UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Physical Sensors and Systems for Biomedical Imaging

2627-2-F9103Q020

Aims

The main aims of the course are three:

1. to understand the physical principles on which medical imaging is based;
2. to familiarize with the main medical imaging techniques and understand their operating principles;
3. to acquire the practical capabilities to reconstruct and analyze medical images through standard and AI programming techniques.

Contents

The course will cover the fundamentals of medical imaging, including different types of imaging techniques such as radiography, CT, MRI, PET and ecography. In addition, the course will cover the classical and AI techniques to interpret, reconstruct and analyze medical images provided by these instrumentations.

Detailed program

- Introduction to biomedical imaging and the physical principles underlying different imaging techniques
- Radiography and Computed tomography (CT): physics of photon interaction with matter, and operating principles
- Magnetic resonance imaging (MRI): physics of magnetism and nuclear resonance, and operating principles
- Nuclear medicine (PET and SPECT): physics of radioactive decays, and operating principles
- Ultrasound imaging, ecography, eco-Doppler: physics of wave and sound propagation and of the doppler effect, and operating principles
- Python environment for medical imaging: basic python concepts and available packages for medical

imaging manipulation.
- Case study: medical image classification, comparison between different NN.- Case study: medical image segmentation using a Unet

Prerequisites

Knowledge of basic physics, python and standard machine learning techniques

Teaching form

The classes will be in the form of frontal lectures and of computer laboratories in which students will work in groups.

Textbook and teaching resource

The main resource will consist of the slides and other materials (such as scientific papers) provided by the teachers during the lectures. Some recommended, but not mandatory, textbooks are:
J.T. Bushberg, J.A. Seibert, E.M. Leidholdt, J. Boone, The essential physics of medical imaging, LIPPINCOTT WILLIAMS & WILKINS, a WOLTERS KLUWER business
F. Chollet, Deep Learning with Python (ISBN: 9781617294433)
Other potentially interesting readings are:
P. Seutens, Fundamentals of Medical Imaging, Cambridge University Press
A.G. Webb, Introduction to Biomedical Imaging, IEEE Press, Wiley
Ian Goodfellow and Yoshua Bengio and Aaron Courville; Deep Learning; MIT Press; http://www.deeplearningbook.org

Semester

First semester

Assessment method

The exam consists of a written test on the theoretical part and of a project about the practical part. The theoretical section consists of 5 multiple choice questions and 2 open-ended questions on the program covered in the theoretical lectures. The practical section covers the laboratory lectures: students have to submit the work on the final laboratory assignment. Students can work on their own or in groups (maximum 3 persons per group), **if working in a group the report should contain a paragraph about the activities performed by each group member**. The report and script/jupyter notebook should clearly specify the names of the students that have worked on it.

Grading criteria: Multiple choice questions are 2 points each, and a mistake is evaluated as -1; open-ended

questions are 5 points each. For the assignment other 20 points will be given, the evaluation will focus on the correctness and clearness of the presented work. Thus, the total available points are 40; all the students who get more than 30 will be evaluated with honor. A minimum score of 18 points is required to pass the exam. Students that reach at least 16 points in the written may choose to take an optional oral exam, that covers both sections of the course. The oral exam can adjust the final grade either positively or negatively.

Office hours

Students can write an email to the teachers whenever they want in order to arrange an appointment.

Sustainable Development Goals

GOOD HEALTH AND WELL-BEING