

ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

105000441 - Image Understanding

DEGREE PROGRAMME

10II - Grado En Ingenieria Informatica

ACADEMIC YEAR & SEMESTER

2022/23 - Semester 2

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1. Description

1.1. Subject details

Name of the subject	105000441 - Image Understanding
No of credits	3 ECTS
Type	Optional
Academic year of the programme	Fourth year
Semester of tuition	Semester 8
Tuition period	February-June
Tuition languages	English
Degree programme	10II - Grado en Ingeniería Informática
Centre	10 - Escuela Técnica Superior De Ingenieros Informáticos
Academic year	2022-23

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Angel Mario Garcia Pedrero (Subject coordinator)	4211	angelmario.garcia@upm.es	Sin horario. Contact the professor by e-mail
Consuelo Gonzalo Martin	4207	consuelo.gonzalo@upm.es	Sin horario. Contact the professor by e-mail

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

- Reconocimiento De Formas
- Probabilidades Y Estadística I
- Inteligencia Artificial

3.2. Other recommended learning outcomes

- Signal and image processing
- Machine Learning
- Python

4. Skills and learning outcomes *

4.1. Skills to be learned

- CG-1/21 - Capacidad de resolución de problemas aplicando conocimientos de matemáticas, ciencias e ingeniería.
- CG-13/CE55 - Capacidad de comunicarse de forma efectiva con los compañeros, usuarios (potenciales) y el público en general acerca de cuestiones reales y problemas relacionados con la especialización elegida.
- CG-19 - Capacidad de usar las tecnologías de la información y la comunicación.
- CG-2/CE45 - Capacidad para el aprendizaje autónomo y la actualización de conocimientos, y reconocimiento de su necesidad en el área de la informática.
- CG-24/25/26/27 - Capacidad para trabajar en el contexto internacional, comunicándose en lengua inglesa y adaptándose a un nuevo entorno.

CG-6 - Capacidad de abstracción, análisis y síntesis

CG-7:10/16/17 - Capacidad para trabajar dentro de un equipo, organizando, planificando, tomando decisiones, negociando y resolviendo conflictos, relacionándose, y criticando y haciendo autocrítica

Ce 12/16 - Conocer los campos de aplicación de la informática, y tener una apreciación de la necesidad de poseer unos conocimientos técnicos profundos en ciertas áreas de aplicación; apreciación del grado de esta necesidad en, por lo menos, una situación.

Ce 13/18 - Comprender lo que pueden y no pueden conseguir las tecnologías actuales, y las limitaciones de la informática, que implica distinguir entre lo que, inherentemente, la informática no es capaz de hacer y lo que puede lograrse a través de la ciencia y la tecnología futuras.

Ce 19/20 - Conocimiento de los tipos apropiados de soluciones, y comprensión de la complejidad de los problemas informáticos y la viabilidad de su solución.

4.2. Learning outcomes

RA284 - Capacitación para diseñar las líneas maestras de un proyecto.

RA276 - Dado un campo de aplicación de la informática, evaluar y diseñar el sistema informático más apropiado para resolver alguno de sus problemas, exponiendo las dificultades técnicas y los límites de la aplicación.

RA277 - Dado un problema real elegir la tecnología informática existente en el mercado mas apropiada para su solución y diseñar su desarrollo e integración, analizando la viabilidad de su solución, lo que se puede y no se puede conseguir a través del estado actual de desarrollo de la tecnología usada, y lo que se espera que avance en el futuro.

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

Image understanding, which is based on the results of image processing and analysis, attempts to interpret the meaning of an image at a high level in order to provide semantic information closely related to human thought, to help make decisions and to guide actions according to the understanding of the scenes. This course is an introduction to the fundamental concepts in image understanding. A variety of interesting vision problems and techniques will be studied. Specifically, the course will cover image characteristics, feature extraction, image classification, and object recognition.

