200642 - ODS - Optimization in Data Science

Coordinating unit: 200 - FME - School of Mathematics and Statistics
Teaching unit: 715 - EIO - Department of Statistics and Operations Research
Academic year: 2016
Degree: MASTER'S DEGREE IN STATISTICS AND OPERATIONS RESEARCH (Syllabus 2013). (Teaching unit Optional)
ECTS credits: 5
Teaching languages: English

Teaching staff
Coordinator: JORDI CASTRO PÉREZ
Others: Primer quadrimestre: JORDI CASTRO PÉREZ - A

Prior skills
Basic concepts of Statistics and Operations Research.

Degree competences to which the subject contributes

Specific:
6. 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.
7. 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.
8. 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.
9. CE-6. Ability to use appropriate software to perform the necessary calculations in solving a problem.
10. CE-7. Ability to understand statistical and operations research papers of an advanced level. Know the research procedures for both the production of new knowledge and its transmission.
11. CE-8. Ability to discuss the validity, scope and relevance of these solutions and be able to present and defend their conclusions.
12. CE-9. Ability to implement statistical and operations research algorithms.

Transversal:
1. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding how companies are organised and the principles that govern their activity, and being able to understand employment regulations and the relationships between planning, industrial and commercial strategies, quality and profit.
2. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.
3. 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.
4. 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.
5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English,
The aim of the course is to introduce students to some applications of "data science" that can be formulated and solved by optimization techniques. The course has three parts:

1. The first part of the course shows how to model and solve some statistical problems by optimization techniques (orthogonal Latin squares, classification problems k-median, etc).
2. The second part presents the mathematical foundations of optimization required to formulate and solve "support vector machines".
3. The third part is an introduction to the field of statistical disclosure control or statistical data protection. This discipline includes a set of methods to ensure the confidentiality of individual data when disseminating statistical data, either microdata or aggregate data in tabular form. This issue is of great importance for national statistical offices, and in general, for any public or private entity that has to release data.

Skills to be acquired

* To formulate some "data science" applications as optimization problems (clustering, support vector machines ...)
* To learn how to solve the formulated "data science" problems using optimization software.
* To know what is the field of statistical disclosure control or statistical data protection.
* To know software for data protection.
* The ability to protect data using any existing technique.
* To become familiar with literature of optimization for "data science".

Learning objectives of the subject

Theory:
The contents of the subject are presented and discussed with a combination of explanations on the board and with transparencies.

Training:
Laboratory sessions which demonstrate the use of software.

Study load

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

<table>
<thead>
<tr>
<th>Optimization in statistical problems.</th>
<th>Learning time:</th>
<th>11h 15m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes:</td>
<td>7h 30m</td>
</tr>
<tr>
<td></td>
<td>Practical classes:</td>
<td>3h 45m</td>
</tr>
</tbody>
</table>

**Description:**

<table>
<thead>
<tr>
<th>Introduction to SVMs</th>
<th>Learning time:</th>
<th>11h 15m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes:</td>
<td>7h 30m</td>
</tr>
<tr>
<td></td>
<td>Practical classes:</td>
<td>3h 45m</td>
</tr>
</tbody>
</table>

**Description:**
Primal formulation of support vector machines (SVMs). KKT conditions of SVMs. The dual formulation of SVMs. Optimization approaches for SVMs.

<table>
<thead>
<tr>
<th>Statistical data protection.</th>
<th>Learning time:</th>
<th>22h 30m</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes:</td>
<td>15h</td>
</tr>
<tr>
<td></td>
<td>Practical classes:</td>
<td>7h 30m</td>
</tr>
</tbody>
</table>

**Description:**

## Qualification system
Completion of exercises and class work.

## Bibliography

**Basic:**