UAB
Universitat Autònoma de Barcelona

Data Visualisation

2026/2027

Code: 104365
Credits: 6

Degree programme	Type	Course
Data Engineering	OB	3

Contact lecturer

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Group languages

You can consult this information at the end of the document.

Prerequisites

It is recommended that students have or review knowledge and concepts of:

- Graph analysis and information retrieval.
- Model adjustment and optimization.
- Computational learning.
- Statistical analysis.

Objectives

The course aims to give students elements to find the best data visualization technique that allows better analysis of data, or allows a specific type of analysis.
KNOWLEDGEMENTS: At the end of the course the student must be able to:

- To know and understand the basic systems of visualization and exploratory analysis of data.
- To know and understand the main visualization models.
- To know and understand current libraries for data visualization (Google Charts, JQuery plug-ins, D3.js)

SKILLS: It is intended that students acquire the following skills:

- Given a set of data, know how to use the most appropriate visualization system and model for data visualization that allows the analysis to be performed.
- Given a data set, know how to use one of the data display libraries toget the best graphical results.

LEARNING OUTCOMES:

1. To know and understand the basic systems of visualization and exploratory analysis of data.
2. To know and understand the main visualization models.
3. To know and understand current libraries for data visualization (Google Charts, JQuery plug-ins, D3.js)
4. To know how to apply the most optimal data visualization techniques for data analysis based on a specific case.
5. To Work cooperatively.

Learning outcomes

1. Students must be capable of collecting and interpreting relevant data (usually within their area of study)

in order to make statements that reflect social, scientific or ethical relevant issues.
2. Search, select and manage information and knowledge responsibly.
3. Relate statistical and artificial-intelligence techniques to the visualisations that best express the underlying information.
4. Identify the usability and interactivity needs of a data-visualisation method and be able to produce a new version of the visualisation that improves on the above aspects.

Contents

1. Introduction to Data Visualization (2 hours)

- Definitions and importànce
- Data visualitation as cognitive tool

2. Data and Tasks (2 hours)

- Data types
- Task-oriented dessign

3. Visual Codification (2 hours)

- Task-oriented visualizatiion
- Visual channels
- Visual codification

4. Tables and Visual Precision (2 hours)

- Table visualization
- Visual honesty
- Good and bad practices

5. Data Processing for Visualization (2 hours)

- Uncertainity and error
- Transformations and Data Massage

6. Advanced Systems (2 hours)

- Multiples variables and multiples dimensions
- Networks
- Vector fields

7. Dessign and Color (2 hours)

- Visual perception
- Composition
- Color

8. Data Processing for Visualization (2 hours)

- Dimensionality reduction
- Computation and important metrics selection

9. Advanced Systems (2 hours)

- 3D data
- Scientific visualization
- Maps

10. Interactivity and Animation (4 hours)

- Introduction
- Interactivity
- Animation
- Factors to implement interactivity

11. Methodologies and Storytelling (2 hours)

- Storytelling
- Narrative with data
- Planning

12. Usability and User Experience (UX) (2 hours)

- Introduction
- Usability
- User experience (UX)

Learning activities and methodology

Title	Hours	ECTS	Learning outcomes
Case studies	4	0.16	
Resolution and practical exercises	12	0.48	
Individual study	26	1.04	
Explanation and problem solving	14	0.56	
Explanation and problem solving	30	1.2	
Lectures	26	1.04	
Resolution of practical exercises	30	1.2	

LEARNING MANAGEMENT SYSTEM (LMS): Virtual Campus (http://cv.uab.cat), Moodle classroom \"Visualització de Dades (24-25)\".

The student learning process is based on two types of face-to-face activities (Theory and Seminars). Attendance at online theory and seminar classes is NOT REQUIRED, but YES HIGHLY RECOMMENDED.

THEORY

Theory classes are taught through master classes with transparencies and blackboard. All course material will be accessible through the Virtual Platform. Some of the theory sessions will be dedicated to solving exercises posed in the same classroom with the aim of delving into the most relevant concepts and teaching students to identify and analyze typical errors.