5.2. Syllabus

1. Introduction

- 1.1. Motivation and Objectives
- 1.2. Definition of Image Understanding
- 1.3. Examples

2. Digital Images

- 2.1. Image Acquisition
- 2.2. Image Characteristics
- 2.3. Image representation

3. Linear Filters

- 3.1. Convolution
- 3.2. Sharpening
- 3.3. Noise reduction
- 3.4. Edge detection

4. Feature Descriptors

- 4.1. Keypoint detection
- 4.2. Local Descriptors
- 4.3. Texture
- 4.4. Convolutional Neural Networks

5. Applications

5.1. Image Classification

5.2. Object recognition

6. Schedule

6.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	Unit 1 Duration: 02:00 Lecture			
2	Unit 2 Duration: 02:00 Lecture			Questionnaire Unit 2 Online test Continuous assessment and final examination Not Presential Duration: 00:30
3	Unit 3 Duration: 02:00 Lecture			
4	Unit 3 Duration: 02:00 Lecture			Questionnaire Unit 3 Online test Continuous assessment and final examination Not Presential Duration: 00:30
5		Lab Practices Duration: 02:00 Laboratory assignments		Lab work 1 Individual work Continuous assessment Not Presential Duration: 00:00
6	Unit 4 Duration: 02:00 Lecture			
7	Unit 4 Duration: 02:00 Lecture			
8	Unit 4 Duration: 02:00 Lecture			Questionnaire Unit 4 Online test Continuous assessment and final examination Not Presential Duration: 00:30
9	Unit 5 Duration: 02:00 Lecture			
10	Unit 5 Duration: 02:00 Lecture			

11		Lab Practices Duration: 02:00 Laboratory assignments		Lab work 2 Individual work Continuous assessment Not Presential Duration: 00:00
12	Unit 6 Duration: 02:00 Lecture			
13	Unit 6 Duration: 02:00 Lecture			Questionnaire Unit 5 Online test Continuous assessment and final examination Not Presential Duration: 00:30
14		Lab Practices Duration: 02:00 Laboratory assignments		Lab work 3 Group presentation Continuous assessment Not Presential Duration: 02:00
15				Class participation Other assessment Continuous assessment Presential Duration: 00:00
16				
17				Final Exam Written test Final examination Presential Duration: 02:00 Lab works Group work Final examination Presential Duration: 00:00

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

* The schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
2	Questionnaire Unit 2	Online test	No Presential	00:30	6.25%	0 / 10	CG-1/21 CG-6
4	Questionnaire Unit 3	Online test	No Presential	00:30	6.25%	0 / 10	CG-1/21 CG-6
5	Lab work 1	Individual work	No Presential	00:00	22%	4 / 10	CG-2/CE45 CG-6 CG-7:10/16/17 Ce 12/16 CG-1/21 Ce 19/20
8	Questionnaire Unit 4	Online test	No Presential	00:30	6.25%	0 / 10	CG-1/21 CG-6
11	Lab work 2	Individual work	No Presential	00:00	22%	4 / 10	CG-6 CG-2/CE45 CG-7:10/16/17 Ce 12/16 Ce 19/20
13	Questionnaire Unit 5	Online test	No Presential	00:30	6.25%	0 / 10	CG-1/21 CG-6
14	Lab work 3	Group presentation	No Presential	02:00	22%	4 / 10	CG-2/CE45 CG-6 CG-7:10/16/17 Ce 12/16 Ce 19/20
15	Class participation	Other assessment	Face-to-face	00:00	9%	0 / 10	CG-13/CE55 CG-24/25/26/27

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
2	Questionnaire Unit 2	Online test	No Presential	00:30	6.25%	0 / 10	CG-1/21 CG-6

4	Questionnaire Unit 3	Online test	No Presential	00:30	6.25%	0 / 10	CG-1/21 CG-6
8	Questionnaire Unit 4	Online test	No Presential	00:30	6.25%	0 / 10	CG-1/21 CG-6
13	Questionnaire Unit 5	Online test	No Presential	00:30	6.25%	0 / 10	CG-1/21 CG-6
17	Final Exam	Written test	Face-to-face	02:00	33%	/ 10	CG-1/21 CG-2/CE45 CG-6 Ce 12/16 Ce 19/20
17	Lab works	Group work	Face-to-face	00:00	33%	/ 10	CG-7:10/16/17

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
The grade of this exam will be 55% of the total grade, being 45% the grade obtained in lab works.	Written test	Face-to-face	02:00	100%	5 / 10	CG-1/21 CG-2/CE45 CG-6 Ce 12/16 Ce 19/20

7.2. Assessment criteria

Progressive evaluation:

The course will be evaluated by:

4 Questionnaires

3 Lab works

Lab works will be done in groups among those enrolled in the course at the beginning of the academic year (the number of elements of each group will be established at the beginning of the course, depending on the number of students enrolled).

