Course guide
270416 - OPT - Optimization

Unit in charge: Barcelona School of Informatics
Teaching unit: 715 - EIO - Department of Statistics and Operations Research.

Degree: BACHELOR'S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2021). (Compulsory subject).

Academic year: 2022  ECTS Credits: 6.0  Languages: Catalan, Spanish

LECTURER
Coordinating lecturer: PAU FONSECA CASAS

Others: Segon quadrimestre:
CECILIO ANGULO BAHON - 11, 12
PAU FONSECA CASAS - 11, 12
MARÍA PAZ LINARES HERREROS - 11, 12

PRIOR SKILLS
Know the concept of model and system.
Knowledge of basic statistics.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE01. To be able to solve the mathematical problems that may arise in the field of artificial intelligence. Apply knowledge from: algebra, differential and integral calculus and numerical methods; statistics and optimization.
CE21. To formulate and solve mathematical optimization problems.

General:
CG1. To ideate, draft, organize, plan and develop projects in the field of artificial intelligence.
CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.

Transversal:
CT2. Sustainability and Social Commitment. To know and understand the complexity of economic and social phenomena typical of the welfare society; Be able to relate well-being to globalization and sustainability; Achieve skills to use in a balanced and compatible way the technique, the technology, the economy and the sustainability.
CT4. Teamwork. Be able to work as a member of an interdisciplinary team, either as a member or conducting management tasks, with the aim of contributing to develop projects with pragmatism and a sense of responsibility, taking commitments taking into account available resources.
CT5. Solvent use of information resources. Manage the acquisition, structuring, analysis and visualization of data and information in the field of specialty and critically evaluate the results of such management.
CT6. Autonomous Learning. Detect deficiencies in one’s own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.

Basic:
CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of ??study.
CBS. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy.
TEACHING METHODOLOGY
The classes will combine lectures with practical sessions where the students will work on the content of the topics they have covered. The laboratory classes will allow you to develop cases that allow you to apply the knowledge acquired.

LEARNING OBJECTIVES OF THE SUBJECT
1. Contextualize the different existing optimization techniques.
2. Be able to apply basic optimization techniques to be able to solve computationally complex problems.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study</td>
<td>90,0</td>
<td>60.00</td>
</tr>
<tr>
<td>Hours small group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
</tbody>
</table>

Total learning time: 150 h

CONTENTS

Introduction to optimization
Description:
The concept and need for optimization will be presented. Examples and real cases will be shown in which some of the techniques that will be explained during the course have been used.

Discrete optimization
Description:
Introducció a l'optimització discreta, dualitat, SIMPLEX...

Heuristics
Description:
Optimització basada en heuristics.

Linear Dynamical Systems
Description:
Introduction to linear dynamical systems and their representations: ordinal differential equations; Laplace transform; Fourier transform

Discrete Dynamical Systems Models
Description:
Discrete representation of dynamical systems and modelling: AR, MA, ARMA, NARMAX
Control and Optimisation of Dynamical Systems

Description:
Control of dynamical systems and optimisation processes for tuning

ACTIVITIES

Introduction to optimization

Description:
Description and classification of the different techniques and approaches to optimization.

Specific objectives:
1, 2

Related competencies:
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CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy
CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of study.

Full-or-part-time: 23h
Theory classes: 4h
Practical classes: 4h
Self study: 15h

Linear programming

Full-or-part-time: 23h
Theory classes: 4h
Practical classes: 4h
Self study: 15h
# Introduction to heuristics

**Specific objectives:**
1, 2

**Related competencies:**
CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.
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**Full-or-part-time:** 27h  
Theory classes: 4h  
Practical classes: 4h  
Laboratory classes: 4h  
Self study: 15h

## Linear Dynamical Systems

**Full-or-part-time:** 27h  
Theory classes: 6h  
Practical classes: 6h  
Self study: 15h

## Modelling Discrete Dynamic Systems

**Full-or-part-time:** 25h  
Theory classes: 4h  
Practical classes: 6h  
Self study: 15h
Control and Optimization of Dynamic Systems

**Full-or-part-time:** 25h
Theory classes: 6h
Practical classes: 4h
Self study: 15h

**GRADING SYSTEM**

For the optimization part, two practical works will be developed.
For the second part there will be a practical exercise and an evaluative written exam.

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For the second part there will be a practical work and an evaluation in the form of a written exam.

For the optimization part, two practical tasks T01 and T02 will be developed
For the second part there will be a practical work T03 and an assessment in the form of an EX written exam

Final Grade= 0.25* T01+0.25*T02+0.25*T03+0.25*EX

**Reassessment**
Only those who have taken the exam and failed it can take the reassessment exam.

**BIBLIOGRAPHY**

**Basic:**