

Degree programme	Type	Course
Data Engineering	OB	2

Contact lecturer

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Prerequisites

This course will touch topics related to mathematical calculations, probability and signal theory. Problems and practices in many cases will be small programs, so a good foundation in mathematics and programming is necessary.

Objectives

The objectives of the subject can be summarized in:

Knowledge:

- Describe and relate the phases of a solution to a problem of signal processing analysis.
- Identify the advantages and disadvantages of signal, image and video processing algorithms.
- Solve real problems related to signal, image and video processing techniques.
- Know how to choose the most suitable signal, image and video processing algorithm to solve a given task.
- Understand and apply feature extraction techniques to derive meaningful characteristics from signals, images, and videos for analysis and classification purposes.
- Evaluate and implement feature selection methods to identify the most relevant features for optimizing processing performance and reducing computational complexity.

Skills:

- Recognize situations in which the application of image processing algorithms may be adequate to solve a problem.
- Analyze the problem to solve and design the optimal solution applying the techniques learned.
- Write technical documents related to the analysis and solution of a problem.
- Program the basic algorithms to solve the proposed problems.
- Evaluate the results of the implemented solution and evaluate the possible improvements.
- Defend the decisions made in the solution of the proposed problems.

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. Develop critical thinking and reasoning and know how to communicate it effectively in both your own language and in English.
4. Demonstrate sensitivity towards ethical, social and environmental topics.
5. Design a system for obtaining images and videos and apply the basic methods of image processing to specific problems.
6. Choose the most suitable knowledge-representation methods for extracting the objects present in the scene, image or video and subsequently analysing them.
7. Extract and analyse movement from a video (following objects, characteristic points throughout a video, etc.)

Contents

1. Introduction to Signal, Image and Video Processing
2. Sampling, Quantization, Digital Images and Color Spaces
3. Frequency Analysis and Spectral Representations
4. Filtering, Convolution and Edge Detection
5. Geometric Transformations, Interpolation and Resampling
6. Compression and Coding
7. Segmentation, Clustering and Morphology
8. Feature Engineering and Local Descriptors
9. Dimensionality Reduction and Representation Learning
10. Video Processing and Spatio-Temporal Analysis

Learning activities and methodology

Title	Hours	ECTS	Learning outcomes
Study in group	35	1.4	
Individual study	45	1.8	
Problem seminars	14	0.56	
Lectures	12	0.48	
Laboratori classes	15	0.6	
Flipped classroom activity	20	0.8	

The coordination of the class will be done through the Virtual Campus (<https://cv.uab.cat/>), which will be used to view the materials, manage the practice groups, make the corresponding deliveries, view the notes, communicate with teachers, etc.

The different activities that will be carried out in the subject are organized as follows:

Lectures

The main concepts and algorithms of each theory topic will be presented.

Problem seminars

They will be classes with small groups of students that facilitate interaction. In these classes, practical cases

will be considered that require the design of a solution in which the methods seen in the theory classes are used.

Laboratory practices

There will be a series of common practical exercises that will allow achieving basic competencies in issues related to signal, image and video processing. Some of the sessions will be marked as control sessions where a practice exercise should be delivered. In these sessions the groups must explain the work done and the teacher will ask questions to all group members to assess the work. Attendance at these sessions is mandatory.

Flipped Classroom

For some topics the methodology of the double flipped classroom will be used.

The double flipped classroom methodology is an advanced variation of the traditional flipped classroom model that involves two levels of content delivery reversal. In a standard flipped classroom, students consume instructional content (like lectures or videos) at home and engage in active learning activities during class time. The double flipped classroom takes this concept further by implementing a second "flip" in the learning process.

First Flip: Students access basic instructional content outside of class through videos, readings, or online materials - similar to a traditional flipped classroom.

Second Flip: Students then create their own instructional content based on what they've learned. This might involve making notebooks, presentations, or teaching materials that they share with classmates. The creation process becomes part of their learning experience.

In-Class Time: Class sessions focus on peer teaching, collaborative problem-solving, discussion of student-created content, and higher-order thinking activities facilitated by the instructor.

The methodology emphasizes student agency and peer learning, with learners transitioning from content consumers to content creators. This approach is designed to deepen understanding through the act of teaching others, promote critical thinking skills, and increase student engagement through active participation in both learning and instruction.

