Course guide
270219 - VI - Information Visualization

Unit in charge: Barcelona School of Informatics
Teaching unit: 723 - CS - Department of Computer Science.
Degree: BACHELOR'S DEGREE IN DATA SCIENCE AND ENGINEERING (Syllabus 2017). (Compulsory subject).
Academic year: 2022  ECTS Credits: 6.0  Languages: English

LECTURER

Coordinating lecturer: PERE PAU VÁZQUEZ ALCOCER

Others: Primer quadrimestre:
ELENA MOLINA LÓPEZ - 11, 12
PERE PAU VÁZQUEZ ALCOCER - 11, 12, 13

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE1. Skillfully use mathematical concepts and methods that underlie the problems of science and data engineering.
CE10. Visualization of information to facilitate the exploration and analysis of data, including the choice of adequate representation of these and the use of dimensionality reduction techniques.
CE4. Use current computer systems, including high performance systems, for the process of large volumes of data from the knowledge of its structure, operation and particularities.
CE5. Design and apply techniques of signal processing, choosing between different technological tools, including those of Artificial vision, speech recognition and multimedia data processing.
CE7. Demonstrate knowledge and ability to apply the necessary tools for the storage, processing and access to data.

General:
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.

Transversal:
CT3. Efficient oral and written communication. Communicate in an oral and written way with other people about the results of learning, thinking and decision making; Participate in debates on topics of the specialty itself.
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.
CT7. Third language. Know a third language, preferably English, with an adequate oral and written level and in line with the needs of graduates.

Basic:
CB3. That students have the ability to gather and interpret relevant data (usually within their area of ??study) to make judgments that include a reflection on relevant social, scientific or ethical issues.
CB4. That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized public.
TEACHING METHODOLOGY

Classes will be given with the support of slides and articles. During the classes, exercises will be proposed and resolved.

For the laboratory part, directed practices will be developed in the laboratory hours.

There will be a partial delivery of laboratory and a final project.

LEARNING OBJECTIVES OF THE SUBJECT

1. Introduction to Information Visualization
2. Introducción a la percepción visual
3. Exploratory data analysis
4. Design of information visualization systems
5. Focus and context
6. Interaction and animation
7. Visualization of multi-dimensional data
8. Multiple views and coordinated views
9. Item and attributes reduction
10. Validation of visualization systems
11. Implementation of visualization applications
12. Advanced visualization techniques

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
<tr>
<td>Hours small group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
<tr>
<td>Self study</td>
<td>90,0</td>
<td>60.00</td>
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Total learning time: 150 h

CONTENTS

**Introduction to visualization**

Description:
In this topic we will discuss the need for visualization of data and the objectives of the visualization tools.

**Perception and color**

Description:
Visual perception is a very important factor when creating visualizations, since the visual system is the one that receives the greatest amount of information that we perceive. In this topic we will talk about the visual system, and some theories of the perception of color and forms.

**Visual representations of the data**

Description:
There are a large number of methods of data representation: tables, graphs, trees, etc. In this topic we will visit them and we will end up giving some guides to select the most appropriate representation for each problem.
**Visualization of multiple data**

**Description:**
In many cases, the information that we want to represent will be highly complex and we will often find ourselves in the situation of having to represent multiple variables. Here we will discuss different possibilities that will be detailed in later issues.

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<thead>
<tr>
<th>Animation and interaction</th>
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<tr>
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<td>To explore the data, you must be able to work on visual representations. This topic will see data changes in different dimensions: time, point of view ...</td>
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<tr>
<td>Advanced data representation systems</td>
</tr>
<tr>
<td>- Maps</td>
</tr>
<tr>
<td>- Time display</td>
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<tr>
<td>- Visualization of 3D data</td>
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<tr>
<td>- Other scientific data</td>
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<th>Implementation of information visualization applications</th>
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<tr>
<td>There are many tools and technologies developed recently that make creating views easier, such as Tableau, Vega, Lyra or using programming languages and libraries such as D3 for JavaScript or Bokeh for Python. The objective of this subject is that students are able to perform visualization applications using some of the most modern tools.</td>
</tr>
</tbody>
</table>
## ACTIVITIES

