UAB
Universitat Autònoma de Barcelona

Advanced Methods of Signal, Image and Video Processing

Code: 104367
ECTS Credits: 6

2025/2026

Degree	Type	Year
Data Engineering	OT	4

Contact

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Teachers

Francesc Xavier Roca Marva

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Teaching groups languages

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

Prerequisites

It is recommended that the student have knowledge and skills in

- programmingthe Python programming language
- Signal, Image and Video Processing
- Statistical validation
- Computer Learning and Deep Learning

Objectives and Contextualisation

Approximately every decade there is a technological tsunami that transforms multiple industries. Artificial Intelligence (AI) is this wave that is sweeping the current technological world. If you've ever wondered:

- how do computers perform face detection in crowds?
- How do video calling apps blur the background or replace the background with other images?
- How do autonomous cars move safely in an urban environment?

- How is the ball followed with such precision in televised sporting events such as tennis, soccer and basketball?

- can we know the most effective cancer treatment from multimodal patient data?
- can we know the emotions of a person with a smart watch and a video?
- How do machines learn to speak?

If we have aroused your curiosity, this course is what you need. In this course we will learn about topics in Computer Vision such as Object Tracking, Volume Processing, Personalized Medicine, Face Detection, Optical Flow, Human Pose estimation and many more.

Unlike other computer vision courses, this course approaches computer vision in a more practical, experiential and intuitive way. Its main component is a set of projects that must be developed by students divided into teams. All that is needed is a working knowledge of the Python programming language.

We will use OpenCV which is the largest and most popular computer vision library in the world. It is used by thousands of companies, products and devices and is tested every day for scalability and performance. We will also learn to design and adapt specific networksand to choose which is the most appropriate processing method according to the requirements and restrictions of each application.

In summary, Advanced methods of signal, image and video processing is an eminently practical and interdisciplinary subject that is situated on the bridge between artificial intelligence and the real world and that aims to cross this bridge in both directions.

Knowledge:

Describe and relate the phases into which the solution to a signal processing analysis problem is divided.

Identify the advantages and disadvantages of computer vision and signal processing algorithms.

Solve real problems related to computer vision techniques.

Understand the results and limitations of vision techniques in different case studies.

Knowing how to choose the most appropriate computer vision algorithm to solve a given task.

Knowing how to choose the most appropriate computer vision techniques to solve contextualized problems.

Skills:

Recognize situations in which the application of signal processing algorithms may be adequate to solve a problem.

Analyze the problem to be solved 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 assess possible improvements.

Defend and argue the decisions made in solving the proposed problems.

Competences

Search, select and manage information and knowledge responsibly.

Conceive, design and implement the most appropriate data acquisition system for the specific problem to be solved.

Develop critical thinking and reasoning and know how to communicate them effectively, both in one's own languages and in English.

That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include reflection on relevant issues.

Learning outcomes

Search, select and manage information and knowledge responsibly.

Develop critical thinking and reasoning and know how to communicate them effectively, both in one's own languages and in English.

Design an image and video acquisition system and apply the basic methods of computer vision to specific problems.

Choose the most appropriate knowledge representation methods for the extraction of the objects present in the scene, image or video and their subsequent analysis.

Extract and analyze the movement of a video (tracking of objects, characteristic points along a video, etc.)

Competences

- Conceive, design and implement smart systems for autonomous leaning and predictive capacity systems.
- Demonstrate sensitivity towards ethical, social and environmental topics.
- Generate innovative and competitive proposals in professional activity and research.
- 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.
- Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.

Learning Outcomes

1. Choose and interpret the most suitable predictive models for environmental management in Smart Cities.
2. Choose and modify the most suitable computational learning methods for the requirements of the health sciences sector.
3. Demonstrate sensitivity towards ethical, social and environmental topics.
4. Generate innovative and competitive proposals in professional activity and research.
5. 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.
6. Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.

Content

1 - Introduction to Computer Vision and OpenCV

2 - Methods based on extraction and selection of characteristics

3 - Methods based on Deep Learning

4 - How to choose the most suitable method. Design and Experimental Validation.

5 - Image Processing and Analysis. Segmentation and Recognition

6 - Processing and Analysis of temporal signals. Video (tracking), time series (biometric signals)

7 - 3D Volume Processing and Analysis.

8 - Multimodal Data Processing and Analysis.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lectures	10	0.4	
Type: Supervised			
Team working seminars	20	0.8	
Type: Autonomous			
Personal work	115	4.6	

The management of the teaching of the subject will be done through the Campus Virtual (http://cv.uab.cat/), which will serve as a management tool for the work teams, make the corresponding deliveries, view grades, communicate with teachers, etc.

The project

The course will follow a teaching learning methodology called Project Based Learning (PBL). The ABP methodology aims to empower and motivate the student in their learning. Groups of between 5 and 6 students will be formed who will be tasked with carrying out a set of projects (of medium size) throughout the semester. There will be weekly monitoring and both group and individual tutoring of the students.

The projects are set by the teaching staff so that they meet the following conditions: be as real as possible; be treatable using elementary tools; not have a standard solution algorithm associated with it.

On the other hand, it is essential to understand that it is not about finding an algorithm that works in 100 x 100 of the cases - often there is no such thing - but simply about "giving a reasonable solution proposal".

