 30 November 2023.

Teachers

Maria Rosa Camps Camprubi

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.

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.

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.

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.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Classroom lectures (theoretical and practical)	49	1.96	
Type: Autonomous			
Problem solving by means of programming	65	2.6	
Theoretical problem solving	32	1.28	

Assessment

The evaluation is based on:

- Homework deliveries (30% of the final grade)
- Exams (70% of the final grade).

To pass the course your must:

- Get a minimum grade of 4.0/10 in each of the exams.
- Get a global mean of 5.0/10, which will be the final grade.

Grades not satisfying these conditions can be studied case by case.

Each of the two exams will have a resit test ("recuperació" in the official terminology of the UAB). The attendance to the resit test shall automatically invalidate the grade of the first one. There is no second call for the homework deliveries.

The student that has attended exams or hand-in homework for a total of 50% or more of the course, according to the weight that appears in the Evaluation Activities table, will be evaluated. Otherwise they will be considered "not avaluable".

The plagiarism in the homework deliveries will be considered an offense as serious as any kind of cheating in an exam, and shall be penalised with an automatic course failure.

Assessment Activities

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

Software

To be determined