HL2027 3D Image Reconstruction and Analysis in Medicine 9.0 credits

Medicinsk bildanalys och rekonstruktion i 3D

This is a translation of the Swedish, legally binding, course syllabus.

Establishment

Course syllabus for HL2027 valid from Spring 2019

Grading scale

A, B, C, D, E, FX, F

Education cycle

Second cycle

Main field of study

Medical Engineering

Specific prerequisites

Bachelor's degree in Biomedical Engineering, Engineering Physics, Electrical Engineering, Computer Science or equivalent. Programming in Python or MATLAB. Basic knowledge of anatomy.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

The use of computer tools for analyzing 3D medical images has improved the diagnosis and treatment of different diseases. This course covers the concepts, theories and most used methods for this aim, starting from obtaining readable 3D images from raw acquired data from the scanners (image reconstruction), improving their quality (image restoration and enhancement), aligning images from the same or different modality (image registration), detecting relevant regions from images (image segmentation) and extracting meaningful information from the images (image analysis). The course is focused to solve medically relevant problems.

After completing of this course, the participant will be able for each of the aforementioned problems to:

·   Understand the main issues and challenges

·   Describe the main approaches and methods and their main differences

·   Summarize pros and cons and scope of different methods

·   Identify and understand the mathematical theory of the most used methods

·   Develop and systematically evaluate different methods for solving simplified problems

·   Use and adapt advanced tools for solving complex problems

·   Select and adapt the most appropriate methods to solve problems in image reconstruction and analysis

·   Analyze the effect of different parameters of the methods in particular cases

·   Explain orally and in writing the proposed strategy for solving specific problems

in order to:

·   understand the complete pipeline for using computational tools for image analysis in a medical context

·   be able to implement computational solutions in image reconstruction and analysis to medically relevant problems

·   have a broad knowledge base that can ease understanding literature in the field

Course contents

The course is divided into 5 modules:

·   Image reconstruction: different methods for tomographic reconstruction (obtaining 3D images from 2D projections) and from frequency domain acquisitions (magnetic resonance).

·   Image restoration and enhancement: image filtering and enhancement in the spatial, frequency and spatial-frequency domain.

·   Image registration: linear and non-linear registration and registration with prior information.

·   Image segmentation: voxel-, graph-, contour- and model-based image segmentation.

·   Image analysis: feature extraction, image classification, image regression, machine learning and deep learning for image analysis.

Every module consists of lectures, laboratories, mathematical exercises and mini-examinations. The participants combine basic and advanced libraries for medical image processing and analysis in Python, including scipy, numpy, SimpleITK, scikit-image, scikit-learn, TensorFlow, among others. Some specific labs use MATLAB. The course also includes introductory labs for students with programming experience but without experience in Python.

Examination

 • PRO1 - Project Work, 9.0 credits, grading scale: A, B, C, D, E, FX, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

If the course is discontinued, students may request to be examined during the following two academic years.

Ethical approach

 • All members of a group are responsible for the group's work.
 • In any assessment, every student shall honestly disclose any help received and sources used.
 • In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.