Data Science applications in Neuroscience

Course Number: 275021

Data Science applications in Neuroscience

Izhar Bar-Gad

Seminar

First Semester. Scope of hours: 2 academic hours (1 credit point)

Course Goals:

The seminar will introduce the frontiers of the scientific research which applies data science approaches to the processing of data related to neuroscience. The seminar will handle the different sub-fields of neuroscience in which data science approaches have been implemented and will discuss recent developments in those fields.

Course content:

The applications of data science will be grouped into several neuroscience sub-fields:

1. Time series analysis of continuous signals derived from physiological, such as EEG (electroencephalography) and behavioral, such as accelerometer, data.

2. Image processing of structural data on multiple scales ranging from EM (electron microscope) to MRI (Magnetic resonance imaging).

3. Image processing of functional data, primarily fMRI.

4. Natural language processing (NLP) usage in linguistics and cognitive psychology.

5. Massive spike train analysis from sources such as calcium imaging and multi-electrode arrays.

6. Behavior analysis from video streams.

Teaching plan:

The seminar will include an introductory lecture followed by field-specific lecture by the lecturers which will be accompanied by presentation of manuscripts related to the sub-fields by the students.

Detailed weekly program:

1	Introduction	Izhar Bar-Gad
2-3	Time series analysis of physiological continuous signals derived	Elana Zion-Golombic
4-6	Image processing of structural and functional data	Gal Chechik
7-8	Natural Language Processing	Michal Ben Shahar
9-10	Massive spike train analysis	Gal Chechik
11-13	Behavior analysis from video streams	Izhar Bar-Gad

Prerequisites

First year courses of the Brain Sciences – Data science track courses.

Duties/requirements/assignments:

Presentation of an article and submission of a final work. Active participation in the seminar,

Grading distribution:

40% Presentation of a manuscript

40% Final home project

20% Active participation and feedback on presentations

Bibliography:

A comprehensive list will be given to the students during the first lessons, examples include:

1. Berman GJ, Choi DM, Bialek W, Shaevitz JW. Mapping the stereotyped behaviour of freely moving fruit flies. J Royal Society Interface. 2014;11(99):20140672.

2. Calhoun AJ, Pillow JW, Murthy M. Unsupervised identification of the internal states that shape natural behavior. Nature Neuroscience. 2019;22(12):2040-2049.

3. Jonas E, Kording KP. Could a Neuroscientist Understand a Microprocessor?. PLoS Computational Biology. 2017;13(1):e1005268.

4. Paninski L, Cunningham JP. Neural data science: accelerating the experiment-analysis-theory cycle in large-scale neuroscience. Current Opinions in Neurobiology. 2018;50:232-241.

5. Todd JG, Kain JS, de Bivort BL. Systematic exploration of unsupervised methods for mapping behavior. Physical Biology. 2017;14(1):015002.

Applications of Data Science in Brain Research

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