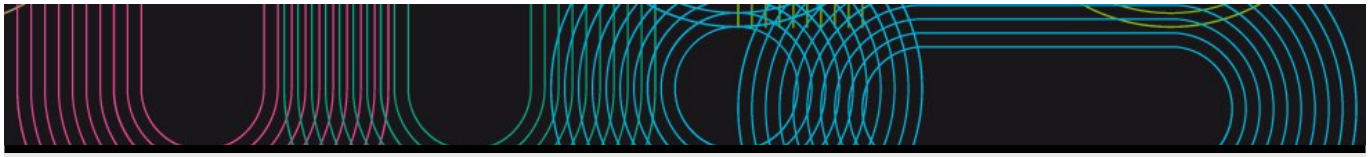

IDENTIFYING DATA				
Mathematical optimization				
Subject	Mathematical optimization			
Code	O06G460V01204			
Study programme	(*)Grao en Intelixencia Artificial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish Galician			
Department				
Coordinator	Mosquera Rodríguez, Manuel Alfredo			
Lecturers	Mosquera Rodríguez, Manuel Alfredo			
E-mail	mamrguez@uvigo.gal			
Web	http://moovi.uvigo.gal			
General description	The main objective of this course is to provide students with basic knowledge and skills in the modeling of mathematical optimization problems, as well as the associated resolution techniques. Both linear and nonlinear optimization problems, with and without integer variables, will be studied. From the practical point of view, it is worth mentioning that the course will focus on the practical implementation in the computer of real models and their resolution by means of the most current optimization tools. In particular, the focus will be on problems and models that may be of special relevance in different areas of artificial intelligence.			

Training and Learning Results	
Code	
A2	That students know how to apply their knowledge to their work or vocation in a professional manner and possess the competencies that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study.
A5	That students have developed those learning skills necessary to undertake further studies with a high degree of autonomy.
B2	Ability to solve problems with initiative, decision making, autonomy and creativity.
B4	Ability to select and justify the appropriate methods and techniques to solve a specific problem, or to develop and propose new methods based on artificial intelligence.
C1	Ability to use mathematical concepts and methods that may arise in the modeling, approach and resolution of artificial intelligence problems.
C2	Ability to use the concepts and methods of probability, statistics and optimization to model and solve artificial intelligence problems.
C3	Ability to solve artificial intelligence problems requiring algorithms, from their design and implementation to their evaluation.
C23	Know and know how to correctly apply and explain the validation techniques of artificial intelligence solutions.
D3	Ability to create new models and solutions in an autonomous and creative way, adapting to new situations. Initiative and entrepreneurial spirit.

Expected results from this subject	Training and Learning Results			
RA1. Know identify and model problems of mathematical optimisation.	A2 A5	B2 B4	C1 C2 C3	D3
RA2. Know resolve problems of mathematical optimisation by means of the technicians and suitable algorithms.	A2 A5	B2 B4	C1 C2 C3 C23	

RA3. Know and identify the structure and properties of the problems of mathematical optimisation.	A2 A5	B2 B4	C1 C2 C3	D3
RA4. Familiarise with the interrelationships between mathematical optimisation and machine learning.	A2 A5	B4	C1 C2 C3 C23	

Contents
Topic
Introduction to the mathematical optimisation.
Modelling and practical resolution of problems of optimisation.
Linear programming.
Integer programming.
Problems of optimisation in networks.
Foundations of no linear optimisation with restrictions.
Optimisation for machine learning.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	22	46	68
Problem solving	9	19	28
Laboratory practical	14	34	48
Problem and/or exercise solving	6	0	6

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Lecturing	Exhibition by part of the professor of the contents on the matter object of study, theoretical bases and/or guidelines of a work, exercise that the/the student has to develop
Problem solving	Resolution of problems, readings, summaries, diagrams and questions of each one of the subjects of the program of the matter. Resolution of the exercises in the blackboard by part of the students/professor
Laboratory practical	Activities application of knowledge to specific situations and basic skills acquisition and related procedural matter under study. They are developed in computer rooms and with specific software of mathematical optimisation. They are not compulsory but is highly recommended the assistance for a better understanding of the subject.

Personalized assistance

Methodologies	**Description**
Lecturing	The attention to the students will do of face-to-face way and under the modality of previous appointment.
Tests	**Description**
Problem and/or exercise solving	The attention to the students will do of face-to-face way and under the modality of previous appointment.

Assessment

	Description	Qualification	Training and Learning Results			
Problem and/or exercise solving	You test/questionnaires in which the student has to solve a series of problems and/or exercises in a time/condition established/ace by the professor. Results of learning evaluated: RA1, RA2, RA3, RA4	100	A2 A5	B2 B4	C1 C2 C3 C23	D3

Other comments on the Evaluation

SYSTEM OF CONTINUOUS EVALUATION

THEORETICAL TESTS

Description: it will consist of **several tests** to make along the formative period linked to the subject and that will include the evaluation of theoretical concepts, of identification of the models of optimisation adapted and of the interrelationships between mathematical optimisation and automatic learning.