Projects must develop each team with the maximum possible autonomy. Each team will be assigned a tutor who will follow the evolution but in principle will refrain from imposing their ideas. On the other hand, the student must be clear that it is not a question of looking for the 'solution' of the problem in other places, but of making an original contribution. This does not mean that you have to give up the information that may exist in the bibliography or on the Internet; but when it is used, the teacher must be informed and explain it in memory.

The realization of the project must end in a program and a final report. In addition to delivering it in written form,the results of this report will be the subject of an oral presentation. Both, written memory and oral

presentation, should be directed mainly to the entity, surely hypothetical, that would have proposed the problem. As a general rule, technicalities will be relegated to specific sections of the written report.

In the oral presentations of the projects, the entire class is expected to attend, and that they intervene through questions and observations.

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

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Group Note	50%	5	0.2	3, 1, 2, 4, 5
Individual Note	40%	0	0	3, 1, 2, 4, 6
Peer Coevaluation Note	10%	0	0	3

Given that most of the work revolves around a set of projects that is developed throughout the course, the evaluation has a continuous nature, and does not provide for the single evaluation system.

Evaluation Methodology

At the end of each project, the students will make an oral presentation of the project and will deliver a report of the work carried out. Both will be evaluated by the teachers of the subject, whether or not they are tutors. Students will not take any written exams.

For the evaluation, the following INSTRUMENTS and ACTIVITIES will be used:

- An evaluation made by the teachers from the presentation of the projects carried out by the group (quality of work, presentation, memory delivered). Group grade (0 to 10) From:

  PROJECT REPORT: Document explaining the development of the work done: project plan, meeting minutes, information sought, explanation of the application implemented with a small user manual and tests carried out. The document must contain the following sections: introduction describing the objectives of the project and the state of the art; methodology section explaining the implemented solution in a reasoned way; experiments and results explaining the experimental design, metrics used, tests carried out and analysis of the results; Conclusions including proposals for improvement based on the analysis of the results

  PRESENTATION: Oral presentation in 5-7 slides on the project developed and results obtained. At the end, the evaluators will ask questions that will be taken into account in the individual grade of each student

  APPLICATION:Program developed with structured and commented code so that the project can be replicated.

- An individual evaluation based on the observations made by the tutors in the tutored sessions, where the attitude, initiative, participation, attendance and punctuality of the student in the group sessions will be taken into account. In the individual grade, it will be also taken into account that the student has

participated in all parts of the oral presentation: introduction, methodology, results and conclusions. Individual Grade (0 to 10).

- Co-evaluation and self-evaluation surveys among group members at the end of each project. Peer Coevaluation Note (0 to 10).

Grades

Each project will have a grade that will be calculated as follows:

Project Grade = 0.5 * Group Grade + 0.4 * Individual Grade + 0.1 * Peer Coevaluation Grade

where

- The Group grade will evaluate the work presented both in the oral presentation and in the documentation delivered
- The Individual grade will evaluate participation in class and response to questions on the day of the presentation
- The Co-Evaluation of colleagues will evaluate: the individual contribution to the team's work, the attitude in the team, the fulfillment of responsibilities and the management of conflicts.

The final grade will come from the weighted average of the projects carried out. The weighting will be the same for all projects

To pass the subject, all of the following requirements must be met:

- The final grade must be greater than or equal to 5
- have delivered all the projects.
- The grade for all projects must be greater than or equal to 4

To distinguish between 'failed' and 'no-show', a deadline is set for students to unsubscribe from the evaluation, in which case they will appear as 'no-show'. To unsubscribe,you must notify the teacher, in writing or by email, and obtain an acknowledgment of receipt.

Recovery:

In the event that any of the projects have a grade lower than 4, they may be resubmitted on the day set as a recovery exam in the schedules published by the coordination on the school website.

Honors matriculations:

Awarding an honor roll grade is the decision of the teaching staff responsible for the subject. UAB regulations indicate that MH may only be granted to students who have obtained a final grade equal to or greater than 9:00 and their number cannot exceed 5% of the total number of enrolled students.

In the event that the number of students with a grade greater than or equal to 9 is more than 5% of the total enrolled, the criteria to be applied in the order listed below will be the following:

1. Those with the highest Individual Grade are prioritized.
2. Those with the highest Company Co-Evaluation Score are prioritized.
3. Those with the highest Class Co-evaluation Note are prioritized.

Grade Review Procedure

Students will have the right to review the grades published in the indicated place and on the days indicated.

Irregularities on the part of the student, copying and plagiarism

Without prejudice to other disciplinary measures that are deemed appropriate, and in accordance with current academic regulations, irregularities committed by a student that may lead to a change in the grade will be graded with a zero (0). For example, plagiarize, copy, allow copying... an evaluation activity will involve failing this activity with a zero (0). Evaluation activities qualified in this way and for this reason will not be recoverable. If it is necessary to pass any of these evaluation activities to pass the subject, this subject will be suspended directly, without the opportunity to recover it in the same course.

Bibliography

Forsyth & Ponce, Computer Vision: A Modern Approach, Pearson, 2002, ISBN 0130851981

Computer vision, Linda G. Shapiro and George C. Stockman.

Introductory techniques for 3-D computer vision, Emanuele Trucco and Alessandro Verri.

Software

Python with OpenCV libraries, pytorch. Eventually Matlab. As far as possible, it will facilitate access to clusters of GPUs and CPUs

Groups and Languages

Please note that this information is provisional until 30 November 2025. You can check it through this link. To consult the language you will need to enter the CODE of the subject.

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	81	Catalan/Spanish	first semester	morning-mixed