### Introduction to data visualization systems

**Description:**
Development of the theme: Introduction to visualization

**Specific objectives:**
1, 4

**Related competencies:**
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CE10. Visualization of information to facilitate the exploration and analysis of data, including the choice of adequate representation of these and the use of dimensionality reduction techniques.
CE7. Demonstrate knowledge and ability to apply the necessary tools for the storage, processing and access to data.
CE4. Use current computer systems, including high performance systems, for the process of large volumes of data from the knowledge of its structure, operation and particularities.
CT3. Efficient oral and written communication. Communicate in an oral and written way with other people about the results of learning, thinking and decision making; Participate in debates on topics of the specialty itself.
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.
CB4. That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized public.
CB3. That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant social, scientific or ethical issues.

**Full-or-part-time:** 5h
- Theory classes: 1h 30m
- Practical classes: 0h 30m
- Laboratory classes: 2h
- Self study: 1h
# Color and perception

**Description:**
Development of the subject: perception and color
Ranking of Mackinlay
Pre-attentive care
Type of dimensions
Principles of perception
Brands and channels
Color

**Specific objectives:**
2, 3, 4

**Related competencies:**
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CE10. Visualization of information to facilitate the exploration and analysis of data, including the choice of adequate representation of these and the use of dimensionality reduction techniques.
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**Full-or-part-time:** 6h
Theory classes: 3h
Practical classes: 1h
Self study: 2h
Design of information visualization systems

Description:
Development of topic 3: Design of information visualization systems

Specific objectives:
3, 4, 7

Related competencies:
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CE1. Skillfully use mathematical concepts and methods that underlie the problems of science and data engineering.
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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.
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Full-or-part-time: 7h
Theory classes: 2h 30m
Practical classes: 1h 30m
Self study: 3h
**Exploratory data analysis**

**Description:**
Development of the subject: Exploratory data analysis

**Specific objectives:**
4, 6, 7

**Related competencies:**
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CE1. Skillfully use mathematical concepts and methods that underlie the problems of science and data engineering.
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**Full-or-part-time:** 3h 30m
Theory classes: 1h
Practical classes: 0h 30m
Self study: 2h
Exploratory data analysis

Description:
Development of the theme: Multi-dimensional view
Multiple brands and channels
Complex diagrams: Trellis, SPLOM, PCP
Views

Specific objectives:
2, 3, 4, 6, 7

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Full-or-part-time: 4h
Theory classes: 1h 30m
Practical classes: 0h 30m
Self study: 2h
Design of views in a commercial tool such as QlikView

Description:
Design of views in a commercial tool such as QlikView

Specific objectives:
3, 7, 11

Related competencies:
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Full-or-part-time: 14h
Laboratory classes: 6h
Guided activities: 2h
Self study: 6h
Interaction and animation

Description:
Development of the theme: Interaction and animation

Specific objectives:
3, 4, 5, 8

Related competencies:
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Full-or-part-time: 6h
Theory classes: 3h
Practical classes: 1h
Self study: 2h
View manipulation

Description:
Development of the theme: View manipulation

Specific objectives:
5, 6, 7, 8

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Full-or-part-time: 4h
Theory classes: 1h 30m
Practical classes: 0h 30m
Self study: 2h
Focus + context

Description:
Techniques of focus and context of the data:
- Delete information
- Superimposition of information
- Distortion

Specific objectives:
2, 4, 5, 8

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Full-or-part-time: 4h
Theory classes: 1h 30m
Practical classes: 0h 30m
Self study: 2h
Data reduction

**Description:**
Development of the subject: Data reduction

**Specific objectives:**
4, 5, 7, 9, 10

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**Full-or-part-time:** 3h
Theory classes: 1h
Self study: 2h
Advanced data representation systems

Description:
Advanced data representation systems

- Maps

- Time display

- Visualization of 3D data

- Other scientific data

Specific objectives:
3, 4, 7, 12

Related competencies:
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Full-or-part-time: 7h
Theory classes: 3h
Practical classes: 1h
Self study: 3h
Validation of information visualization systems

Description:
Evaluation and validation of data visualization systems

Specific objectives:
3, 4, 10

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Full-or-part-time: 3h
Theory classes: 1h 30m
Practical classes: 0h 30m
Self study: 1h
Partial exam

