Diffusion MR Imaging: from physics to brain networks

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2.5 ECTS

Course description

Summary
Utilizing diffusion MR imaging in the living brain enables the mapping of tissue microstructure and the identification of axonal fiber bundles connecting diverse cortical regions. This technique has evolved into a pivotal neuroimaging tool widely employed in both clinical and fundamental neuroscience research. This course is designed to offer participants a comprehensive understanding of the relevant theory and hands-on experience, allowing them to gain proficiency in various facets of this technology. Participants will acquire the knowledge necessary to seamlessly integrate diffusion MR imaging into their own research endeavors.

Dates and schedule
The course will take place from February 19 – 26, 2024. Detailed program below.

Objectives
Upon completion of the course, participants will have acquired the following skills and knowledge:

- Articulate the physical principles, processing techniques, and statistical methods pertinent to diffusion imaging.
- Understand the fundamentals of biophysical modeling, microstructure analysis, tractography, and connectome mapping.

Additionally, participants will have accomplished the following:

- Conducted a voxel-based analysis and a basic connectome analysis using provided data.
- Engaged in reading representative diffusion research papers.

Furthermore, participants will have experienced the benefits of interdisciplinary collaboration by addressing questions and engaging in hands-on exercises within groups of two peers.

Format

- Flipped Classroom Sessions:
  - Assigned readings before and during class
  - In-class quizzes and group discussions
- Engaging frontal teaching with interactive elements
- Collaborative hands-on exercises involving the processing of provided data in pairs.

Tools used

- FSL, Freesurfer
- Matlab
- Mrtrix
- Connectome Mapper

Evaluation

- Assessment Components:
  - Multiple Choice Questions administered at the conclusion of the course (50% of the final grade)
  - Submission of a 2-page report on the hands-on exercise within one week after the course concludes (50% of the final grade)
- Attendance to all sessions is compulsory to earn course credits.

Reading materials

Course materials will be stored on the UNIL e-learning platform Moodle. You can access by doing the following:

- go to "https://moodle2.unil.ch"
- log in with your institutional/university address
- click on "Faculté de Biologie et de Médecine" > "Ecole doctorale / doctoral school" > "Lemanic Neuroscience Doctoral School"

The materials are stored under **"Diffusion MR Imaging: from physics to brain networks 2024"**. The access key for the moodle will be provided to participants before the course start. Please contact Ulrike.toepel@unil.ch in case of problems.

Course location

The course will take place in Lausanne @ UNIL-Sorge, Amphipole building (room POL 204.2). **Theoretical sessions** (marked in greenish colors below) will be held in room POL 340.1. The **hands-on sessions** (marked in light blue in the table below) will take place in the PC room POL 204.2.

Registration

The course is limited to 16 participants. **Register before January 18, 2024** !

Local students:, Write an e-mail to *lndscourses@gmail.com* (with your supervisor in copy) and stating "Diffusion MR Imaging" as subject.

International students: ***FENS*** *and* ***IBRO-PERC*** *provide* ***4 stipends*** *of* ***750 EUR for Master and/or PhD students located in Europe*** *interested in attending this course. Through these stipends FENS and IBRO-PERC aim to encourage and promote international experience of students; hence, students that are currently residing or studying in Switzerland are not eligible for a FENS and IBRO-PERC stipend for this course. More information* https://www.fens.org/careers/networks/nens/nens-grants/slots-in-nens-courses

The course slots are reserved; please do not write to the e-mail address above as local students.

Schedule details

Day 1	**Monday February 19**	
8.45-9.00	Introduction	P Hagmann, E Fornari M Bach Cuadra, I. Jelescu, Y. Alemán-Gómez
9.00-9.45	Overview from diffusion to microstructure and basics of dMRI	P Hagmann
10.00-10.45	Inverted class on diffusion MRI	P. Hagmann
11.00-11.45	Diffusion MRI physics	I. Jelescu
12.00-13.00	Lunch time	
13.00-13.45	Pre-processing	M Bach Cuadra
14.00-14.45	Diffusion-based scalars	I. Jelescu & E. Fornari
Day 2	**Tuesday February 20**	
9.00-9.45	Microstructure & biophysical modeling	I Jelescu
10.00-10.45	Voxel-wise, ROI and TBSS (I)	Y. Alemán-Gómez & E Fornari
11.00–11.45	Voxel-wise, ROI and TBSS (II)	Y. Alemán-Gómez & I Jelescu & E Fornari
12.00-13.00	Lunch time	
13.00-16:00	**Hands-on**: group analysis of diffusion scalar maps	Y. Alemán-Gómez, M Bach Cuadra
	Wednesday February 21	
	Home reading of allocated resources	
Day 3	**Thursday February 22**	
9.00-9.45	Diffusion MR reconstruction	Y. Aleman-Gomez
10.00-10.45	In-class reading of allocated resources	J. Patiño
11.00-11.45	Tractography	J. Patiño
12.00-13.00	Lunch time	
13.00-13.45	Tour of available software and tools	Y. Alemán-Gómez
13.45-16:45	**Hands-on**: Reconstruction and Tractography	E. Mullier & Y. Alemán-Gómez
Day 4	**Friday February 23**	
9.00-9.45	Connectomics	A. Griffa
10.00-10.45	Graph Signal Processing	T. Bolton
11.00-11.45	Clinical applications	P. Hagmann
12.00-13.30	Lunch time	
13.30-16.30	**Hands-on**: Connectomics	T. Bolton / A. Griffa
Day 5	**Monday February 26**	
9.00-10.00	Validation and translation considerations	I. Jelescu
10.30-11:30	MCQ Exam	P Hagmann, E Fornari M Bach Cuadra, I. Jelescu, Y. Aleman-Gomez