BIO-641

Data Science applications in Neuroimaging

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Cursus	Sem.	Type
Neuroscience		Opt.

Language	English
Credits	2
Session	
Exam	Written
Workload	60h
Hours	**64**
Lecture	34
Exercises	30
Number of positions	

Frequency

Every year

Remark

Postopned to spring 2023

Summary

Attention: it is also necessary to register at https://tinyurl.com/edsan2022 in addition to signing up for the course. The "Examples of Data Science Applications in Neuroimaging" (EDSAN) course illustrates the use of open & reproducible data science in neuroimaging, with a strong focus on MRI.

Content

Schedule (all lectures are 2 hour-long)
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Lecture	Date & Time
Introduction to NeuroImaging and MR Imaging	MON FEB 21, 09AM-11AM
FAIR data / BIDS	MON FEB 28, 09AM-11AM
Introduction to MRI data	MON MAR 07 , 09AM-11AM
Preprocessing pipelines	MON MAR 14 , 09AM-11AM
Structural MRI Part 1	MON MAR 21, 09AM-11AM
Structural MRI Part 2	MON MAR 28 , 09AM-11AM
Diffusion MRI	MON APR 04 , 09AM-11AM
Functional task MRI Part 1	MON APR 11 , 09AM-11AM
Functional task MRI Part 2	MON APR 25 , 09AM-11AM
Functional task MRI Part 3	MON MAY 02 , 09AM-11AM
Functional task MRI Part 4	MON MAY 09 , 09AM-11AM
Brain Connectivity / Networks Part 1	MON MAY 16 , 09AM-11AM
Brain Connectivity / Networks Part 2	MON MAY 23 , 09AM-11AM
Potential lecture for topic reinforcement	MON MAY 30 , 09AM-11AM

Syllabus
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o FAIR data / BIDS: FAIR data for reproducibility, Converting MRI data to BIDS structure

o Introduction to MRI data: Basic MRI principles, MRI modalities, MRI data structure and filetypes, Manipulating BIDS data with pybids

o Preprocessing pipelines: Pipeline engine, Tool / software interfaces, Creating a workflow, Deploying a workflow

o Structural MRI
Part 1: Preprocessing MRI data, Templates & registration, MRI data segmentation and visualization, Brain tissue quantification, Data quality control
Part 2: Structural data group analysis at ROI level, Group analysis at voxel or vertex level

o Diffusion MRI: Preprocessing, Fiber orientation estimation, Microstructure quantification, Deterministic tractography, Probabilistic tractography

o Functional task MRI
Part 1: Signal generation, Signal processing, Preprocessing (manual), Preprocessing (automated),
Part 2: Basic fMRI design to understand brain processes, Block design, Event design
Part 3: Estimating brain encoding with GLM analysis, Mass univariate analysis, Statistical contrast, Effect of BOLD signal, Design matrix, First level and second level analyses
Part 4: Machine learning for Brain decoding, Building features from MRI data, Regression task, Classification task, Searchlight

o Brain connectivity / brain networks
Part 1: Functional networks with resting state fMRI, Functional networks with dynamic resting state fMRI, Structural networks with diffusion MRI, Relating structural and functional networks
Part 2: ML applied to connectivity networks, Predicting behavioral score, Prediction subject group

Note

The course will be made available in hybrid mode, with attendance either physically in the auditorium of Campus Biotech in Geneva or remotely by connecting to our dedicated computing infrastructure during the lectures. In addition to the evaluation, credits will only be provided for those attending live at least 80% of the lectures (remotely or physically). An email address of an official accredited university is required. A computer is required to attend the live lectures: a laptop if attending on site, a laptop or a desktop if attending remotely.

Attention: it is also necessary to register at https://tinyurl.com/edsan2022 in addition to signing up for the course.

Questions: Contact https://people.epfl.ch/michael.dayan

Learning Outcome: To implement in Python a neuroimaging MRI data science project within a Linux environment while using best practices of FAIR data and reproducible science.

Keywords

Data Science; NeuroImaging; MRI; Python; Machine Learning

Learning Prerequisites

Required courses

Introduction to Open & Reproducible Data Science (IORDS)