Multimedia Data Modelling

Luca Guarnera, Ph.D.

Research Fellow
luca.guarnera@unict.it

University of Catania
Dipartimento di Economia e Impresa

About Me

- Prof. Luca Guarnera, Ph.D.

- Email: luca.guarnera@unict.it

- Web Page: https://www.dmi.unict.it/lguarnera/

- MDM: https://www.dmi.unict.it/lguarnera/teachings/2023-24/MDM/

- Department of Mathematics and Computer Science, Room 311 (second floor, first block)

Course Details

Details

- Course: Multimedia Data Modelling

- 6 CFU (42h)

- Lectures: See Syllabus

  - The first part of the course is about digital images
  - The second part of the course is about digital video
  - The third part of the course covers Low-Level Vision
  - The fourth part of the course concerns modeling and processing of digital data

Lecture Schedule

theory

- MON 15:00-17:00 - DMI - Aula MI6

- FRI 09:00-11:00 - DMI - Aula MI6

Lab Session

Note that some lessons may start at 8:00/8:15 in order to make up hours of classes not taken!

Università di Catania

Calendar

Calendar

Calendar

Total lesson hour

- October: 12 h
- November: 12 h
- December: 14 h

Total: **38h**/**42h**

We have to make up 4 hours of lessons…

Calendar
Making up lesson hours

OCTOBER 2023

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2	3	4	5	6	7
8	9 **Lesson (2h)**	10	11	12	13 **Lesson (3h)**	14
15	16 **Lesson (2h)**	17	18	19	20 **Lesson cancelled**	21
22	23 **Lesson (2h)**	24	25	26	27 **Lesson (3h)**	28
29	30 **Lesson (2h)**	31	1	2	3	4

We will start at 8:00 a.m./8:15 a.m.

Making up lesson hours

Università di Catania

Calendar
Making up lesson hours

Total lesson hour

- October: **14 h**

- November: **14 h**

- December: 14 h

Total: **42h/42h**

We have to make up 4 hours of lessons...

Università di Catania
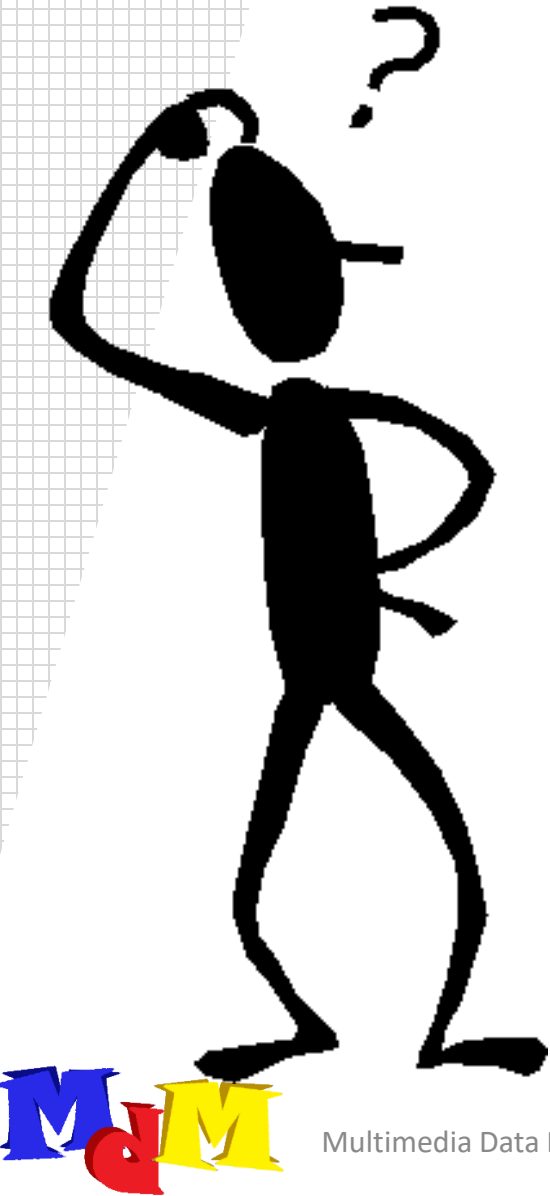
Course Details
Meetings with Students, Official Ms Teams Channel, Teaching Materials

- Tuesdays from 11 a.m. to 1 p.m., or email to schedule a day and time (Meetings can also be done on MS Teams, code **m62umdd**).

  join the team now ;)

- **You will find the teaching materials on MS Teams.**

Università di Catania
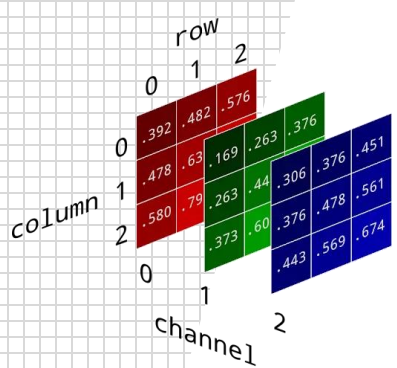
First part: **digital images**

- Introduction to digital images + Lab. Session

- Interpolation operations: replication, bilinear and bicubic + Lab. Session

- Space domain and Frequency domain + Lab. Session

- Fourier and DCT Transform + Lab. Session

- The convolution and convolution theorem

- Lossy and lossless compression

- The JPEG standard

- Mathematical morphology applied to digital images.

- Mathematical morphology applied to gray-scale images + Lab. Session

- Image restoration and Noise models + Lab. Session

- Filters: arithmetic, geometric, harmonic and counter-harmonic mean + Lab. Session

- Median, minimum, maximum, midpoint, + Lab. Session

- Adaptive filters + Lab. Session

- Periodic noise. Noise removal in the frequency domain + Lab. Session

- Filtering in the spatial domain. Edge detector. Canny's algorithm + Lab. Session

- Steganography and Steganalysis + Lab. Session

Second part: **digital video**

- Introduction to digital video and main definition: aspect ratio, resolution, video file format.
- Lab. Session: OpenCV and Digital Video
- Video formats (MPEG-1, MPEG-2, MPEG-4, H.264).

Università di Catania
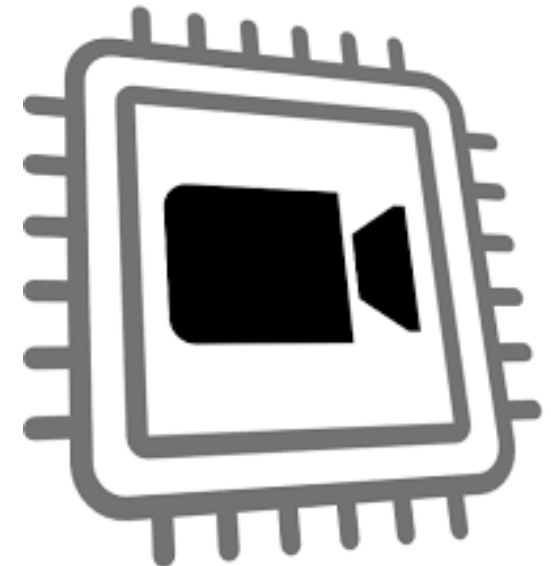
Third part: **Low-Level Vision**

- Low-Level Vision: Filters and Features: Edges, Textures, Laplacian Pyramid, Corner Detection (Harris, …), SIFT.

- Computer Vision applications: face detection and recognition, etc..

Università di Catania

Fourth part: **modeling and processing of digital data**

- Data modeling (features extracted from multimedia contents) and classification tasks
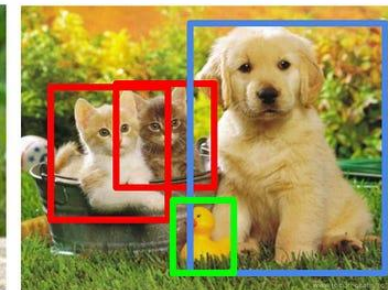
Laboratory Session

- The python language applied to digital image and video processing

- Introduction to OpenCV and other image/video processing libraries

- Implementation of Computer Vision algorithms (studied in the theoretical part)

and, if we get there … seminars on state-of-the-art topics related to the course will also be held

- Several seminars will be scheduled during the course on different topics related to the, topics covered in the course, such as "Hints on Multimedia Content Manipulation and Detection Techniques: from Image Forgery to Deepfakes"

Final examination & "in itinere" test

Final Examination

(1) There will be an "in itinere" test (t_1) in **November** and **one at the end of the course** (t_2). Both will consist of a 30-question multiple-choice test

+ Project P (optional)

$$vote = \frac{t_1 + t_2}{2} + P + \sum k, \qquad P \in [0,5]$$

$$k = 0,5 \ for \ each \ correct \ Homework \ (for \ a \ maximum \ of \ 2 \ points \ per \ student)$$

30-question multiple-choice test

1. What is a digital image?
   - a) A photograph taken with an analogue camera
   - b) A matrix of light intensity values
   - c) A compressed video
   - d) A hand-drawn image

2. What are the types of images?
   - a) Black and White, Gray and Blue
   - b) Gray and Green, Color, Pink and Blue
   - c) Black and White, Greyscale, Color
   - d) Yellow and Red, Green and Blue, Color

3. What does the RGB color space represent?
   - a) A series of abstract coordinates
   - b) A color representation based on red, yellow and blue
   - c) The gray line
   - d) A color representation based on red, green and blue

Python Project:
- Share the Python Code
- Technical Documentation

Università di Catania

Homework

- You will be shared a jupyter (paper) notebook that you will need to replicate

- If **BONUS k** will be present:
  - Solve the exercise using only the notes made available in class. Using additional documentation (except in exceptional cases) and searching the Internet is not allowed! Otherwise, the student will not be able to benefit from the bonus k
  - The exercise must be complete and working by 15 minutes before the end of the lesson.
  - All students may participate, and all may acquire the bonus k

Write a python program that reads a sequence of digital images. Using the command line, the user chooses the interpolation operation to apply to the digital data. Save the results in a dedicated folder chosen by the user.

Multimedia Data Modelling - 6 CFU

Introduction to Python lab

IMAGE PROCESSING LABORATORY

1. Using Python as a Calculator

Numbers

The interpreter acts as a simple calculator: you can type an expression at it and it will write the value. Expression syntax is straightforward: the operators +, -, * and / can be used to perform arithmetic; parentheses (()) can be used for grouping. For example:

```
In [2]:   2 + 2
Out[2]:   4

In [3]:   50 - 5*6
Out[3]:   20

In [4]:   (50 - 5*6) / 4
Out[4]:   5.0

In [5]:   8 / 5
Out[5]:   1.6
```

With Python, it is possible to use the ** operator to calculate powers:

```
In [6]:   5 ** 2   # 5 squared
```

Università di Catania

Final Examination

- Morphological filters (5 pt)
- JPEG encoding (5 pt)
- SIFT (5 pt)

15 - question multiple-choice test

1. What is a digital image?
   a) A photograph taken with an analogue camera
   b) A matrix of light intensity values
   c) A compressed video
   d) A hand-drawn image

2. What are the types of images?
   a) Black and White, Gray and Blue
   b) Gray and Green, Color, Pink and Blue
   c) Black and White, Greyscale, Color
   d) Yellow and Red, Green and Blue, Color

3. What does the RGB color space represent?
   a) A series of abstract coordinates
   b) A color representation based on red, yellow and blue
   c) The gray line
   d) A color representation based on red, green and blue

2 Written test t (15 Multiple-choice and 3 open-answer tests) and Project P (optional)

$$vote = t + P + \sum k, \qquad P \in [0,5]$$

$k = 0,5 \; for \; each \; correct \; Homework \; (for \; a \; maximum \; of \; 2 \; points \; per \; student)$

Python Project:
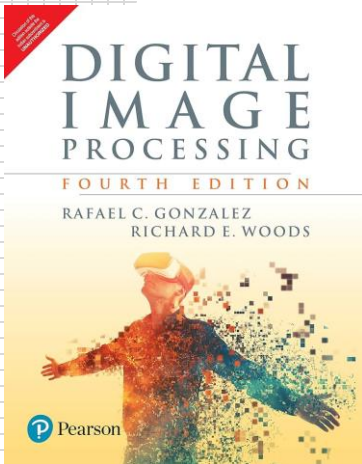- Share the Python Code
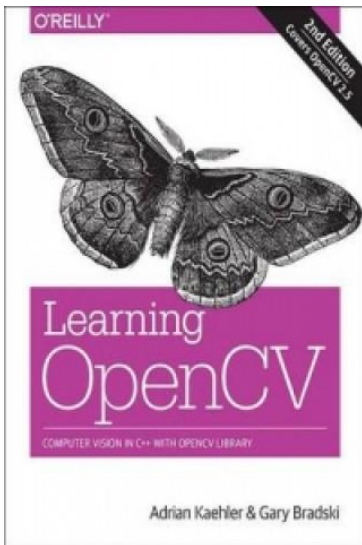- Technical Documentation

Università di Catania

Requirements

- Bring your own laptop to each lesson

- Knowledge of the basics of computing (programming in the **Python language**)

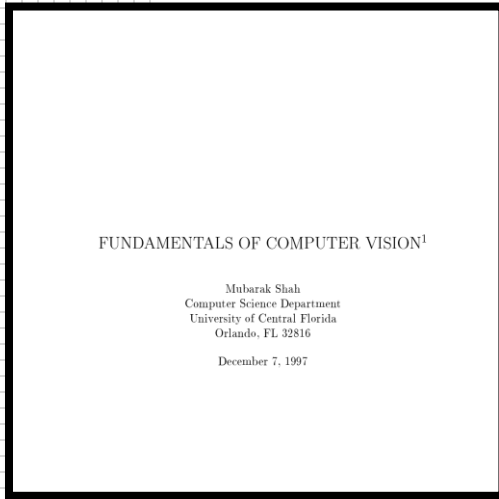Università di Catania
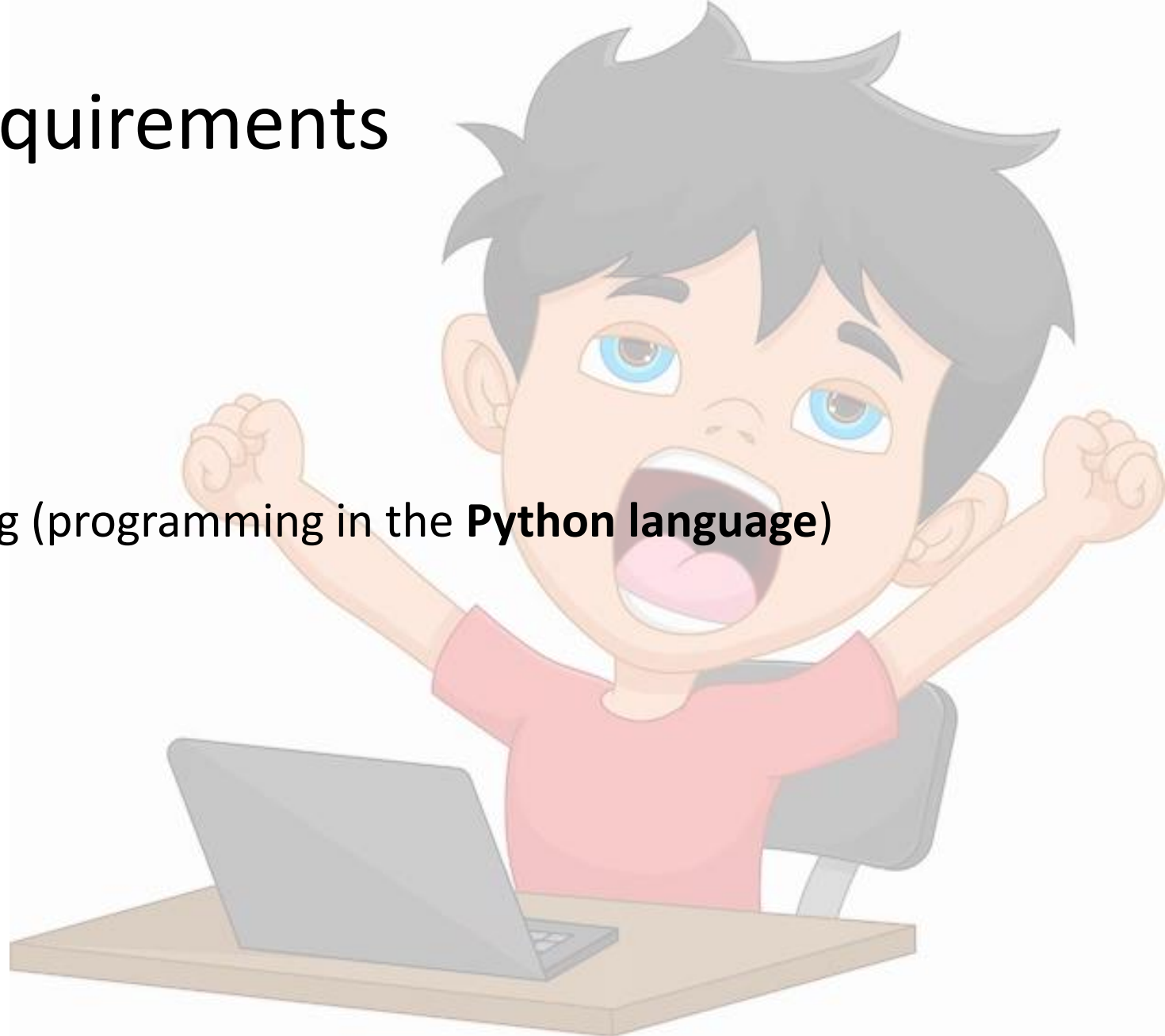
Books and Resources

Digital Image Processing, (3rd Edition) Rafael C. Gonzalez, Richard E. Woods, Ediz. Pearson, Prentice Hall
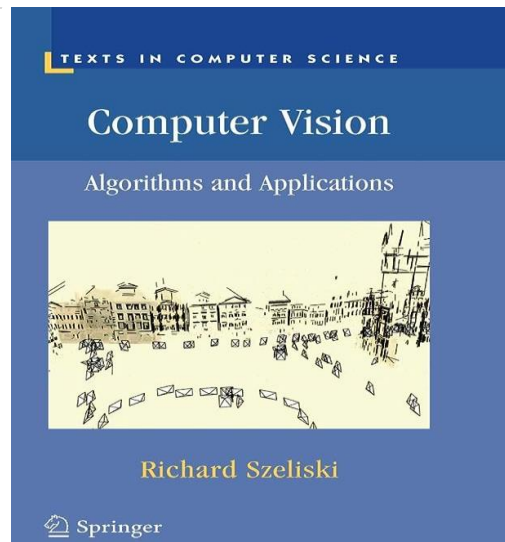
G. Bradski, A. Kaehler, "Learning OpenCV Computer Vision with the OpenCV Library" O'Reilly Media, 2008;

Books and Resources

FUNDAMENTALS OF COMPUTER VISION[1]

Mubarak Shah
Computer Science Department
University of Central Florida
Orlando, FL 32816

December 7, 1997

Mubarak Shah, "Fundamentals of Computer Vision"

https://www.cse.unr.edu/~bebis/CS485/Handouts/ShahBook.pdf

Richard Szeliski, Computer Vision: Algorithms and Application, Springer 2010

Resources

Slides, assignments and other teaching materials will be shared with students.

- https://www.dmi.unict.it/lguarnera/teachings/2023-24/MDM/
- MS Teams: **m62umdd**

Questions?

Luca Guarnera, Ph.D.

Research Fellow
luca.guarnera@unict.it

University of Catania
Dipartimento di Economia e Impresa

Break… See you in 10 minutes

Multimedia Data Modelling

Luca Guarnera, Ph.D.

Research Fellow
luca.guarnera@unict.it

University of Catania
Dipartimento di Economia e Impresa