Course guide
270542 - VD - Data Visualization

Unit in charge: Barcelona School of Informatics
Teaching unit: 723 - CS - Department of Computer Science.
Degree: MASTER'S DEGREE IN INFORMATICS ENGINEERING (Syllabus 2012). (Optional subject).
Academic year: 2022 ECTS Credits: 3.0 Languages: Catalan, English

LECTURER

Coordinating lecturer: PERE PAU VÁZQUEZ ALCOCER
Others: Segon quadrimestre: PERE PAU VÁZQUEZ ALCOCER - 10

PRIOR SKILLS
Students should have a basic knowledge of statistics and eventually computer graphics. They should also be able to program in some general programming language, preferably Python.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CDG3. Capability to manage research, development and innovation projects in companies and technology centers, guaranteeing the safety of people and assets, the final quality of products and their homologation.
CTE11. Capability to conceptualize, design, develop and evaluate human-computer interaction of products, systems, applications and informatic services.
CTE12. Capability to create and exploit virtual environments, and to the create, manage and distribute of multimedia content.
CTE9. Capability to apply mathematical, statistical and artificial intelligence methods to model, design and develop applications, services, intelligent systems and knowledge-based systems.

Generical:
CG9. Capacity to understand and apply ethical responsibility, law and professional deontology of the activity of the Informatics Engineering profession.

Transversal:
CTR4. INFORMATION LITERACY: Capability to manage the acquisition, structuring, analysis and visualization of data and information in the area of informatics engineering, and critically assess the results of this effort.
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.

Basic:
CB7. Ability to integrate knowledges and handle the complexity of making judgments based on information which, being incomplete or limited, includes considerations on social and ethical responsibilities linked to the application of their knowledge and judgments.
CB8. Capability to communicate their conclusions, and the knowledge and rationale underpinning these, to both skilled and unskilled public in a clear and unambiguous way.
CB9. Possession of the learning skills that enable the students to continue studying in a way that will be mainly self-directed or autonomous.
TEACHING METHODOLOGY

The course will be taught in a very practical way. Some theoretical concepts will be discussed each day, and the rest of the session will be devoted to working on the concepts in the laboratory. It will start with solving simple visualization exercises and then move on to developing a two-stage project. In a first stage, a static multi-view view will be performed and in a second stage, interaction will be added.

LEARNING OBJECTIVES OF THE SUBJECT

2. Introduction to Visualization
3. Perception
4. Basic and advanced data visualization techniques
5. Multiple Views, Interaction, and Data Reduction
6. Implementation of data visualization systems

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guided activities</td>
<td>3,0</td>
<td>4.00</td>
</tr>
<tr>
<td>Self study</td>
<td>48,0</td>
<td>64.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>12,0</td>
<td>16.00</td>
</tr>
<tr>
<td>Hours small group</td>
<td>12,0</td>
<td>16.00</td>
</tr>
</tbody>
</table>

Total learning time: 75 h

CONTENTS

Visualization 101

Description:
This section will introduce the most important visualization concepts, some bad practices will be described. The history of the display will also be discussed.

Data visualization idioms

Description:
This topic will show the most basic data visualization techniques and also present some more advanced techniques for visualizing complex data, such as multi-variable visualization or geospatial visualization.

Perception

Description:
The basic operation of the visual perception system will be explained. Some important concepts such as attentional variables, the importance of color, and the most important principles of perception will also be described. It will also describe which visual variables are perceived more carefully than others.
Multiple view design

Description:
To represent highly complex information, it is very common to need multiple variables and views. This section will cover how to design complex systems using multiple views: how to organize views, separate data, and how to create linked interactions.

Implementation of data visualization applications

Description:
There are many tools and technologies developed that allow the programming of data visualization systems. There are tools that do not require any programming such as Tableau, Vega, Lyra or that provide more control over the result using programming languages and libraries such as Altair for Python, Matplotlib for R, or D3 for JavaScript. The aim of this topic is for students to be able to assess the needs of a project in order to be able to choose the right tool. In addition, it will also be essential for students to learn how to make interactive data visualization applications using a modern library, such as Altair or Vega.

ACTIVITIES

Introduction to visualization and data visualization systems

Description:
Topic development: Introduction to visualization

Specific objectives:
2

Related competencies:
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Full-or-part-time: 4h
Theory classes: 1h 30m
Practical classes: 0h 30m
Self study: 2h
Perception

Description:
Topic development: perception and color.
Ranking of visual variables.
Concepts of perception: preattentive variables.
Principles of perception.
Marks and channels.
Use of color and color palettes.

Specific objectives:
2, 3

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Full-or-part-time: 6h
Theory classes: 3h
Practical classes: 1h
Self study: 2h
**Visualization techniques**

**Description:**

**Specific objectives:**
4, 5

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**Full-or-part-time:** 19h
- Theory classes: 1h 30m
- Practical classes: 0h 30m
- Laboratory classes: 4h
- Guided activities: 7h
- Self study: 6h

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**Multiple view design**

**Description:**

**Full-or-part-time:** 25h
- Theory classes: 3h
- Practical classes: 1h
- Laboratory classes: 2h
- Guided activities: 9h
- Self study: 10h
Implementation of data visualization applications.

Description:
Learning a data visualization tool or library. Data visualization project.

Specific objectives:
2, 3, 4, 5, 6

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Full-or-part-time: 21h
Laboratory classes: 6h
Guided activities: 9h
Self study: 6h
Lab1 delivery

Description:
Delivery of the first part of the project: Static visualization

Specific objectives:
2, 3, 4, 5, 6

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Full-or-part-time: 10h
Self study: 10h
Lab2 delivery

Description:
Delivery of the second part of the project: Lab2

Specific objectives:
3, 4, 5, 6

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Full-or-part-time: 10h
Self study: 10h
Final exam

Description:
There will be a final test to demonstrate the knowledge acquired in the subject.

Specific objectives:
2, 3, 4, 5, 6

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Full-or-part-time: 6h
Guided activities: 2h
Self study: 4h

GRADING SYSTEM
The subject will be evaluated with a project that will have two deliveries and a final exam. The first installment will be a static display (Lab1) and the second will be an interactive display (Lab2). The final grade will be: \( NF = \text{Lab1} \times 0.3 + \text{Lab2} \times 0.4 + 0.3 \times \text{FinalExam} \)

BIBLIOGRAPHY

Basic: