Course guides
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: 2021  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.

General:
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>Self study</td>
<td>48,0</td>
<td>64.00</td>
</tr>
<tr>
<td>Theory classes</td>
<td>12,0</td>
<td>16.00</td>
</tr>
<tr>
<td>Laboratory classes</td>
<td>12,0</td>
<td>16.00</td>
</tr>
<tr>
<td>Guided activities</td>
<td>3,0</td>
<td>4.00</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: 26h
Theory classes: 1h 30m
Practical classes: 0h 30m
Laboratory classes: 4h
Guided activities: 4h
Self study: 16h

Multiple view design

Description:

Full-or-part-time: 30h
Theory classes: 3h
Practical classes: 1h
Laboratory classes: 2h
Guided activities: 4h
Self study: 20h
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: 45h
Laboratory classes: 6h
Guided activities: 4h
Self study: 35h
Lab1 delivery

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

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

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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.

**Full-or-part-time:** 20h
Self study: 20h
Lab2 delivery

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

Specific objectives:
3, 4, 5, 6

Related competencies:
CG9. Capacity to understand and apply ethical responsibility, law and professional deontology of the activity of the Informatics Engineering profession.
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Full-or-part-time: 25h
Self study: 25h

GRADING SYSTEM

The subject will be evaluated with a project that will have two deliveries. The first installment will be a static display (Lab1) and the second will be an interactive display (Lab2). The final grade will be: \( NF = \text{Lab1} \times 0.5 \text{ Lab2} \times 0.5 \)

BIBLIOGRAPHY

Basic: