Neuroimaging

Academic Year: (2023 / 2024) **Review date: 25-05-2022**

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)

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

OBJECTIVES

Basic competences

CB6 Having and understanding the knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context
CB7 Students know how to apply their acquired knowledge and problem-solving skills in new or unfamiliar settings within broader (or multidisciplinary) contexts related to their field of study.
CB8 Students are able to integrate knowledge and to face the complexity of making judgments based on information that, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgments.
CB9 Students know how to communicate their conclusions and the knowledge and ultimate reasons behind them to specialised and non-specialised audiences in a clear and unambiguous way.
CB10 Students have the learning skills that will enable them to continue studying in a way that will be largely self-directed or autonomous.

General competences

CG2 Ability to apply the knowledge of skills and research methods related to engineering.
CG3 Ability to apply the knowledge of research skills and methods related to Life Sciences.
CG4 Ability to contribute to the widening of the frontiers of knowledge through an original research, part of which merits publication referenced at an international level.
CG5 Ability to perform a critical analysis and an evaluation and synthesis of new and complex ideas.
CG6 Ability to communicate with the academic and scientific community and with society in general about their fields of knowledge in the modes and languages commonly used in their international scientific community.

Specific competences

CE6 Ability to understand the basis of the main technologies involved in biomedical imaging systems.
CE7 Ability to solve a biomedical problem from an engineering perspective based on the acquisition and processing of biomedical images

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
AF5 Tutorials
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%
AF5	3	0	0%
AF6	15	0	0%
AF7	34	0	0%
AF8	2	2	100%
TOTAL SUBJECT	75	23	30,6%

ASSESSMENT SYSTEM

% end-of-term-examination: 0

% of continuous assessment (assigments, laboratory, practicals…): 100

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

Evaluation system (%)	Minimum weighting (%)	Maximum Weighting (%)
SE1	0	20
SE2	0	100
SE3	0	60

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