Neuroimaging

Academic Year: (2023 / 2024) **Review date: 16-05-2023**

Department assigned to the subject: Bioengineering Department

Coordinating teacher: DESCO MENENDEZ, MANUEL

Type: Electives ECTS Credits : 3.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

- Biomedical image processing (in case the student had not taken a similar subject in the bachelor degree)

OBJECTIVES

Neuroimaging is nowadays an essential tool, not only for clinical diagnosis, but also for research in Neuroscience and cognitive processes. The numerous imaging methodologies and the complexity of the data generated lead to the need to use highly specialized image processing techniques, the use of which requires a highly multidisciplinary training.

This course aims, first of all, to familiarize the student with the neurophysiological and neuropsychological knowledge necessary to process and interpret neuroimaging, as well as to impart a basic knowledge of the imaging techniques involved.

On that bases, the fundamentals of preprocessing and processing of structural, diffusion, and functional magnetic resonance neuroimaging data are explained and the student is trained to be able to define his own analyses, conventional or in the context of machine learning, as well as to interpret the results from a critical and multidisciplinary point of view.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction to neuroimaging
   1.1. Introduction: Course presentation; basic concepts in neuroscience, neuroimaging methods
   1.2. Brain and mental processes
   1.3. General concepts: Data formats, MRI acquisition, processing tools
2. Structural MRI
   2.1 Structural MRI processing
   2.2 Practical session 1: MRI basics and structural MRI
3. Diffusion-Weighted Imaging
   3.1 Introduction to diffusion-weighted imaging
4. Functional MRI
   4.1 Functional MRI tasks and BOLD contrast
   4.2 Preprocessing of functional MRI
   4.3 Practical session on fMRI preprocessing
   4.4 Task-based MRI and neuroimaging analysis
   4.5 Resting-state fMRI and functional connectivity
   4.6 Practical session on fMRI and analysis
5. Advanced topics
   5.1 Machine learning in neuroimaging
   5.2 Reliability: Can you believe on your results?

LEARNING ACTIVITIES AND METHODOLOGY

AF3 Theoretical practical classes
AF4 Laboratory practices
AF6 Team work
AF7 Student individual work
AF8 Partial and final exams

Activity code	total #hours	presence #hours	% Student Presence
AF3	16,5	16,5	100%
AF4	4,5	4,5	100%

AF6	15	0	0%
AF7	37	0	0%
AF8	2	2	100%
TOTAL SUBJECT	75	23	30,66%

ASSESSMENT SYSTEM

SE1 Participation in class
SE2 Individual or team works made during the course
SE3 Final exam

Evaluation system (%)	Weighting (%)
SE1	15
SE2	65
SE3	20

% end-of-term-examination:	20
% of continuous assessment (assigments, laboratory, practicals…):	80

BASIC BIBLIOGRAPHY

- Janine Bijsterbosch, Stephen Smith and Christian Beckmann Resting State fMRI Functional Connectivity, Oxford Neuroimaging Primers, 2017
- Mark Jenkinson and Michael Chappell Introduction to Neuroimaging Analysis , Oxford Neuroimaging Primers, 2018
- Russell A. Poldrack, Jeanette A. Mumford, Thomas E. Nichols Handbook of Functional MRI Data Analysis, Cambridge University Press, 2011
- Susumu Mori and J-Donald Tournier Introduction to Diffusion Tensor Imaging: And Higher Order Models, Academic Press, 2013

ADDITIONAL BIBLIOGRAPHY

- Derek K. Jones Diffusion MRI: Theory, Methods, and Applications, Oxford University Press, 2011
- Hernando Ombao, Martin Lindquist, Wesley Thompson and John Aston Handbook of Neuroimaging Data Analysis, Chapman & Hall/CRC Handbooks of Modern Statistical Methods, 2016
- Scott A. Huettel, Allen W. Song, and Gregory McCarthy Functional Magnetic Resonance Imaging, Oxford University Press, 2014

BASIC ELECTRONIC RESOURCES

- . Nipype documentation: https://nipype.readthedocs.io
- . Nibabel documentation: http://https://nipy.org/nibabel/
- . Nilearn documentation: http://https://nilearn.github.io
- . FSL documentation: http://https://fsl.fmrib.ox.ac.uk/fsl/fslwiki
- . ANTs webpage: http://http://stnava.github.io/ANTs