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
Flipped classroom activity	15%	1	0.04	1, 2, 3, 4, 5, 6, 7
Lab validations	35%	2	0.08	1, 3, 4, 5, 6, 7
Individual written tests	50%	6	0.24	3, 4, 5, 6

This class does not allow the unique assessment system. The evaluation is continuous. The student will have information about their progress at all times.

There will be two written exams - a Midterm and a Final exam - that contributed 25% of the grade each.

Lab assignments are done in group but will be evaluated individually during control sessions and will contribute 35% of the grade.

The flipped classroom activity will be done in groups of 4 or 5 students. Each group will prepare and present a small part of a topic from the syllabus. In addition to the presentation, the group will have to prepare three test-type questions for the exams and an exercise for their classmates. The feedback they provide to classmates will also be evaluated. This group project is 15% of the grade for the class. The grade will be individual as it will be multiplied by a factor based on a co-evaluation among group members.

There are no minimum grades in any of the assessments except the final grade. The grade to pass the subject is 5.0.

Recovery process: The two exams can be recovered. The student can opt for recovery as long as they have submitted assessment tasks that represent a minimum of two-thirds of the total qualification of the class. Of these, students who have an average grade higher than 3.5 may apply for recovery.

Criteria for Honors Grade (MH): Awarding an honors grade is the decision of the teaching staff responsible for the class. UAB regulations indicate that MH can only be granted to students who have obtained a final grade equal to or higher than 9.00. Up to 5% of the students can be awarded MH.

Criteria for the grade Not Assessable (NA): A student will be considered not assessable (NA) only if they have not been present for the written exams.

Scheduling of assessment activities: The dates of continuous assessment and submission of assignments will be published on the Virtual Campus and may be subject to schedule changes for reasons of adaptation to possible incidents; information will always be provided on the Virtual Campus about these changes, as the Virtual Campus is the usual mechanisms for exchanging information between professors and students

Review procedure: For each assessment activity, a review location, date and time will be indicated in which the student can review the activity with the professor. In this context, claims can be made about the grade of the activity, which will be evaluated by the teaching staff responsible for the class.

Use of AI tools (eg GPT chat): The use of such tools will only be restricted in written tests (theory exams, problem exams and practice validation tests). This means that it is important that you make critical use of these tools, that is, that you use them to learn, not to copy.

Note on plagiarism: Without prejudice to other disciplinary measures that are deemed appropriate, and in accordance with current academic regulations, irregularities committed by a student will be graded with a zero (0). Assessment activities qualified in this way and by this procedure will not be recoverable. These irregularities include, among others:

- the total or partial copy of a practice, report, or any other assessment activity;
- allowing copying;
- present a group work not done entirely by the members of the group (applied to all members, not only those who have not worked);
- present as own materials prepared by a third party, even if they are translations or adaptations, and in general works with non-original and exclusive elements of the student;
- have communication devices (such as mobile phones, smart watches, pens with cameras, etc.) accessible during individual theoretical-practical assessment tests (exams);
- talk with colleagues during individual theoretical-practical assessment tests (exams);
- copy or attempt to copy from other students during theoretical-practical assessment tests (exams);
- use or try to use writings related to the subject during the theoretical-practical assessment tests (exams), when these have not been explicitly allowed.

The numerical grade of the course will be the lower value between 3.0 and the weighted average of the grades in the event that the student has committed irregularities in an evaluation act.

In short: copying, allowing copying or plagiarism in any of the assessment activities is equivalent to a

SUSPENSION with a grade below 3.0.

Bibliography

- Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, and Jonathan Taylor: An Introduction to Statistical Learning with Applications in Python, Springer (Texts in Statistics) 2023 (<https://statlearning.com>)
- Steven L. Brunton and J. Nathan Kutz: Data-driven Science and Engineering (<https://www.databookuw.com/>)
- Paolo Prandoni and Martin Vetterli: Signal Processing for Communications (<https://www.sp4comm.org/>)
- Richard Szeliski, Computer Vision: Algorithms and Applications, Springer (Texts in computer Science) 2011. (<http://szeliski.org/Book/>)
- Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing (3rd Edition), Prentice Hall 2007.

Software

MatLab

Python

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
(TE) Theory	81	English	second semester	morning-mixed
(PLAB) Practical laboratories	811	English	second semester	morning-mixed
(PLAB) Practical laboratories	812	English	second semester	morning-mixed
(PLAB) Practical laboratories	813	English	second semester	morning-mixed