



UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Matematica e Informatica		
ACADEMIC YEAR	2023/2024		
BACHELOR'S DEGREE (BSC)	COMPUTER SCIENCE		
SUBJECT	ARTIFICIAL VISION		
TYPE OF EDUCATIONAL ACTIVITY	B		
AMBIT	50166-Discipline Informatiche		
CODE	09202		
SCIENTIFIC SECTOR(S)	ING-INF/05		
HEAD PROFESSOR(S)	VALENTI CESARE FABIO	Professore Associato	Univ. di PALERMO
OTHER PROFESSOR(S)			
CREDITS	6		
INDIVIDUAL STUDY (Hrs)	94		
COURSE ACTIVITY (Hrs)	56		
PROPAEDEUTICAL SUBJECTS	05880 - PROGRAMMING AND LABORATORY - INTEGRATED COURSE 16670 - ALGORITHMS AND DATA STRUCTURES 16784 - OPERATING SYSTEMS 16450 - COMPUTER ARCHITECTURES 16671 - THEORETICAL COMPUTER SCIENCE		
MUTUALIZATION			
YEAR	3		
TERM (SEMESTER)	1° semester		
ATTENDANCE	Not mandatory		
EVALUATION	Out of 30		
TEACHER OFFICE HOURS	VALENTI CESARE FABIO Wednesday 14:30 18:30 da concordare via email		

PREREQUISITES	Basic knowledge of trigonometry and calculus.
LEARNING OUTCOMES	- Knowledge and understanding. Acquisition of advanced tools for the analysis of digital images and to design computer systems, interfaces and simple computer vision programs. Ability to use the technical language of this specific field. - Applying knowledge and understanding. Ability to recognize the main characteristics of the images and to design an ad hoc system for their processing and interpretation. - Making judgments. Being able to evaluate the implications and the results of image processing systems, considering their nature and the use of the produced information (for example, for biomedical or satellite data surveys, for the realization of virtual systems). - Communication skills. Capacity to expose the specific problem and the expected results by the developed system. To be able to support and to highlight both the importance and the reliability of the carried out processing (eg, validation of the unsupervised classification). - Learning skills. Ability to upgrade through scientific publications regarding the fields of image analysis, computer vision and, more in general, the theory of algorithms. Ability to attend, using the knowledge acquired during the course, second level masters, in-depth courses, specialized seminars both in image analysis and computer graphics industry. - Acquired competencies. Implement basic numerical algorithm methods (e.g., search algorithms, common quadratic and $O(N \log N)$ sorting algorithms, fundamental graph algorithms, string-matching algorithm) to solve an industry problem and select the appropriate algorithm for a particular context. Analyze and evaluate a user interface that considers the context of use, stakeholder needs, state-of-the-art response interaction times, design modalities taking into consideration universal access, inclusiveness, assistive technologies, and culture-sensitive design. Formulate an industry problem specified in a natural language (e.g., English) as a constraint satisfaction problem and implement it using an appropriate technique (e.g., chronological backtracking algorithm or stochastic local search).
ASSESSMENT METHODS	Practice test and oral examination to verify skills and disciplinary knowledge provided by the course. Both the ripeness of the examinee and the clarity of the presentation will be evaluated. Excellent (29-30 / 30 cum laude) - excellent knowledge about the topics, excellent ability of the technical language, good analytical ability, the student is able to apply knowledge to solve independently all proposed problems, providing also original solutions. Very good (27-28) - very good knowledge about the topics, excellent ability of the technical language, the student is able to apply knowledge to solve independently all proposed problems. Good (24-26) - good knowledge about the topics with reasonable ability of the technical language, the student is able to apply knowledge to solve most proposed problems. Sufficient (18-23) - the student does not have full ability of the main topics but he has the underlying knowledge; just sufficient ability of the technical language with little ability to apply independently the knowledge acquired. Insufficient - the student does not have an acceptable knowledge about the contents of the topics covered during the course.
EDUCATIONAL OBJECTIVES	The aim of the course is the study of the basic tools for the analysis of digital images and for computer graphics. In particular the convolution theorem, examples of non-linear filters, spatial operators, mathematical morphology on grayscale images, improving quality techniques, segmentation and compression algorithms will be presented. The main acquisition methods and the most popular graphics formats for their proper storage will be described. Laboratory activities will include examples of image acquisition and enhancement and their interpretation. Determine the characteristics of a given problem that an intelligent system must solve and present the results to a project team.

	Implement an appropriate search algorithm for an industry problem by characterizing time and space complexities. Present the costs and benefits of dynamic and static data structure implementations, choosing the appropriate data structure for modeling a given engineering problem. Demonstrate common coding errors, constructing and debugging programs using the standard libraries available with a chosen programming language. Design an interactive application, applying a user-centered design cycle with related tools and techniques (modes, navigation, visual design), to optimize usability and user experience within a corporate environment.
TEACHING METHODS	Lectures and lab activities.
SUGGESTED BIBLIOGRAPHY	Qualsiasi testo di livello universitario che descriva gli argomenti trattati durante il corso (principalmente elaborazione dei segnali digitali e delle immagini in particolare). Le lezioni saranno supportate da presentazioni che NON sostituiscono i seguenti testi consigliati. / Any university-level book that describes the topics discussed during the course (mainly digital signal processing and digital images in particular). The lessons will be supported by presentations that do NOT supersede the following recommended texts. - Testo principale, carattere generale / Main suggested book, general topic: R.C.Gonzales, R.E.Woods. Elaborazione delle Immagini Digitali. Pearson Prentice Hall, 2008. ISBN-13:978-8871925066 - Testo specifico per la morfologia matematica / Book about mathematical morphology: P.Soille. Morphological Image Analysis. Springer-Verlag, 2010. ISBN-13:978-3642076961 Durante il corso saranno presentati casi reali e proposti articoli presenti nella letteratura del settore per evidenziare l'applicazione delle tecniche discusse. Tali articoli saranno anch'essi argomento d'esame / Real cases and articles present in the literature will be discussed during the course to highlight the application of the proposed techniques will be studied. These articles will integrate the topics of examination.

SYLLABUS

Hrs	Frontal teaching
4	Introduction to the visual system, limited to the aspects useful to justify the technological choices that will be presented during the course (e.g. separating luminance / chrominance channels, Bayer filter, interlacing).
6	Digital acquisition systems. Color spaces. Truecolor and indexed images; quantization. Histogram of the gray levels; stretching; equalization; thresholding. Geometric transforms (e.g. resize and rotate). Segmentation and quadrees.
6	Convolution (mean, Gauss, Laplace, Sobel, Prewitt).
6	Edge Histogram. Median filter. Fast convolution algorithms. Dithering, Deepgrey.
6	Mathematical morphology for grayscale images (erosion, dilation, opening, closing). Applications (e.g. contours and contrast enhancement).
6	Digital image compression; Error measures. Two-dimensional discrete cosine transform and wavelet (e.g. Haar filter bank, multiresolution, a trous).
6	Static graphic formats (e.g. BMP, GIF, HAM, JPG) and for simple animations (e.g. GIF, IFF).
Hrs	Workshops
4	Real applications (e.g. noise reduction, contrast enhancement, inpainting and normalized convolution).
4	Real applications (e.g. fast radial symmetry, dithering, Hough transform).
4	Real applications (e.g. face detection, gesture recognition).
4	Real applications (e.g. segmentation and unsupervised analysis of medical images).