Master project

Location: EPFL ENT-R CIBM-AIT, Bâtiment CH F.
Dates/Duration: Spring 2021 semester / 4 – 6 months.

Diffusion MRI: a non-invasive microscope into brain disease

During an MRI experiment, water molecules in the brain diffuse over a few microns - a distance on the same order as major microstructural features of the tissue - and their mobility is largely governed by restrictions and hindrances related to the tissue architecture. In other words, the diffusion-weighted signal encodes information about length scales much smaller than the actual MR image resolution of millimeters, and thus about features of the underlying tissue microstructure that lie in the mesoscale and that we otherwise cannot spatially resolve in vivo.
Our group combines the sensitivity of the diffusion-weighted signal to tissue microstructure with biophysical modeling to:

- Infer properties of brain tissue microstructure such as axonal/neurite density, compartment diffusivities and membrane permeability. Goal: bring MRI to the level of a non-invasive in vivo microscope
- Apply these tools to inform about specific features of healthy and diseased tissue, and thereby identify biomarkers of disease progression and response to treatment.

The project will involve the translation and validation of biophysical models of brain tissue to characterize neurodegeneration in datasets of healthy and diseased brain.

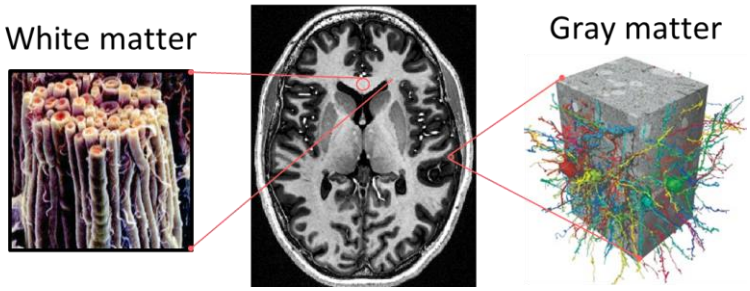

Figure 1 : Biophysical models of brain tissue are required to extract specific and relevant information about tissue microstructure from the diffusion MRI signal.

References

[1] Jelescu IO, Budde MD. Design and validation of diffusion MRI models of white matter. Frontiers in Physics **2017**; 5:61.

[2] Jelescu IO, Palombo M, Bagnato F and Schilling KG, Challenges for biophysical modeling of microstructure. J Neuroscience Methods 2020; 344: 108861.

[3] Tristão Pereira C*, Diao Y*, Yin T, da Silva AR, Lanz B, Pierzchala K, Poitry-Yamate C and Jelescu IO, Synchronous nonmonotonic changes in functional connectivity and white matter integrity in a rat model of sporadic Alzheimer's disease. NeuroImage 2021; 225:117498.

[4] Jelescu IO, Zurek M, Winters KV, Veraart J, Rajaratnam A, Kim NS, Babb JS, Shepherd TM, Novikov DS, Kim SG and Fieremans E, In vivo quantification of demyelination and recovery using compartment-specific diffusion MRI metrics validated by electron microscopy. NeuroImage 2016; 132:104-14.

Main supervisor

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Collaborators

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Qualification, previous experience and background

This master project is suitable for students with a background in physics, engineering or data science, and with an interest in biomedical imaging and data analysis.

Requested Skills

Previous programming experience (Matlab, Python, bash...)

Desirable

Experience with medical image analysis tools or image visualization tools.

How to apply:

Please send your CV and motivation letter to the main supervisor: ileana.jelescu@epfl.ch

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About CIBM

The CIBM Center for Biomedical Imaging was founded in 2004 and is the result of a major research and teaching initiative of the partners in the Science-Vie-Société (SVS) project between the Ecole Polytechnique Fédérale de Lausanne (EPFL), the Université de Lausanne (UNIL), Université de Genève (UNIGE), the Hôpitaux Universitaires de Genève (HUG) and the Centre Hospitalier Universitaire Vaudois (CHUV), with the generous support from the Fondation Leenaards and Fondation Louis-Jeantet.
CIBM brings together highly qualified, diverse, complementary and multidisciplinary groups of people with common interest in biomedical imaging.

We welcome you in joining the CIBM Community.