NX-421

Neural signals and signal processing

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Cursus	Sem.	Type
Biomedical technologies minor	H	Opt.
Computational biology minor	H	Opt.
Life Sciences Engineering	MA1, MA3	Opt.
Microtechnics	MA1, MA3	Opt.
Minor in Imaging	H	Opt.
Neuro-X minor	H	Opt.
Neuro-X	MA1, MA3	Opt.
Neuroscience		Obl.
Robotics	MA1, MA3	Opt.

Language of teaching	English
Credits	6
Session	Winter
Semester	Fall
Exam	Written
Workload	180h
Weeks	14
Hours	**6 weekly**
Courses	4 weekly
Exercises	2 weekly
Number of positions	

Summary

Understanding, processing, and analysis of signals and images obtained from the central and peripheral nervous system

Content

Understanding neural signals obtained by electrophysiology and imaging techniques requires knowledge both about their origin and the measurement process. This course will introduce the properties of a wide range of neural signals that are used to study the brain in health and disease. The relevance of these signals for applications in fundamental and clinical neuroscience will be made clear. In addition, a broad range of signal processing tools and their implementations will be presented with the specific focus to implement and tailor analysis of these signals, which typically comes as large, noisy, but richly structured datasets. Exercises and lab exercises will provide insights into the analysis of imaging data and electrophysiological neural signals.

Keywords

Electrophysiology, nervous system, neuroimaging, brain mapping, systems-level neuroscience, MRI

Learning Prerequisites

Required courses

Mathematics at the engineering level (i.e., matrix algebra, probability theory)
Basic signal processing, statistics, and machine-learning concepts
Basic knowledge of programming

Learning Outcomes

By the end of the course, the student must be able to:

- Analyze processing steps of neural signals and imaging data
- Assemble a neural data processing pipeline
- Critique suitability of analysis methods
- Interpret results of neural signals analysis
- Explain choice of methodology

Transversal skills

- Use a work methodology appropriate to the task.
- Make an oral presentation.

- Give feedback (critique) in an appropriate fashion.

Teaching methods

Weekly lectures (4h) and weekly exercise session (2h)
Mini-projects during the semester

Expected student activities

Attendance at lectures and exercises

Assessment methods

Attendance and completion of mini-projects with presentations
Written exam

Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes

Resources

Virtual desktop infrastructure (VDI)

Yes

Bibliography

- H. Op de Beeck, C. Nakatani, "Introduction to Human Neuroimaging", Cambridge University Press, 2019.
- N. V. Thakor, "Handbook of Neuroengineering", Springer, 2020.

Ressources en bibliothèque

- Handbook of Neuroengineering / N. V. Thakor
- Introduction to human neuroimaging / Hans Op de Beeck, Chie Nakatani

Moodle Link

- https://go.epfl.ch/NX-421