Course coordinators: Iván Davidovich and Soledad Gonzalo Cogno

Lecturers: Iván Davidovich and Soledad Gonzalo Cogno

Language: English

Location: Trondheim – _Kavli Institute for Systems Neuroscience

Registration: Students at NTNU sign up using studweb as normal. External candidates from other universities. Those who are admitted as PhD candidates at other Norwegian universities must apply through this link: https://www.ntnu.edu/phd/courses_external.

The deadline is 1st of February

Course content:
Many fields within the Biological Science are becoming increasingly quantitative and interdisciplinary. This poses the double challenge of having a good understanding of the biological aspects of the problem under study, as well as of the mathematics used to analyze the acquired data and to develop models for it. The goal of this course is to introduce biologists to basic concepts in Linear Algebra that they will encounter in most of the analysis techniques and models they will employ in their research. The course will smoothly introduce the language of mathematics, with the aim of easing interdisciplinary communication. No previous knowledge of Linear Algebra is required, as we will start from the basics, namely: sets, vectors and matrices. We will then introduce the concepts of vector spaces and subspaces, while also covering linear combinations, bases, coordinates and dimensions. We will finish by discussing linear transformations, change of basis and eigendecomposition. We will integrate the acquired knowledge by introducing and discussing the technique of Principal Component Analysis.

Learning methods and activities:
Each class will be divided into a lecture and a practical session. The practical sessions will consist on solving exercises in order to assimilate the concepts introduced during the lectures. We will use the practical sessions to monitor the progress that the students make with the exercises.

At the end of the course, and right before the exam, there will be a recap reserved for further discussion. The evaluation of the course will consist on a digital home exam, which will contain exercises similar to the ones discussed during the course. Additionally, students will be required to submit 4 short assignments throughout the course, which they will need to pass in order to be allowed to take the exam.

Learning outcome:
After completing the course the student will:
- Have been exposed to basic constructive mathematical reasoning, including a very limited exposure to mathematical proofs.
- Have a familiarity with fundamental and ubiquitous concepts from Linear Algebra including, but not limited to, the notion of a basis, coordinates and the dimension of a vector space, and an understanding of the concept of linear transformations, as well as eigenvalues and eigenvectors of a matrix.
- Be able to use this newfound knowledge to better understand the foundations of many analysis techniques widely employed in the Biological Sciences, such as Principal Component Analysis.

Specific requirements:
The course is meant for PhD students at the Kavli Institute for System Neuroscience and at the Department of Neuromedicine and Movement Science.

Bibliography:
To be announced.

Tentative timetable:

19-Feb	Sets, vectors and matrices, dot and cross products.	Soledad Gonzalo Cogno
26-Feb	Vector spaces: definition and examples. Subspaces.	Ivan Davidovich
05-Mar	Linear combinations, linear independence. Spanning sets.	Soledad Gonzalo Cogno
12-Mar	Basis, coordinates. Change of basis. Dimension.	Ivan Davidovich
19-Mar	Linear transformations	Ivan Davidovich
26-Mar	Eigenvalues and eigenvectors. Inner product.	Soledad Gonzalo Cogno
09-Apr	Orthogonality. SVD.	Ivan Davidovich
16-Apr	Application to PCA and examples from Neuroscience.	Soledad Gonzalo Cogno
23-Apr	Recap.	Both
30-Apr	Exam.	