Neural data science

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To get information about the registration, please enter your email here:

https://forms.gle/mPV4YxWvsjXeMGx2A

Zoom link:

https://tu-dresden.zoom-x.de/j/69602074515?pwd=VwxGjiogVwn37K9xQaCYvwgtmNbdwJ.1

2 teaching units per week

Wed and Fri [both from 11:10-12:40]

Wed on classroom APB/E010 at TU Dresden, Computer Sci. Dept.

Fri on classroom HSZ/0E05 at TU Dresden, Computer Sci. Dept.

Link to Opal

https://bildungsportal.sachsen.de/opal/auth/RepositoryEntry/46518075402/CourseNode/17282682984184060007

In this course, we will learn various machine-learning methods for analyzing neural data. We will implement basic algorithms and apply them to real data, preparing us to handle real neural data. Such methods are also applicable to a wider range of data.

The course covers the preprocessing of electrophysiological data, from raw signals to fully usable signals (which include spike detection and spike sorting), analysis of spike train, analysis of neural population data, such as multi-array spike and LFP data, as well as advanced topics such as spectral analysis of field potentials, and methods for multi-scale analysis of neural data.

Course Schedule

Lecture 1	16 Oct 2024	Organization of research flow
Lecture 2	23 Oct 2024	Introduction to Computational Neuroscience
Lecture 3	30 Oct 2024	Neurons, circuits and networks
Lecture 4	6 Nov 2024	Spectral analysis basics (Fourier analysis and filtering)
Lecture 5	13 Nov 2024	Spike sorting
Lecture 6	27 Nov 2024	Spike train analysis
Lecture 7	4 Dec 2024	Spectral analysis of field potentials 1
Lecture 8	11 Dec 2024	Neural data engineering
Lecture 9	18 Dec 2024	Spectral analysis of field potentials 2
Lecture 10	8 Jan 2025	Multi-scale analysis of neural data (uni-variate)
Lecture 11	15 Jan 2025	Multi-scale analysis of neural data (multi-variate)
Lecture 12	22 Jan 2025	Research in CMC lab
Lecture 13	29 Jan 2025	Project presentations

Syllabus

1. Introduction to Computational Neuroscience
2. Organizing exploratory analysis of neural data
3. Organizing a research flow
4. Spike detection
5. Spike sorting
6. Identifying single neurons
7. Analyzing single spike trains
8. Analyzing population spike trains
9. Spectral analysis of field potentials 1
    a. Fourier analysis
    b. Basic signal processing
10. Spectral analysis of field potentials 2
    a. Local field potential (LFP)
    b. Electroencephalogram (EEG)
11. Spectral analysis of field potential 3
    a. Spectral decomposition
    b. Identifying transient dynamics
12. Multi-scale analysis of neural data (uni-variate)
    a. Uni-variate phase-locking analysis
    b. Statistical analysis of pair-wise coupling
13. Multi-scale analysis of neural data (multi-variate)
    a. Multi-variate phase-locking analysis
    b. Statistical analysis of population data

Prerequisite

- Familiarity with biology
- basic machine learning
- basic mathematical physics/engineering (e.g., Fourier analysis)
- basic statistics

Course material and evaluation

Slides and pointers to appropriate references (book chapters and papers) will be provided during the course. The course will have weekly assignments (mainly programming with Python). For most assignments, a pre-filled IPython notebook containing the instructions

for the exercise will be provided. The final assessment will be based on a written 90-minute exam.

Number of participants

Up to 36 participants