SEMINARS

In the seminar sessions we will alternate two activities: problems (7 sessions) and practices (6 sessions).

In the PROBLEMS sessions we will propose exercises to solve on the following topics:

- Simple graphs (bars, lines, boxplots, scatter, etc.) - Tool: R

- Complex graphs (parallel coordinates, small multiples, networks, etc.) - Tool: R
- Other tools (commercial and free) - Tools: Tableau Public, DataWrapper, Gephi
- Network visualization
- Map display
- Multivariable and multidimensional data graphs
- Animated and interactive graphics - Tools: R, 3D viewer
- Presentation (Titles, scales, captions and annotations) - Tools: R and design software such as Inkscape
- Dashboards - Tools: Table vs. R

In these problem sessions the exercises to be solved are proposed, which the students do with the tutoring of the teacher. All documentation (script statements, problem results) of the seminars is available on the Virtual Platform.

In the PRACTICAL session, the aim is to train the students on the concepts explained in the previous seminars, to study and define different visualizations and treatments with a predetermined data set. Given a data set provided by the teachers, it is necessary to clean, prepare and visualize with exploratory graphics, justifying which is the best. It will be done in groups of THREE or FOUR people and will require about 4 hours, two of which will be supervised by a teacher. Attendance at the practical session is not mandatory, but HIGHLY RECOMMENDED.
In the PROJECT sessions, more complete visualizations and data treatments will be requested, explained in the seminars taught or given during the realization of the project. The main characteristics of the project are:

- It will be done in groups of FIVE or SIX people and for each student a dedication of around 10 hours will be required in 5 sessions supervised by a teacher and 30 hours of individual or group work to prepare the project, work without teacher supervision and for in the preparation of reports.
- Choice of datasets. The group will choose or generate the datasets for the project and propose a set of hypotheses or studies about them. These datasets will be treated and visualizations will be generated that validate or refute the hypotheses or respond to the studies that the group proposes.
- Attendance at the teacher-supervised project sessions IS HIGHLY RECOMMENDED, as it influences the individual grade of the project. Duly justified cases of absence will be studied.
- You will find the operating regulations, deliverables and evaluation of the project on the Virtual Platform (cv.uab.cat).

Annotation: within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continuous assessment activities

Title	Weight	Hours	ECTS	Learning outcomes
Prorject mark (oral presentation, rapport and individual exam)	50%	4	0.16	1, 2, 3, 4
Theory Mark (partial exams)	50%	4	0.16	1, 2, 3

The subject assessment is done by continous evaluation, based in two indicators: Theory and seminars:practices.

THEORY

There will be two individual written exams, with a weight of 50% each on the Theory Note. The first test (ExPar1) will be taken approximately halfway through the semester and will assess the concepts explained to date and the ability to solve visualization problems similar to those worked on in the seminar sessions. The second test (ExPar2) will be held at the end of the semester and will evaluate the concepts explained so far, of theory and the ability to solve problems similar to those worked on in the seminar sessions. Both exams are evaluated out of 10.

Recovery exam: In the event that the grade for a partial theory exam does not reach the pass mark, the student may take a make-up exam on the contents of the failed partial exam. The maximum mark for the recoveries will be above 8.

PRACTICE WORK

The mark for the practical work (Pract) carried out in a seminar session has a score of 1 point that will be added to the first term exam. You have two indicators:

- Group Mark: (PG mark) Delivery of a group report. Score: 0.75 points
- Individual Mark (PI mark). Exam on the day of the first partial exam: Score: 0.25 points.

The mark for the practical work in the second part of the semester (after the first semester exam) consists of an Optional Practical Exercise (EPO) that will be proposed in a theory or seminar session without prior notice to be carried out and delivered during the session and it will be worth 1 point as a maximum. This mark will be added to the mark of the second partial exam.

These two Pract and EPO grades of a maximum of 1 point will be added to the respective partial exam if it has a grade of 4 points or more. And in no case will it be saved for the recovery exams.

