200618 - OGD - Large Scale Optimization

Coordinating unit: 200 - FME - School of Mathematics and Statistics
Teaching unit: 715 - EIO - Department of Statistics and Operations Research
Academic year: 2017
Degree: MASTER'S DEGREE IN STATISTICS AND OPERATIONS RESEARCH (Syllabus 2013). (Teaching unit Optional)
ECTS credits: 5

Teaching staff

Coordinator: JORDI CASTRO PÉREZ
Others: Segon quadrimestre:
JORDI CASTRO PÉREZ - A
ESTEVE CODINA SANCHO - A

Prior skills

Basic knowledge of Operations Research / Optimization / Modelling in Mathematical Programming / Basic Linear Algebra.

Degree competences to which the subject contributes

Specific:
3. CE-2. Ability to master the proper terminology in a field that is necessary to apply statistical or operations research models and methods to solve real problems.
4. CE-3. Ability to formulate, analyze and validate models applicable to practical problems. Ability to select the method and / or statistical or operations research technique more appropriate to apply this model to the situation or problem.
5. CE-5. Ability to formulate and solve real problems of decision-making in different application areas being able to choose the statistical method and the optimization algorithm more suitable in every occasion.

Transversal:
1. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.
2. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

6. CE-6. Ability to use appropriate software to perform the necessary calculations in solving a problem.
7. CE-9. Ability to implement statistical and operations research algorithms.
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Teaching methodology
Both lectures about theory and practice:

* Theoretical sessions: The contents of the course will be presented and discussed by combining explanations on the board and with transparencies.

* Problem-solving sessions: Interspersed with theory classes; problems and case studies are introduced and solved.

* Practicals: Lab sessions in which software for solving large-scale problems are studied.

* Language: the course can be imparted in either English, Catalan or Spanish.

Learning objectives of the subject
The objective of this course is to introduce students to the solution of large-scale problems as well as the different existing methodologies, specially decomposition methods for structured problems and interior-point methods. On completion of the course, students should be familiar with different types of structured problems and should be able to identify the most appropriate methodology for each problem, in addition to obtaining the solution to the optimization problem in an efficient way.

Skills to be learned
* Given an optimization model, identify whether or not it is suitable to use a decomposition technique.
* Learn the main role played by Lagrangian duality and its relation with different decomposition techniques.
* Implement decomposition methods using algebraic languages for mathematical programming in different models with the aim of resolving them.
* Learn the differences between the simplex method for Linear Programming and the interior-point methods, as well as when it is suitable to use the former or the latter.
* Learn the foundations of the interior point methods, for LP, QP and convex NLP.
* Implement simple versions of interior-point methods with high-level languages (matlab), as well as learning the required linear algebra tools.

Study load

<table>
<thead>
<tr>
<th>Study load</th>
<th>Hours large group:</th>
<th>Hours medium group:</th>
<th>Hours small group:</th>
<th>Guided activities:</th>
<th>Self study:</th>
</tr>
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<tbody>
<tr>
<td>Total learning time: 125h</td>
<td>30h</td>
<td>0h</td>
<td>15h</td>
<td>0h</td>
<td>80h</td>
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<tbody>
<tr>
<td>Total learning time: 125h</td>
<td>24.00%</td>
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<tr>
<td>Hours large group:</td>
<td>0.00%</td>
</tr>
<tr>
<td>Hours medium group:</td>
<td>12.00%</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>0.00%</td>
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<tr>
<td>Guided activities:</td>
<td>64.00%</td>
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</tbody>
</table>
### Content

| **DUALITY** | **Learning time:** 6h  
Theory classes: 6h |
|-------------|----------------------|
| **Description:**  

| **DECOMPOSITION METHODS** | **Learning time:** 13h 30m  
Theory classes: 13h 30m |
|---------------------------|-----------------------------|
| **Description:**  

| **INTERIOR-POINT METHODS** | **Learning time:** 19h 30m  
Laboratory classes: 19h 30m |
|-----------------------------|-----------------------------|
| **Description:**  

### Qualification system

Two practical assignments for each part of the course (1. Duality and decomposition; 2 interior-point methods). Each assignment is a 50% of the overall mark.
# Bibliography

## Basic:

- **Chvátal, Vasek.** Linear programming. Freeman, 1983.

## Complementary:

- **Sierksma, Gerard.** Linear and integer programming theory and practice. 2nd ed. Marcel Dekker, 1996.