DEPARTMENT OF NEUROBIOLOGY, CARE SCIENCES AND SOCIETY

H1F3064, Imaging in Neuroscience: with a Focus on Structural MRI Methods, 1.5 credits (hec)

Hjärnavbildning inom neurovetenskap: med fokus på strukturella MRI metoder, 1,5 högskolepoäng

Third-cycle level / Forskarnivå

Approval

This syllabus was approved by The Committee for Doctoral Education on 2023-11-23, and was last revised on 2026-02-20. The revised course syllabus is valid from autumn semester 2026.

Responsible department

Department of Neurobiology, Care Sciences and Society, Faculty of Medicine

Prerequisite courses, or equivalent

No prerequisite courses, or equivalent, demanded for this course.

Purpose & Intended learning outcomes

Purpose

The main purpose of the course is to enable the students to acquire a solid understanding of the tools available to analyze brain structural data measured with structural magnetic resonance imaging (sMRI). The students will get the opportunity to develop the ability to critically review results provided by different methods, to select the most adequate tools and experimental designs to answer different questions and to compare their relative advantages.

Intended learning outcomes

After attending the course the student should be able to:

- Explain how MR images are generated, what causes artifacts and how to control for them.
- Describe how MRI is used today for dementia investigations.
- Formulate the basics of surface-based analysis and voxel-based morphometry (differences, similarities, quality control etc.).
- Formulate the basis for multivariate data analysis using structural data in combination

with other type of data.
- Formulate the basis for network analysis (using graph theory) using structural data in combination with other types of data.
- Give an overview of different methods for analyzing diffusion tensor imaging (DTI) as well as other imaging modalities.

Course content

The course focuses on neurodegenerative disorders and in vivo measurements of brain structure. The fundamentals of image processing will be introduced together with an overview of basic MRI physics, including noise and inhomogeneities as well as optimization of pulse sequences. The course covers the methodological approach to computerized segmentation of MRI anatomy using both surface-based and voxel-based methods.

We will also present how MRI is used today in clinical practice to aid the diagnosis of dementia. Further, we will discuss methods for studying white matter integrity (DTI). We will discuss various approaches to assess the validity and reliability of the gained results. We will also cover advanced methods (multivariate data analysis and graph theory) to analyze structural data in combination with other type of data (functional MRI, demographic, cognitive and other biomarker data).

Forms of teaching and learning

In-person lectures, seminars and workshops for 5 full days. The students will perform group projects including a critical assessment of relevant scientific literature.

Language of instruction

The course is given in English

Grading scale

Pass (G) /Fail (U)

Compulsory components & forms of assessment

Compulsory components

All parts of the course are mandatory. Absence from lectures can be compensated for by a written assignment. A missed seminar or workshop has to be compensated for at a later course occasion.

Forms of assessment

The examination takes the form of a critical, in-depth discussion of the group project works, where a topic relevant to brain morphometry has been studied via a review of the scientific literature. Students will be individually assessed regarding their ability to discuss their own and others' group work in relation to the intended learning outcomes of the course.

Course literature

These are just some suggestions, they are not mandatory material for the course:

Basic MRI:
http://www.cis.rit.edu/htbooks/mri/

Books:
- Magnetic Resonance in Dementia. Frederik Barkhof, Jaap Valk, Nick C. Fox, Philip Scheltens. ISBN 9783642625978

- Brain Mapping The Systems. Arthur W. Toga & John C. Mazziotta. ISBN 0-12-692545-3

- Introduction to human neuroimaging. Hans Op de Beeck & Chie Nakatani. ISBN 9781316847916

- Brain Mapping: An Encyclopedic Reference. Volume 1: Acquisition Methods, Methods and Modeling. Editors: Arthur W. Toga, Peter A. Bandettini, Paul Thompson, Karl Friston. ISBN 978-0-12-397316-0

- Fundamentals of Brain Network Analysis. Alex Fornito, Andrew Zalesky, Edward Bullmore. ISBN 9780124081185

Tools for MRI analysis:
- FreeSurfer: https://surfer.nmr.mgh.harvard.edu/
- FSL: https://fsl.fmrib.ox.ac.uk/fsl/fslwiki
- SPM: https://www.fil.ion.ucl.ac.uk/spm/