UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2023/2024
MASTER'S DEGREE (MSC)	BIOMEDICAL ENGINEERING
SUBJECT	IMAGE DIAGNOSTICS EQUIPMENT
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50351-Ingegneria Biomedica
CODE	20280
SCIENTIFIC SECTOR(S)	ING-INF/06
HEAD PROFESSOR(S)	CONTINO SALVATORE Ricercatore a tempo determinato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	144
COURSE ACTIVITY (Hrs)	81
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**CONTINO SALVATORE** Monday 10:00 12:00 Laboratorio d'Interazione Uomo-Macchina, Edificio 6, terzo piano Friday 10:00 12:00 Laboratorio d'Interazione Uomo-Macchina, Edificio 6, terzo piano

DOCENTE: Prof. SALVATORE CONTINO

PREREQUISITES	Python Programming Base Statistics Signal Processing
LEARNING OUTCOMES	*Knowledge and understanding* When having attended the course, students will own knowledge and methodologies to solve problems related to both using the main medical imaging modalities and analyzing the images they produce. Students will know adequately the physics behind image formation for each modality; they will know how the equipment is used, and the different acquisition techniques. Moreover, students will have good knowledge of medical image formats, and their use in systems like PACS, RIS, and HIS. Finally, students will have a good knowledge of medical image processing and analysis techniques. Such an objective will be verified through on oral test containing different open questions related to the topics faced during the course. *Applying knowledge and understanding* When having attended the course, students will own knowledge and methodologies solve problems related to the characterization of medical imaging modalities, and how to devise the acquisition parameters for each modality. Students will have good knowledge of the Python programming language along with the main library for visualizing and analyzing data like Numpy, SciPy, Scikitlearn, Matplotlib, PyDicom, Nibabel, and the main functions of a PACS viewer. Such an objective will be reached through a series of guided practices aimed at developing pipelines for medical image analysis. Such an objective will be verified through an oral test containing both calculus and programming exercises. *Making judgements* Students will be able to compare the features of the different imaging modalities for assessing the best suited images and acquisition parameters to be used in different application contexts. Moreover, students will be able to assess the best analysis pipeline to be used for processing such images. To reach this objective, the course includes explicitly the discussion of the results of each guided practice. Such an objective will be verified through an oral test containing different open questions related to the topics faced during the course, which involve problem solving tasks. *Communication* Students will be able to talk about complex issues related to medical image processing, modality configuration and functioning, in highly specialized contexts, using the proper language. To reach this objective, the course is arranged guided practices for developing case studies, and the discussion of the results with the whole class. Such an objective will be verified through an oral test containing both calculus and programming exercises. *Lifelong learning skills* Students will be able to face autonomously whatever issue related to the development of medical image processing pipelines, modality functioning and configuration. They will be able to deepen complex topics such as comparing the performances of different frameworks for medical image analysis to devise their strengths and weaknesses. To reach such objective, the course is arranged in guided practices for analyzing some case studies related to the development of a complete pipeline for medical image analysis; moreover, the results will be discussed with the whole class. Such an objective will be verified through an oral test containing both calculus and programming exercises.
ASSESSMENT METHODS	Final examination is arranged as an oral test including both open questions and exercises. The test is aimed at verifying the knowledge degree of the topics faced during the course, while exercises are intended to verify the students' competencies in medical image analysis using the software frameworks explained in the practices. Evaluation will based on verifying both the methodological correctness and the results of exercises; moreover also correct use of language will be evaluated along with the ability to deepen the topics outlined by the open questions. An approximate grade ranking follows: • 18-23: sufficient or limited knowledge of theoretical topics; limited ability in using medical image analysis techniques. • 24-26: discrete knowledge of theoretical topics; discrete ability in using medical image analysis techniques. • 27-28: good knowledge of theoretical topics; good ability in using medical image analysis techniques. • 29-30: very good knowledge of theoretical topics; very good ability in using medical image analysis techniques.

	With the final decision of the teacher, particular excellence and originality in completing the test along with autonomous deepening of the topics faced by the open questions will receive honors. Students that will not attend lessons will be evaluated using the same criteria as the other ones.
EDUCATIONAL OBJECTIVES	The course "Medical Imaging" is aimed at providing students with a deep knowledge of both the functioning and configuration of the main medical imaging modalities; moreover the course covers the issues related to the main techniques for medical image processing and analysis. The course allows acquiring 9 ECTS, and it is arranged in lessons, exercises, and guided practices on some casestudies proposed by the teacher along through the development of a pipeline for medical image analysis. Results of guided practices are presented and discusses with the class. After a summary of the Python programming language, lessons start presenting at first an introduction to digital images along with the main image processing techniques. Next, the main medical image formats are presented, and their use in systems like PACS, RIS, and HIS. Then, all the imaging modalities are studied: Radiology, CT, MR, Ultrasounds, and Nuclear Medicine. The physics behind image formation for each modality is explained, along with the different acquisition methodologies, equipment functioning, and safety issues. Moreover, the main medical image analysis techniques are faced: both classification and model fitting are deepened in more detail. The last part of the course is devoted to visualization techniques for diagnosis and therapy. Practices are related to the configurations of the software environments that are used throughout the course, the explanation of the topics faced in the lesson using some calculus and Python programming exercises, and the development of complex pipelines for medical image analysis starting from real case studies.
TEACHING METHODS	Lessons, exercises, and guided practices for developing medical image analysis pipelines.
SUGGESTED BIBLIOGRAPHY	Paul Suetens, Fundamentals of Medical Imaging - 3rd edition del 11/05/2017, Cambridge University Press, ISBN: 978-1107159785, prezzo orientativo € 85,40

SYLLABUS

Hrs	Frontal teaching
1	Introduction
8	Python programming
7	Digital Images: Signal Processing basics, image formation, quality measures, grey level transformations, multiimage operations, geometric transformations, filters, frequency filters, mathematical morphology
2	Medical image formats: DICOM, and Nifti. PACS, RIS, and HIS
6	Radiography: X-rays, interaction with tissues, X-ray detectors, Radiographic imaging, equipment, clinical use and safety
6	CT: X-ray detectors for CT, image formation, dynamic CT and multi-energy CT, CT imaging, equipment, clinical use and safety
6	MR: magnetic field, radio waves, detection of the signal, image formation, MRI, equipment, clinical use and safety
6	Nuclear medicine: radioactive decay, interaction of particles with the matter, data acquisition, image formation, Nuclear Medicine imaging, equipment, clinical use and safety
5	Ultrasound: physics of acoustic waves, ultrasound generation and diffusion, image formation, measuring blood flow and tissue deformation, ultrasound imaging, equipment, clinical use, and safety
4	Machine learning basics: classification and clustering, model capacity, types of error, training and test
6	Medical Image analysis: segmentation, registration, active contours
3	DNN for bio-medical imaging
3	Visualizing medical images: MIP, MinIP, MPR, shading, Marching cubes algorithm

Hrs	Practice
3	Installing and configuring the Python environment along with the main packages
3	Guided practice on digital image prepocessing
3	Guided practice on medical image formats
1	Development of a mini PACS viewer
3	Guided practice on medical image analysis techniques
5	Guided practice on the main DNN for medical image analysis