PROJECT WORK

The mark of the project carried out in PRJ sessions in the calendar has a score of 10 points. You have the following indicators:

- Project Delivery Mark (Prj nark). Work carried out, report and oral presentation of the project.
- Individual Exam (Prj_Exa mark). Individual examination on the project. The grade can have the following values: 0, 5, 10.
- Class attendance factor (fassist): Factor that assesses attendance in tutoring sessions from the first session of the project, with the following values:
- fassist = 1: Attendance at more than 80.01% of the sessions
- fassist = 0.75: Attendance between 50.01% and 80% of sessions
- fassist = 0.5: Attendance less than 50% of the sessions with and at least one.
- fassist = 0.0: Attendance at none of the sessions.

Recovery: A date will be established for the recovery of the project's group grade, both for the delivery of the report and the oral presentation. The maximum grade for the recovery will be 8.

MARK INDICATORS:

The final grade of the subject is calculated in the following way (between square brackets the minimum marks to make half):

- *Pract = PG + PI*
- *Par1 = ExPar1 + Pract [ExPar1 >=4]*
- *Par2 = ExPar2 + EPO [ExPar2 >=4]*
- *Theory Mark = 0,5 * (Par1) + 0,5 * (Par2) [Par1, Par2 >=5]*
- *Project Mark = (0,9 * Prj + 0,1 * Prj_Exa) * fassist [Prj, Prj_Exa >=5]*

*FINAL SUBJECTMARK = 0,5 * Theory Mark + 0,5 * Project Mark*

Marks will be published in LMS platform (cv.uab.cat).

ASSESSMENT CRITERIA:

- PERMANENCE IN THE EXAMS: In any exam the student will not be able to leave the classroom during the first 45 minutes of the exam time, except for justified reasons or by indication of the teaching staff.
- In all retakes of assessable activities (partial or practice exams, RV project, etc.), the maximum mark will be 8.

- IMPROVING AN EXAM MARK: Students may take a retake to improve an exam score. Failure to pass the exam means waiving the previous exam mark obtained. In case it does not deliver it means that it accepts the previous exam mark obtained.
- To calculate the finalgrade of the subject, the theory and practices work marks must be approved.
- NOT EVALUABLE: In the case of not reaching the minimum required in any of the assessment activities, if the calculation of the final grade is equal to or greater than 5, a 4 note will be placed on thefile.
- NOT PASS: In the event of not reaching the minimum required inany of the evaluation activities, if the calculation of the final grade is equal to or greater than 5, a grade of 4will be added to the file.
- MH: The student with a grade equal to orhigher than 9 points will be able to obtain an MH, at the discretion of the teacher. As the number of MHs cannot exceed 5% of the enrolled students, they will be awarded to those with the highest final grades, at the discretion of the teacher. Students who have taken all the assessment tests in the first call will be awarded.
- REPEATING STUDENTS: No approved part is approved (theory, problems, practices) from one academic year to another.

UNIQUE ASSESSMENT:

This subject doesn't provide the unique assessment system.

EVALUATION TIMETABLE:

- Partial Exam: Dates at the end of the teaching guide, published in the LMS and provided to students on the first day of class.
- Recovery Exam: According to the academic calendar ofthe Schoolof Engineering.
- Exams and deliveries of practices: Dates in the rule of practices, that will publish inthe Virtual Platform.
- Exams and project deliveries: Dates in the project's operating document, which will be published on the Virtual Platform.

The dates of continuous evaluation and delivery of work will be published on the Virtual Platform and may be subject to schedule changes for reasons of adaptation to possible incidents. The Virtual Platform will always be informed about these changes since it is understood that this is the usual means of information exchange between teachers and students outside the classroom.

