ACADEMIC PROGRAM

COMPUTER VISION

B.F.A. IN **COMPUTER SCIENCE**

MODALITY: ON CAMPUS

ACADEMIC YEAR: 2023-2024

Name of the course:	Computer Vision
Degree :	Computer Science
Location:	Centro Universitario de Tecnología y Arte Digital
Area:	Data Engineering
Year:	4º
Teaching period:	1
Type:	OBM
ECTS credits:	6
Teaching modality:	On campus
Language:	English
Lecturer / Email	-
Web page:	http://www.u-tad.com/

SUBJECT DESCRIPTION

Area description

The contents of the subject allow students to understand the flow of searching, ingesting, storing, processing and analyzing data information and brings students closer to the techniques and technologies necessary for managing large amounts of data.

Subject description

In this subject we will learn about computer vision techniques, both traditional and through artificial neural networks. Starting with the fundamentals of digital imaging, low-level image coding and image processing. Later we will embark on vision through deep learning, with the use of convolutional networks and their variations. During the semester we will build different systems related to object recognition, autonomous vehicles and image processing

COMPETENCIES AND LEARNING OUTCOMES

Competencies

BASIC AND GENERAL SKILLS

CG1 - Ability to understand, schedule and solve problems trough software development

CG3 - Knowledge of the scientific fundamentals applicable to the resolution of computer problems

CG4 - Ability to simplify and optimize computer systems by understanding their complexity

CG9 - Ability to learn, modify and develop new software solutions

CG10 -Use of creative techniques to carry out computer projects

CG11 - Ability to search, analyze and manage information for insights capture

BC1: Students should demonstrate knowledge in an area of study that builds upon the foundation of general secondary education and goest beyond at a level that, while supported by advanced textbooks, also encompasses certain aspects derived from the cutting edge of their field of study.

BC2: Students should be able to apply their knowledge to their work or vocation in a professional manner, and they should possess the competencies typically demonstrated through the development and defence of arguments as well as problem-solving within their field of study.

BC3: Students must possess the ability to gather and interpret relevant data (usually within their field of study) in order to make judgments that involve reflection on socially, scientifically, or ethically significant issues.

BC4: Students should be capable of conveying information, ideas, problems, and solutions to both specialized and non-specialized audiences.

BC5: Students should have developed the learning skills necessary to pursue further studies with a high degree of autonomy.

TRANSVERSAL SKILLS

CT1 - Knowledge of the definition, scope and implementation of the fundamentals of project management methodologies for technology projects

CT2 - Knowledge of the main sectorial players and the life cycle of a digital content development and commercialization project

CT4 -Ability to update the knowledge acquired in the management of digital tools and technologies according to the current state of affairs of the sector and the technological solution

CT5 -Development of the basic skills for digital entrepreneurship.

SPECIFIC SKILLS

CE3 - Knowledge of relational algebra and querying in procedural languages for the design of standardized database schemas based on entity-relationship models

CE10 - Ability to work with a release manager and generate application documentation automatically.

Learning outcomes

Upon completion of the degree, the graduate will be able to:

- To know and develop storage procedures and data management in distributed environments.

- To know and apply supervised, unsupervised and semisupervised learning techniques.

- To know and apply Deep Learning techniques

- To be able to retrieve information using web scraping or standard APIs

- To know and understand Natural Language Processing techniques

- To be able to analyze social networks contents.

- To understand the nature and representation of digital images.

- To know the applications of neural networks to the analysis and generation of sound, static images and video.

- To develop software solutions for computer vision.

- To develop a fully-fledged data project applying iterative methodology from design to delivery.

CONTENTS

Fudamentals of digital image

Fourier Series

Digital image processing

Shape descriptors

SUBJECT SYLLABUS

Topic 1. Fundamentals of digital image.

What is vision and how digital image capture occurs.

Topic 2. Basic image processing.

Basic image transformation:

• Fundamentals of convolution.

• Linear low-pass filtering: box-type filter and Gaussian filter.

• Linear high-pass filtering: Prewitt filter, Gaussian derivative filter, Sobel filter, Laplacian filter.

• Nonlinear filtering: median filtering, truncated mean filtering, bilateral filtering, Rolling-Guidance filtering.

• Canny edge detector.

Images description:

• FAST algorithm for corner detection

• Patch detection algorithms: LoG, DoG, HoG, SIFT algorithm, SURF algorithm.

• Image descriptors: BRIEF algorithm.

Invariances in images and how they affect algorithms.

Topic 3. Fundamentals of convolutional neural networks.

Brief review of the fundamentals of neural networks.

Image processing with neural networks:

• Flatten layer to process images with perceptron.

• Convolutional layer.

• Binary and multi-class classification with convolutional networks.