Methodology applied: Resolution of problems and/or exercises

% Qualification: No proof will exceed 10%.

Competitions evaluated: All.

Resulted of learning evaluated: RA1, RA3, RA4.

PRACTICAL TESTS

Description: it will consist of **several tests** to make along the formative period linked to the subject and that will include the resolution of problems and/or exercises.

Methodology applied: Resolution of problems and/or exercises

% Qualification: No proof will exceed 40%.

Competitions evaluated: All.

Resulted of learning evaluated: All.

FINAL TEST

Description: It will include the evaluation of theoretical and practical concepts and problem solving and/or exercises to verify that the student has consolidated the content of the course. The student who has obtained a **grade equal to or higher than 5 points (out of 10)** in the weighted average of all tests taken throughout the training period related to the subject **will be exempted** from taking this test.

Methodology applied: Resolution of problems and/or exercises

% Qualification: 100%.

Competitions evaluated: All

Resulted of learning evaluated: All

- If a student does not present to any of the proofs, but for the final proof, will assign him a qualification of 0 in her.

SYSTEM OF GLOBAL EVALUATION

Procedure for the election of the modality of global evaluation:

The students will owe to communicate to the coordinator of the subject the renunciation to the system of continuous evaluation before the last day of the formative period linked to the subject.

TESTS OF GLOBAL EVALUATION

Description: Proof that will include the evaluation of theoretical concepts, practical and resolution of problems and/or exercises.

Methodology applied: Resolution of problems and/or exercises

% Qualification: 100%.

Competitions evaluated: All

Resulted of learning evaluated: All

CRITERIA OF EVALUATION FOR EXTRAORDINARY ANNOUNCEMENT AND END OF CAREER

It will employ the system of global evaluation.

PROCESS OF QUALIFICATION OF RECORDS

For the qualification in records will take into account the following cases:

1. The students that have opted by the system of **global evaluation** will receive the qualification obtained in the proof of global evaluation.
2. The students that have opted by the system of **continuous evaluation:**
    1. If *present to the final proof* will receive the qualification obtained in said final proof.
    2. If *do not present to the final proof*:
        1. If they have obtained a weighted average note smaller than 5 points (on 10) in the theoretical and practical proofs, will receive the qualification of "Not presented".
        2. In another case, will receive the weighted average note of the theoretical and practical proofs like final qualification.

DATE OF EVALUATION

The dates of the corresponding proofs to the system of continuous evaluation will publish in the calendar of activities, available in the web page of the ESEI https://esei.uvigo.es/docencia/horarios/.

The official dates of examination of the different announcements, approved officially by the Xunta de Centro of the ESEI, find published in the web page of the ESEI https://esei.uvigo.es/docencia/horarios/.

FRAUDULENT PROCEDURES

That student that use or cooperate in fraudulent procedures (copy, present by another student, plagiarism, ...) In any of the activities of evaluation (article 13.2.d) Of the Statute of the University Student) will have a final qualification of suspense in this academic course. This fact will be him communicated to the competent authority so that it take the corresponding disciplinary actions that consider timely.

CONSULTS/APPLICATION OF TUTORSHIPS

The tutorships hours can be consulted through the personal page of the teachers, accessible through https://esei.uvigo.es/docencia/profesorado/

Sources of information

Basic Bibliography

AHUJA, R.K., MAGNANTI, T.L., ORLIN, J.B., **Network Flows. Theory, Algorithms and Applications**, 9781292042701, Pearson, 2013

BAZARAA, M., JARVIS, J., SHERALI, H., **Linear programming and networks flows**, 9780470462720, John Wiley & Sons, 2010

HILLIER, F., LIEBERMAN, G., **Introduction to operations research**, 9780073376295, McGraw-Hill, 2010

LUENBERGER, D.G., YE,Y., **Linear and Nonlinear Programming**, 9780387745022, Springer, 2008

Complementary Bibliography

BAZARAA, M., SHERALI, H., SHETTY, C.M., **Nonlinear programming: theory and algorithms**, 9781118857564, John Wiley & Sons, 2014

GALLIER, J., QUAINTANCE, J., **Linear Algebra And Optimization With Applications To Machine Learning. Volume II: Fundamentals of Optimization Theory with Applications to Machine Learning**, 9789811216565, World Scientific, 2020

SALAZAR GONZÁLEZ, J. S., **Programación Matemática**, 9788479785048, Díaz de Santos, 2001

SUH, C., **Convex Optimization for Machine Learning**, 9781638280538.
https://www.nowpublishers.com/article/DownloadEBook/9781638280521?format=pdf, Now Publishers, 2022

Recommendations

Subjects that it is recommended to have taken before

Mathematics: algebra/O06G460V01101
Mathematics:/O06G460V01102
Mathematics: Statistics/O06G460V01107
Mathematics:/O06G460V01105