Notwithstanding other disciplinary measures deemedappropriate, and in accordance with the current academic regulations, irregularities committed by a student that may lead to a variation of the qualification will be classified by zero (0). Assessment activities qualified in this way and by this procedure will not be recoverable. If it is necessary to pass any of these assessment activities to pass the subject, this subject will be suspended directly,without opportunity to recover it in the same course. These irregularities include, among others:

- The total or partial copy of a practice,report, or any other evaluation activity
- Let copy
- Present a group work not done entirely by the members of the group.
- Present as own materials produced by a third party, although they are translations or adaptations, and generally works with non-original and exclusive elements of the student.
- Have communication devices (such as mobile phones, smart watches, etc.) accessible during theoretical-practical tests (individual exams).

If you do not pass the subject due to the fact that none of the evaluation activities do not reach the required minimum level of work, the numerical note of the file will be the lowest value between 4 and the weighted average of the notes. With the exceptions that the \"non-evaluable\" qualification will be awarded to students who do not participate inany of the assessmentactivities, and that the numericalnote of the file will be the lowest value between3.0and the weighted average of the notes in case the student has committed irregularities in an evaluation act (and therefore not approved for compensation).

SUMMING UP: Copying, copying, or plagiarizing any of the assessment activities is equivalent to a SUSPENSION with a score of less than 3.5.

USE OF AI: Restricted use

For this subject, the use of Artificial Intelligence (AI) technologies is permitted exclusively in tasks such as bibliographic or information searches, text correction or translations. THEIR USE IN CODE PROGRAMMING IS NOT PERMITTED. The student must clearly identify which parts have been generated with this technology, specify the tools used and include a critical reflection on how these have influenced the process and the final result of the activity. The lack of transparency in the use of AI in this assessable activity will be considered a lack of academic honesty and may lead to a partial or total penalty in the grade of the activity, or greater sanctions in serious cases.

Bibliography

SUBJECT MATERIALS (notes, slides, papers): In LMS.

BASIC BIBLIOGRAPHY:

- T. Munzner, Visualization Analysis & Design, CRC Press, 2014.
- A. Kirk, Data Visualization. A handbook for Data Driven Design, 2nd edition, SAGE Publications, 2019.
- C.O. Wilke, Fundamentals of Data Visualization. A Primer on Making Informative and Compelling Figures, O'Reilly Media, 2019.

C OMPLEMENTARY BIBLIOGRAPHY:

- A. Cairo, The funcional art, http://www.thefunctionalart.com/2012/09/download-three-chapters-of-functional.html, 2012 (darer accés: juliol 2024).
- S. Few, Information Dashboard Design: Displaying Data for At-a-glance Monitoring, 2nd edition, Analytics Press, 2013.
- A. Cairo, The truthful art. Data, charts and maps for communication, New Riders, 2016.

WEB LINKS:

- https://cloud.r-project.org/ , Web per a baixar instal·lador de R per Windows, Mac i Linux. (darrer accés: octubre 2020).

Software

In this subject we will use the following software:

- Software R: R is 'GNU S', a freely available language and environment for statistical computing and graphics which provides a wide variety of statistical and graphical techniques. You can download this environment in the following link: https://cran.rstudio.com/ .
- RStudio: Es tracta d'un framework que treballa sobre R i Python. This framework can be downloaded in different (Windows, MacOs, Linux) in the following link: https://www.rstudio.com/products/rstudio/ .
- Tableau: is a powerful data analysis and visualization tool used in the area of Business Intelligence. We have an educational license for our students to use. We can also download a free demo version in the following link: https://www.tableau.com/es-es/why-tableau/what-is-tableau .
- Power BI: Framework with Graphica User Interface (GUI) similar to Tableau, developed by Microsoft to data Visualization, which we have an user license for students.

All software to be used is freely accessible or offered free of charge to students with educational licenses. It is recommended to have a laptop with at least an i5, 4Gb processor. of RAM and 500Gb. of HD to use the software in class.

Course groups and languages

The information provided is provisional until November 30. After this date, you will be able to consult the language of each group through

this link. To access the information, you will need to enter the course CODE

Type of teaching	Group	Language	Semester	Shift
(PAUL) Classroom practices	81	Catalan/Spanish	second semester	afternoon
(PAUL) Classroom practices	82	Catalan/Spanish	second semester	afternoon