Course guide
270600 - AMMM - Algorithmic Methods for Mathematical Models

Unit in charge: Barcelona School of Informatics
Teaching unit: 701 - DAC - Department of Computer Architecture.
723 - CS - Department of Computer Science.

Degree: MASTER’S DEGREE IN INNOVATION AND RESEARCH IN INFORMATICS (Syllabus 2012). (Compulsory subject).

Academic year: 2022 ECTS Credits: 6.0 Languages: English

LECTURER

Coordinating lecturer: ENRIC RODRIGUEZ CARBONELL

Others: Primer quadrimestre:
ENRIC RODRIGUEZ CARBONELL - 11, 12
LUIS DOMINGO VELASCO ESTEBAN - 11, 12

PRIOR SKILLS

Students should be familiar with basic concepts in linear algebra: vector, matrix, rank, matrix inverse and solving systems of linear equations.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEE2.1. Capability to understand models, problems and algorithms related to distributed systems, and to design and evaluate algorithms and systems that process the distribution problems and provide distributed services.
CEE3.2. Capability to use a wide and varied spectrum of algorithmic resources to solve high difficulty algorithmic problems.

Generical:
CG1. Capability to apply the scientific method to study and analyse of phenomena and systems in any area of Computer Science, and in the conception, design and implementation of innovative and original solutions.
CG3. Capacity for mathematical modeling, calculation and experimental designing in technology and companies engineering centers, particularly in research and innovation in all areas of Computer Science.

Transversal:
CTR3. TEAMWORK: Capacity of being able to work as a team member, either as a regular member or performing directive activities, in order to help the development of projects in a pragmatic manner and with sense of responsibility; capability to take into account the available resources.
CTR6. REASONING: Capacity for critical, logical and mathematical reasoning. Capability to solve problems in their area of study. Capacity for abstraction: the capability to create and use models that reflect real situations. Capability to design and implement simple experiments, and analyze and interpret their results. Capacity for analysis, synthesis and evaluation.

TEACHING METHODOLOGY

Since the goal of the course is to provide the students with the necessary expertise to use different formalisms and tools to solve concrete problems, the teaching methodology will take that into account. Theory classes will always use motivating examples. In these sessions, students will solve simple exercises that will be key ingredients of more complicated algorithms.

In the laboratory sessions the students will become familiar with tools for solving problems computationally.

In the development of the project the students will be supervised by the instructors.
LEARNING OBJECTIVES OF THE SUBJECT

1. Modelling in various mathematical formalisms the problems arising in different computer science disciplines
2. Becoming familiar with state-of-the-art tools used to solve various mathematical models
3. Understanding the basics of the algorithms used for solving various mathematical models

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours small group</td>
<td>12,0</td>
<td>8.00</td>
</tr>
<tr>
<td>Self study</td>
<td>96,0</td>
<td>64.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>39,0</td>
<td>26.00</td>
</tr>
<tr>
<td>Guided activities</td>
<td>3,0</td>
<td>2.00</td>
</tr>
</tbody>
</table>

Total learning time: 150 h

CONTENTS

Linear Programming

Description:

Integer linear programming

Description:

Non-linear programming

Description:
Basics on non-linear programming, Modelling examples.

Metaheuristics

Description:
Constructive procedures. Local search. Metaheuristics: GRASP, Simulated Annealing, Tabu Search, Genetic algorithms, Ant Colony, Path Relinking, etc.
ACTIVITIES

**Linear programming**

**Specific objectives:**
1, 3

**Related competencies:**
CG3. Capacity for mathematical modeling, calculation and experimental designing in technology and companies engineering centers, particularly in research and innovation in all areas of Computer Science.

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CEE2.1. Capability to understand models, problems and algorithms related to distributed systems, and to design and evaluate algorithms and systems that process the distribution problems and provide distributed services.

CTR6. REASONING: Capacity for critical, logical and mathematical reasoning. Capability to solve problems in their area of study.

CTR3. TEAMWORK: Capacity of being able to work as a team member, either as a regular member or performing directive activities, in order to help the development of projects in a pragmatic manner and with sense of responsibility; capability to take into account the available resources.

**Full-or-part-time:** 23h
Theory classes: 12h
Self study: 11h

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**Integer Linear Programming**

**Specific objectives:**
1, 3

**Related competencies:**
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**Full-or-part-time:** 20h
Theory classes: 8h
Self study: 12h
Linear Programming Laboratory

Specific objectives:

2

Related competencies:
CG3. Capacity for mathematical modeling, calculation and experimental designing in technology and companies engineering centers, particularly in research and innovation in all areas of Computer Science.
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Full-or-part-time: 13h
Labotory classes: 4h
Self study: 9h

Non-linear programming

Specific objectives:

1, 3

Related competencies:
CG3. Capacity for mathematical modeling, calculation and experimental designing in technology and companies engineering centers, particularly in research and innovation in all areas of Computer Science.
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Full-or-part-time: 7h
Theory classes: 4h
Self study: 3h
Metaheuristics

Specific objectives:
1, 3

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Full-or-part-time: 28h
Theory classes: 16h
Self study: 12h

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Metaheuristics Laboratory

Specific objectives:
2

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Full-or-part-time: 15h
Laboratory classes: 6h
Self study: 9h
Project

Specific objectives:
1, 2

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Full-or-part-time: 27h
Guided activities: 3h
Self study: 24h

Exam

Specific objectives:
1, 2, 3

Related competencies:
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CEE2.1. Capability to understand models, problems and algorithms related to distributed systems, and to design and evaluate algorithms and systems that process the distribution problems and provide distributed services.
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Full-or-part-time: 17h
Guided activities: 3h
Self study: 14h

GRADING SYSTEM

The final grade of the course will take into account:

A) A practical work (project): 40%

B) A final exam: 60%
BIBLIOGRAPHY

Basic:

Complementary: