UAB
Universitat Autònoma de Barcelona

Adjustment of Optimisation Models

Code: 104360
ECTS Credits: 6

2024/2025

Degree	Type	Year
2503758 Data Engineering	OB	3

Contact

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Teachers

Sundus Zafar

Teaching groups languages

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

Prerequisites

We recommend that students have the following knowledge and skills:

- Probabilities and statistics
- Differential and integral calculus in several variables
- Programming in Python
- Graphs
- Image and video Processing
- Vector spaces

These concepts correspond to the contents of the subjects:

- Probabilistic descriptions
- Fundamentals of Mathematics
- Fundamentals of programming and advanced programming
- Graphs, topology and discrete geometry
- Signal, image and video processing
- Vector spaces

Objectives and Contextualisation

The main objective of the subject is to provide the elements for the modeling of experimental data, optimization with and without restrictions, multi-target optimization. Optimization methods and search algorithms, such as variational calculation, gradient descent methods, evolutionary computing. In particular:

Mathematically analyze the properties of a certain cost function to be optimized in order to choose the best optimization method and /or search algorithm

Formulate the most appropriate cost function for a particular problem of adjusting parameters or mathematical model according to the characteristics of the experimental data and requirements/restrictions of the problem

Competences

- Analyse data efficiently for the development of smart systems with the capacity for autonomous learning and/or data mining.
- Develop critical thinking and reasoning and know how to communicate it effectively in both your own language and in English.
- 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.
- Use the concepts and methods of algebra, differential and integral calculus, numerical methods, statistics and optimisation necessary for solving engineering problems.
- Work cooperatively in complex and uncertain environments and with limited resources in a multidisciplinary context, assuming and respecting the role of the different members of the group.

Learning Outcomes

1. Analyse mathematically the properties of a particular cost function to be optimised in order to pick the best optimisation method and/or search algorithm.
2. Choose the search algorithm and programming paradigm for a problem of optimisation of parameters or states
3. Develop critical thinking and reasoning and know how to communicate it effectively in both your own language and in English.
4. Formulate the most suitable cost function for a specific problem of parameter adjustment or mathematical model, in line with the characteristics of the experimental data and the requirements/restrictions of the problem.
5. 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.
6. Work cooperatively in complex and uncertain environments and with limited resources in a multidisciplinary context, assuming and respecting the role of the different members of the group.

Content

1. Mathematical foundations: Multivariate functions (optimization, integration); Probabilities/Statistics
2. Variational Approaches: formulation, regularization terms, models with restrictions, Lagrange multipliers, numerical methods (gradient descent, stochastic gradient descent, global search), Application to image/video processing (inverse problems, segmentation)
3. Probabilistic Approaches: Bayesian formulation, variational versus probabilistic, expectation maximization, graphical models (conditional random fields, hidden markov models), Application to image/video processing (segmentation)
4. Regression and classification models: Linear models: Least-squares, regularized least-squares (e.g. Lasso), Minimization of cross entropy

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Practice classes	16	0.64	1, 3, 5, 6
Problem assessment	24	0.96	1, 5
Theory Classes	30	1.2	1, 2, 4, 5, 6
Type: Autonomous			
Studi	60	2.4	1, 2, 3, 4, 5, 6

The subject is structured based on theory classes, problems and practices. Theory classes will introduce the concepts and techniques described in the course syllabus. you can continue to use the recommended basic bibliography. Problem classes aim to work on and understand concepts. The lists of problems and, once they have been solved in class, also the solutions will be posted on the Virtual Campus. The aim of the practices, to obtain and clarify the results of the procedures that have been introduced in the classes of theory and problems. The statement of each practice will be posted on the Virtual Campus in advance.

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
Practices	10%	10	0.4	1, 2, 3, 4, 5, 6
Final exam	40%	4	0.16	1, 2, 4
Midterm exam	30%	4	0.16	1, 2, 4
Problem assessment and continuous evaluation	20%	2	0.08	1, 2, 3, 4, 5, 6

The assessment of the subject will consist of:

1. Midterm exam (30%)

2. Final exam (40%)

3. Exam of problems and continous evaluation (20%)

4. Practices (10%)

None of the Assessment activities removes material for the final exam. The final grade will be the weighted average of the activities. No minimum grade policy is set for any activity. If applying the weights mentioned above the student's grade is 5 or higher, the subject is considered passed and this may not be the subject of a new assessment. A student is considered to be "Not assessed" in the subject as long as there is no

participation in any of the assessment activities. Therefore, it is considered that a student who performs some component of Continuous Assessment can no longer qualify for an "Unassessed".

Recovery Process "To participate in the Recovery Process, students must have previously been assessed in a set of activities that represent a minimum of two thirds of the total grade of the subject or module." Section 3 of Article 112b. Recovery (UAB Academic Regulations). Students must have obtained an average grade of the subject between 4.0 and 4.9. The date of this test will be scheduled in the calendar of examinations of the Faculty. The student who presents and passes it will pass the subject with a grade of 5. Otherwise he will keep the same grade.

Irregularities in the Evaluation

Without prejudice to Other disciplinary measures deemed appropriate, and in ACCORDANCE with current academic regulations, "in the event that the student commits any Irregularities that may lead to a significant variation in the rating of an assessment actor, he / she will be graded with an 0 this actor of evaluation, independently of the disciplinary Process that can instruct. in case that produce Several Irregularities in the Acts of evaluation a same subject, the final qualification of this subject will be 0 ". Section 10 of Article 116. Results of the Evaluation. (UAB Academic Regulations) The Proposed Evaluation may undergo some modification depending on the restrictions on attendance imposed by the health authorities.

Bibliography

To be provided at the begining of the course

Software

To be provided at the begining of the course

Language list

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	811	Catalan	first semester	afternoon