**Description:**
Partial exam

**Specific objectives:**
2, 3, 4, 6, 7, 8

**Related competencies:**
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**Full-or-part-time:** 5h 30m
Guided activities: 1h 30m
Self study: 4h
Lab project

Description:
Lab project

Specific objectives:
3, 4, 11

Related competencies:
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CE1. Skillfully use mathematical concepts and methods that underlie the problems of science and data engineering.
CE10. Visualization of information to facilitate the exploration and analysis of data, including the choice of adequate representation of these and the use of dimensionality reduction techniques.
CE5. Design and apply techniques of signal processing, choosing between different technological tools, including those of Artificial vision, speech recognition and multimedia data processing.
CE7. Demonstrate knowledge and ability to apply the necessary tools for the storage, processing and access to data.
CE4. Use current computer systems, including high performance systems, for the process of large volumes of data from the knowledge of its structure, operation and particularities.
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.
CT7. Third language. Know a third language, preferably English, with an adequate oral and written level and in line with the needs of graduates.
CT3. Efficient oral and written communication. Communicate in an oral and written way with other people about the results of learning, thinking and decision making; Participate in debates on topics of the specialty itself.
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.
CB4. That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized public.
CB3. That students have the ability to gather and interpret relevant data (usually within their area of ??study) to make judgments that include a reflection on relevant social, scientific or ethical issues.

Full-or-part-time: 6h
Guided activities: 2h
Self study: 4h
Implementation of information visualization applications

Description:
Implementation of information visualization applications

Specific objectives:
3, 4, 7, 11

Related competencies:
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CE1. Skillfully use mathematical concepts and methods that underlie the problems of science and data engineering.
CE10. Visualization of information to facilitate the exploration and analysis of data, including the choice of adequate representation of these and the use of dimensionality reduction techniques.
CE5. Design and apply techniques of signal processing, choosing between different technological tools, including those of Artificial vision, speech recognition and multimedia data processing.
CE7. Demonstrate knowledge and ability to apply the necessary tools for the storage, processing and access to data.
CE4. Use current computer systems, including high performance systems, for the process of large volumes of data from the knowledge of its structure, operation and particularities.
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.
CT7. Third language. Know a third language, preferably English, with an adequate oral and written level and in line with the needs of graduates.
CT3. Efficient oral and written communication. Communicate in an oral and written way with other people about the results of learning, thinking and decision making; Participate in debates on topics of the specialty itself.
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.
CB3. That students have the ability to gather and interpret relevant data (usually within their area of ??study) to make judgments that include a reflection on relevant social, scientific or ethical issues.

Full-or-part-time: 44h
Laboratory classes: 22h
Guided activities: 2h
Self study: 20h
Final exam

Description:
Final exam

Specific objectives:
2, 3, 4, 5, 6, 7, 8, 9, 10

Related competencies:
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CE1. Skillfully use mathematical concepts and methods that underlie the problems of science and data engineering.
CE10. Visualization of information to facilitate the exploration and analysis of data, including the choice of adequate representation of these and the use of dimensionality reduction techniques.
CE5. Design and apply techniques of signal processing, choosing between different technological tools, including those of Artificial vision, speech recognition and multimedia data processing.
CE7. Demonstrate knowledge and ability to apply the necessary tools for the storage, processing and access to data.
CE4. Use current computer systems, including high performance systems, for the process of large volumes of data from the knowledge of its structure, operation and particularities.
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.
CT7. Third language. Know a third language, preferably English, with an adequate oral and written level and in line with the needs of graduates.
CT3. Efficient oral and written communication. Communicate in an oral and written way with other people about the results of learning, thinking and decision making; Participate in debates on topics of the specialty itself.
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.
CB4. That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized public.
CB3. That students have the ability to gather and interpret relevant data (usually within their area of ??study) to make judgments that include a reflection on relevant social, scientific or ethical issues.

Full-or-part-time: 4h
Self study: 4h

GRADING SYSTEM

During the course there will be two laboratory practices (Labo1 and Labo2). In addition, there will be a partial exam (Partial) and a final exam (Final).

The final grade is calculated as:

Final Note = 0.15 Labo1 + 0.3 Labo2 + max(0.15 Partial + .4 Final, 0.55 Final)

The re-evaluation exam substitutes the theoretical contents, not the lab part.

BIBLIOGRAPHY

Basic: