Course guide
270969 - VD - Data Visualization

Last modified: 03/02/2025

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).
MASTER'S DEGREE IN INNOVATION AND RESEARCH IN INFORMATICS (Syllabus 2012). (Optional subject).
MASTER'S DEGREE IN DATA SCIENCE (Syllabus 2021). (Optional subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: PERE PAU VÁZQUEZ ALCOCER - OSCAR ARGUDO MEDRANO

Others: Segon quadrimestre:
OSCAR ARGUDO MEDRANO - 10
MARTA FAIREN GONZALEZ - 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:
CE11. Analyze and extract knowledge from unstructured information using natural language processing techniques, text and image mining
CE5. Model, design, and implement complex data systems, including data visualization

Generical:
CG2. Identify and apply methods of data analysis, knowledge extraction and visualization for data collected in disparate formats

Transversal:
CT4. INFORMATION LITERACY: Capacity for managing the acquisition, the structuring, analysis and visualization of data and information in the field of specialisation, and for critically assessing the results of this management.

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 subject will be taught with theoretical content and problems that will be raised during the development of the theoretical classes and more technical content taught in the laboratory classes. In the laboratories, you will start by solving simple visualization exercises and then you will move on to developing a project in two stages. In a first stage, a static multi-view visualization will be performed and in a second stage, interaction and more complex visualization elements will be added.

LEARNING OBJECTIVES OF THE SUBJECT

1.Introduction to Visualization
2.Perception
3.Basic data visualization techniques
4.Advanced visualization techniques
5.Geospatial visualization
6.Implementation of data visualization systems
7.Trees and graphs visualization
8.Time-oriented visualization
9.Text visualization
11.Multiple Views
12.Advanced visualization concepts

STUDY LOAD

Type	Hours	Percentage
Self study	96,0	64.00
Hours small group	27,0	18.00
Hours large group	27,0	18.00

Total learning time: 150 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.

Visualization for specialized data

Description:
This section will deal with data that have a specific nature, such as geospatial data, temporal data, textual data, etc.

Advanced concepts

Description:
In this section, we will deal with advanced visualization concepts, that may include areas such as the visualization of scientific data, dimensionality reduction algorithms, etc.

ACTIVITIES

Introduction to visualization and data visualization systems

Description:
Topic development: Introduction to visualization

Specific objectives:
1

Related competencies :
CG2. Identify and apply methods of data analysis, knowledge extraction and visualization for data collected in disparate formats
CE11. Analyze and extract knowledge from unstructured information using natural language processing techniques, text and image mining
CE5. Model, design, and implement complex data systems, including data visualization
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Full-or-part-time: 8h
Theory classes: 3h
Practical classes: 1h
Laboratory classes: 2h
Self study: 2h

Visualization techniques

Description:
Topic development: Visual representations of data. Basic visualization techniques. Advanced visualization techniques.

Specific objectives:
3, 4

Related competencies :
CG2. Identify and apply methods of data analysis, knowledge extraction and visualization for data collected in disparate formats
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Full-or-part-time: 12h
Theory classes: 3h
Practical classes: 1h
Laboratory classes: 2h
Self study: 6h

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

Related competencies :
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CE5. Model, design, and implement complex data systems, including data visualization
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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: 8h
Theory classes: 3h
Practical classes: 1h
Laboratory classes: 2h
Self study: 2h

Techniques for specialized data visualization

Description:
This section will deal with the specific types of data: geospatial data, text, etc., which are particular because of the way the data is represented, and the techniques required for its visualization.

Specific objectives:
5, 7, 8, 9

Related competencies :
CG2. Identify and apply methods of data analysis, knowledge extraction and visualization for data collected in disparate formats
CE11. Analyze and extract knowledge from unstructured information using natural language processing techniques, text and image mining
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Full-or-part-time: 12h
Theory classes: 6h
Practical classes: 2h
Self study: 4h

Multiple view design

Description:
Development of the topic: Design of multiple views. Organization of multiple views. Coordinated views. Interaction. Exploratory data analysis.

Specific objectives:
11

Related competencies :
CG2. Identify and apply methods of data analysis, knowledge extraction and visualization for data collected in disparate formats
CE11. Analyze and extract knowledge from unstructured information using natural language processing techniques, text and image mining
CE5. Model, design, and implement complex data systems, including data visualization
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Full-or-part-time: 12h
Theory classes: 1h 30m
Practical classes: 0h 30m
Self study: 10h

Advanced visualization concepts

Description:
In this section, advanced concepts will be introduced, such as dimensionality reduction algorithms, visualization of scientific data, etc.

Specific objectives:
12

Related competencies :
CG2. Identify and apply methods of data analysis, knowledge extraction and visualization for data collected in disparate formats
CE11. Analyze and extract knowledge from unstructured information using natural language processing techniques, text and image mining
CE5. Model, design, and implement complex data systems, including data visualization
CT4. INFORMATION LITERACY: Capacity for managing the acquisition, the structuring, analysis and visualization of data and information in the field of specialisation, and for critically assessing the results of this management.
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Full-or-part-time: 2h
Theory classes: 1h 30m
Practical classes: 0h 30m

Implementation of data visualization applications.

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

Specific objectives:
1, 2, 3, 4, 5, 6, 8, 11

Related competencies :
CG2. Identify and apply methods of data analysis, knowledge extraction and visualization for data collected in disparate formats
CE11. Analyze and extract knowledge from unstructured information using natural language processing techniques, text and image mining
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Full-or-part-time: 72h
Laboratory classes: 18h
Guided activities: 1h
Self study: 53h

Lab1 delivery

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

Specific objectives:
1, 2, 3, 5, 6

Related competencies :
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CE11. Analyze and extract knowledge from unstructured information using natural language processing techniques, text and image mining
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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: 6h
Self study: 6h

Lab2 delivery

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

Specific objectives:
1, 2, 3, 4, 5, 6, 7, 8, 9, 11

Related competencies :
CG2. Identify and apply methods of data analysis, knowledge extraction and visualization for data collected in disparate formats
CE11. Analyze and extract knowledge from unstructured information using natural language processing techniques, text and image mining
CE5. Model, design, and implement complex data systems, including data visualization
CT4. INFORMATION LITERACY: Capacity for managing the acquisition, the structuring, analysis and visualization of data and information in the field of specialisation, and for critically assessing the results of this management.
CB9. Possession of the learning skills that enable the students to continue studying in a way that will be mainly self-directed or autonomous.
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.

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:
1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12

Related competencies :
CG2. Identify and apply methods of data analysis, knowledge extraction and visualization for data collected in disparate formats
CE11. Analyze and extract knowledge from unstructured information using natural language processing techniques, text and image mining
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Full-or-part-time: 10h
Guided activities: 2h
Self study: 8h

GRADING SYSTEM

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

BIBLIOGRAPHY

Basic:
- Knaflic, Cole Nussbaumer. Storytelling with data : a data visualization guide for business professionals. Hoboken, New Jersey: John Wiley & Sons, Inc, 2015. ISBN 9781119002062.