In order to pass the course the requirements are:

To obtain a minimum of 50 points out of 100 in the added evaluation.

It is **MANDATORY** to do the lab works.

In each lab work students must obtain a minimum of 40 points out of 100.

Final score in this evaluation will be calculated as follows:

- 25% Questionnaires (6.25% each)
- 66% Lab works (3 practices, 22% each)
- 9% class participation, given the nature of this activity, this percentage will be **non-recoverable**.

Global evaluation.

Students who have not done the questionnaires in due time for **justified reasons**, will have to do so after the progressive evaluation is finished and before the global exam.

Furthermore, those students who have not completed or passed some or all of the lab works may recover the grade of said activity by submitting the work in question within a period to be established by the professors (before the global evaluation day) and taking an exam on the subject.

In this case, the grade for this evaluation will be as follows:

- 25% Questionnaires
- 33% Lab works
- 33% exam on the subject
- 9% class participation (from the progressive evaluation)

The minimum grade to pass is 50/100. The Head of Studies will determine the dates on which the exam will be held.

Referred (re-sit) examination. If the course is not passed during the ordinary call (progressive evaluation or global evaluation), the student will take an exam. The grade of this exam will be 100% of the total grade. The minimum the referred grade to pass is 50/100. The Head of Studies will determine the dates on which the exams will be held.

Measures against academic fraud

In the case that an academic fraud is detected during the development of the evaluation assessments, the professors will apply the UPM rules, as established in article 13 of UPM evaluation rules approved in May 2022.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Moodle	Web resource	http://moodle.upm.es
Szeliski, R. (2010). Computer vision: algorithms and applications. Springer Science & Business Media.	Bibliography	Book available free online: http://szeliski.org/Book/
Zhang, Y. (2017). Image Understanding. Walter de Gruyter GmbH & Co KG.	Bibliography	https://books.google.es/books?id=B7UwDwAAQBAJ&lpg=PR5&ots=dIKZ3RRil&dq=Image%20understanding%20Yu-Jin%20Zhang&lr&pg=PR8#v=onepage&q=Image%20understanding%20Yu-Jin%20Zhang&f=false
Digital Image Processing, 4th Edition Rafael C. Gonzalez, Richard E. Woods, 4th Edition, Pearson (2017)	Bibliography	https://www.pearson.com/us/higher-education/program/Gonzalez-Digital-Image-Processing-4th-Edition/PGM241219.html

ImageProcessingBasics.com Digital image processing tutorials and interactive applets	Others	http://www.imageprocessingbasics.com
Scientific articles	Bibliography	Specific scientifics articles will be recommended for each project assignment
Python.	Others	https://www.w3schools.com/python/default.asp
OpenCV	Others	https://opencv-python-tutroals.readthedocs.io/en/latest/
Jupyter notebook	Others	Jupyter notebook. https://jupyter-notebook.readthedocs.io/en/stable/notebook.html
Google Colaboratory	Web resource	https://colab.research.google.com
ImageJ	Others	https://imagej.nih.gov/ij/

9. Other information

9.1. Other information about the subject

This course presents contents related mainly to the following Sustainable Development Goals (SDGs):

SDG3, SDG6, SDG11, SDG12, SDG14 and SDG15. Good Health and Well-Being, Clean Water and Sanitation, Sustainable Cities and Communities, Responsible Production and Consumption, Underwater Life, Life of Terrestrial Ecosystems.

The topics addressed during this course could be used in different domains such as Medical Imaging and Earth observation, driven by the needs of Society and by the improvement in different technologies, these topics are an essential tool for understanding the different modalities of images that provide information about health and managing interactions between Earth and Man.