Diffusion MR Imaging: from physics to brain networks

Organisers: A. Griffa, I. Jelescu, Y. Alemán-Gómez, P. Hagmann, E. Fornari, M. Bach Cuadra

2.5 ECTS

Course description

Summary

Diffusion MR imaging of the living brain allows mapping tissue microstructure and axonal fiber bundles connecting different cortical regions. As such it has become an essential neuroimaging tool that is largely used in clinical and basic neuroscience research. The course will provide relevant theory and practical exposure for the participant to become familiar with the various aspects of this technology such that he can integrate it in his own research.

Objectives:

At the end of the course the student will be able to:

- Explain the physical principles as well as the processing, analysis methods and statistical approaches relevant to diffusion imaging
- Explain basics of bio-physical modeling, microstructure, tractography, and connectome mapping.

At the end of the course the student will have:

- Performed a voxel-based analysis and a simple connectome analysis on provided data
- Read representative diffusion papers

Discovered the power of inter-disciplinary interaction by working on questions and hands-on exercises in a group of two.

Format:

- Inverted classes
  - Pre class and in class reading
  - In class quizzes and discussion
- Frontal classic but interactive teaching
- Hands-on exercises with processing of provided data in groups of two persons

Technology used:

- FSL, Freesurfer
- Matlab
- Mrtrix
- Connectome Mapper

Evaluation:

- Multiple Choice Questions at the end of the course (50% of the final mark)
- 2-page report on hands-on exercise to be handed in one week after end of course (50% of the final mark)
- Participation to all sessions is mandatory to get the credits

Reading materials

Course materials are 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 2023"**. Please use the self-enrollment method to access. Contact Ulrike.toepel@unil.ch in case of problems.

Course location (to be confirmed)

The course will take place @ UNIL-Sorge, Amphipole building (rooms POL 202 & POL 204.2). **Theoretical sessions** (marked in greenish colors below) will be held in room **POL 202.** 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 December 20, 2022,, by writing a mail to lndscourses@gmail.com (with your supervisor in copy) and stating "Diffusion MR Imaging" as subject. Places will be given on a first come-first served basis.

Dates and schedule

The course will take place from 30 January – 6 February, 2023. Detailed program below.

Day 1	**Monday January 30, 2023**	**Room POL 202**
8.45-9.00	Introduction	P Hagmann, E Fornari M Bach Cuadra, I. Jelescu, Y. Aleman-Gomez
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	E Fornari
Day 2	**Tuesday January 31, 2023**	**Room POL 202**
9.00-9.45	Microstructure & biophysical modeling	I Jelescu
10.00-10.45	In-class reading of allocated resources	E Fornari
11.00–11.45	Voxel-wise, ROI and TBSS contest	E Fornari
12.00-13.00	Lunch time	
13.00-16:00	**Hands on (Room POL 204.2)**: group analysis of diffusion scalar maps	E Fornari, I Jelescu M Bach Cuadra
	Wednesday February 1, 2023	
	Home reading of allocated resources	
Day 3	**Thursday February 2, 2023**	**Room POL 202**
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 (Room POL 204.2)**: Reconstruction and Tractography	Y. Alemán-Gómez
Day 4	**Friday February 3, 2023**	**Room POL 202**
9.00-9.45	In-class reading of allocated resources	T Bolton
10.00-10.45	Connectomics	T Bolton
11.00-11.45	Clinical applications	P. Hagmann
12.00-13.30	Lunch time	
13.30-16.30	**Hands on (Room POL 204.2)**: Connectomics	T Bolton
Day 5	**Monday February 6, 2023**	**Room POL 202**
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