• Data augmentation for images.

Topic 4. Advanced convolutional networks.

• Advanced architectures: VGG, ResNet, AlexNet, etc.

• Networks for segmentation and object detection: Yolo, Faster R-CNN, etc.

• Transfer learning for images and representation of learning

TRAINING ACTIVITIES AND TEACHING METHODOLOGIES

TRAINING ACTIVITIES

LEARNING ACTIVITIES	Total hours	Hours of presence
Theoretical / Expository classes	29,38	29,38
Practical classes	23,25	23,25
Tutorials	4,00	2,00
Independent study and autonomous work of the student	50,00	0,00
Elaboration of work (group or individual)	31,88	0,00
Evaluation Activities	5,25	5,25
Project Follow-Up	6,25	6,25
TOTAL	150	66,13

Teaching methodologies

Expository method or master lesson

Case learning

Learning based on problem solving

Project based learning

Cooperative or collaborative learning

inquiry learning

Flipped classroom methodology

Gamification

Just in time Teaching (JITT) or classroom on time

Expository method or master lesson

Case method

Learning based on problem solving

Project based learning

Cooperative or collaborative learning

inquiry learning

Flipped classroom methodology

Gamification

TEMPORAL DEVELOPMENT

DIDACTIC UNITS / TOPICS TIME PERIOD

Digital Imaging Fundamentals Week 1-2

Basic Image Processing Weeks 2-5

Fundamentals of Convolutional Neural Networks Weeks 5-9

Advanced Convolutional Networks Weeks 9-15

EVALUATION SYSTEM

ASSESSMENT SYSTEM	MINIMUM SCORE RESPECT TO THE FINAL ASSESSMENT (%)	MAXIMUM SCORE RESPECT TO THE FINAL ASSESSMENT (%)
Assessment of participation in class, exercises or projects of the course	10	30
Assessment of assignments, projects, reports, memos	40	80
Objective test	10	60

GRADING CRITERIA

ASSESSMENT SYSTEM	ORDINARY EVALUATION	EXTRAORDINARY EVALUATION
Assessment of participation in class, exercises or projects of the course	20	20
Assessment of assignments, projects, reports, memos	40	40
Objective test	40	40

General comments on the evaluations/assessments

• The course evaluation is divided into 2 types of student activities:

o Theoretical exams: They will consist of a written test carried out during class hours with the objective of evaluating the student's theoretical knowledge of each of the topics.

o Practices: Tests to put into practice the knowledge acquired in the theoretical classes.

• For each of the 3 topics into which the subject is divided there will be an exam and a practice.

• The student's final grade will be calculated as follows:

o Exams (40%):

 Exam 1: Topic 1 and 2 (10%).

 Exam 2: Topic 3 (15%).

 Exam 3: Topic 4 (15%).

o Practices (60%):

 Practice 1: Traditional image processing (15%)

 Practice 2: Multi-class classification competition (25%)

 Practice 3: Free topic presentation (20%)

• The presentation corresponding to practice 3 will be developed in class and will correspond to 20% of the participation in class, in practices or in projects of the subject. The topic will be freely chosen by the student. Students will choose a topic which can be consulted with the teacher to verify its suitability for the subject. However, there will be a list with certain recommended topics.

• No grades of any kind will be kept between different academic years.

• Active participation will be required from the student, necessary for the development of the classes.

LIST OF REFERENCES (BOOKS, PUBLICATIONS, WEBSITES):

Basic:

Richard Szeliski. Computer Vision: Algorithms and Applications. Springer. 2010.

Andriy Burkov. The Hundred-Page Machine Learning Book. 2020

Recommended:

Courses available online:

Librow “The Art of Interface” [Online; accessed August, 2022] Available: http://www.librow.com/articles

Noah Snavely CS6670: Computer Vision [Online; accessed August, 2022] Available: https://www.cs.cornell.edu/courses/cs6670/2011sp/lectures/lec02_filter.pdf

Deva Ramanan 16-720 Computer Vision Spring 2017 [Online; accessed August, 2022] Available:

http://16720.courses.cs.cmu.edu/

Books:

David Foster. Generative Deep Learning. O'Reilly Media, Inc. 2019

François Chollet. Deep Learning With Python. Manning Publications 2017.

Ian Goodfellow, Yoshua Bengio, Aaron Courville. Deep Learning. MIT Press 2016

Python Manuals:

- https://www.w3schools.com/python
- https://numpy.org/
- https://matplotlib.org/
- https://seaborn.pydata.org/
- https://www.tensorflow.org/

Neural networks manuals:

- https://keras.io/

REQUIRED MATERIALS, SOFTWARE AND TOOLS

Type of classroom
Theory classroom

Board and projection system

Materials:
Personal Computer

Software:
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