UAB
Universitat Autònoma de Barcelona

Research and Innovation

Code: 43475
ECTS Credits: 6

2025/2026

Degree	Type	Year
Modelización para la Ciencia y la Ingeniería / Modelling for Science and Engineering	OB	1

Contact

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Teachers

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Teaching groups languages

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

Prerequisites

There are no specific prerequisites. Students must have mathematical skills at a graduate level of a scientific or technological degree.

Objectives and Contextualisation

The aim of this module is to show students the variety of fields in which they will be able to apply the tools acquired during the Master courses. Hopefully they will be able to use them as guidance when looking for Internships in Companies and Institutions and also when choosing a topic and an advisor for the Master's Thesis. We also expect that it will help them to find a career path.

Learning Outcomes

1. CA06 (Competence) Properly integrate modelling tools and/or results from different fields or of different types, especially in the context of multidisciplinary work environments.
2. CA07 (Competence) Critically assess the need for and presence of ethical, sustainability, gender equality and/or social justice criteria in studies or modelling projects.

3. CA07 (Competence) Critically assess the need for and presence of ethical, sustainability, gender equality and/or social justice criteria in studies or modelling projects.
4. CA08 (Competence) Work in multidisciplinary teams on the development of activities and projects in the field of Modelling.
5. KA06 (Knowledge) Identify the programming languages and environments, as well as the most relevant mathematical tools, that are used in the industrial and research field.
6. KA06 (Knowledge) Identify the programming languages and environments, as well as the most relevant mathematical tools, that are used in the industrial and research field.
7. KA06 (Knowledge) Identify the programming languages and environments, as well as the most relevant mathematical tools, that are used in the industrial and research field.
8. KA07 (Knowledge) Identify the main sectors and professional contexts in which mathematical modelling is applied.
9. KA08 (Knowledge) Describe the main results and/or predictions of the different mathematical tools used in the professional sector to construct models.
10. KA08 (Knowledge) Describe the main results and/or predictions of the different mathematical tools used in the professional sector to construct models.
11. SA07 (Skill) Correctly contextualise computer applications aimed at modelling an industrial or specific process, using an appropriate programming environment.
12. SA08 (Skill) Properly interpret the results and predictions obtained from applying a mathematical model to solve specific problems in the industrial or research field.

Content

We have two types of activities during the semester: to attend a three innovative mini-courses and attend a series of lectures given by people who work for companies or researchers working in universities or research centres.

The courses are the following:

1. Modeling in the cloud. Introduction to asset impact, cat risk and early warning. How to model natural hazards. From the model to a cloud service.
2. Introduction to Python for analytical purposes. Python basics. Data with Python. Problem solving with Python. Machine Learning with Python.
3. Machine learning. Machine learning, artificial intelligence and data science: from deterministic to stochastic point of view. Supervised and unsupervised techniques: from trees to random forests. Introduction to neural networks and mathematical challenges: performance assessment. ROC curves and cross validation.

We will invite specialists in the fields of Modelling Complex Systems, Modelling of Engineering, Mathematical Modelling and Data Science. Among the others we will have talks from people coming from:

- IIIA, Institut d'Intel·ligència Artificial, https://www.iiia.csic.es
- CRM, Centre de Recerca Matemàtica, http://www.crm.cat
- Accenture, https://www.accenture.com
- DSBlab, Dynamical Systems Biology lab (UPF), https://www.upf.edu/web/dsb
- Meteosim, https://www.meteosim.com

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Attending Lectures	16	0.64	CA06, CA07, CA08, KA07, SA08, CA06

Attending Mini-courses	22	0.88	CA06, CA08, KA06, KA07, KA08, SA07, SA08, CA06

The methodology of the three courses is based on master classes which consist in the presentation of the theory, examples and some case studies.

Relating the lectures, they will be announced previously on the virtual campus of the module Research and Innovation. There the students will find the title of the talk, the name of the speaker, a short summary and links of interest.

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
Attending Lectures	10%	16	0.64	CA06, CA07, KA07, KA08, SA08
Making a report on Maching Learning	30%	32	1.28	CA06, CA08, KA06, KA08, SA07, SA08
Making a report on Natural Hazards	30%	32	1.28	CA06, CA08, KA06, KA07, KA08, SA07, SA08
Report on Python for analitical purposes	30%	32	1.28	CA06, CA08, KA06, KA08, SA07, SA08

Students must present three projects corresponding to the three courses taught, in groups of two or three people.

Each of these projects accounts for 30% of the grade.

On the other hand, attendance to the talks, which is mandatory, contributes 10% of the final grade.

Bibliography

- Bibliography and links of interest

- https://www.python.org/about/gettingstarted/
- https://www.learnpython.org/
- https://learntocodewith.me/posts/python-for-data-science
- Pitts W McCulloch W. A logical calculus of the ideas immanent in nervous activity. Bulletin of Mathematical Biophysics, 5, 1943.
- L. Breiman, J.H. Friedman, R.A. Olshen and C.J Stone. Classification and Regression Trees. Wadsworth, Belmont, Ca, 1988.

- Friedman, Jerome H. Data Mining and Statistics: What's the connection?". Computing Science and Statistics. 29. 1998.
- B Ripley. Pattern Recognition and Neural Networks, Cambridge University Press, Cambridge. 2002.
- T Hastie, R Tibshirani, J Friedman. The Elements of Statistical Learning. Data Mining, Inference and Prediction, Springer, New York. 2009.
- Bishop, C. M. Pattern Recognition and Machine Learning, Springer, ISBN 978-0-387-31073-2. 2006.
- Ethem Alpaydin. Introduction to Machine Learning (Fourth ed.). MIT. 2020.

Software

The software will be detailed in each one of the courses.

Groups and Languages

Please note that this information is provisional until 30 November 2025. You can check it through this link. To consult the language you will need to enter the CODE of the subject.

Name	Group	Language	Semester	Turn
(TEm) Theory (master)	1	English	first semester	afternoon