EPFL

BIOENG-450 **In silico neuroscience**

Romani Armando, Schürmann Felix

Cursus	Sem.	Type
Computational Neurosciences minor	E	Opt.
Life Sciences Engineering	MA2, MA4	Opt.
Neuroprosthetics minor	E	Opt.
Sciences du vivant	MA4	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	Written
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

"In silico Neuroscience" introduces students to a synthesis of modern neuroscience and state-of-the-art data management, modelling and computing technologies.

Content

"In silico Neuroscience" introduces masters students to a synthesis of modern neuroscience and state-of-the-art data management, modelling and computing technologies. Following fundamental structural and functional building blocks of the mammalian brain from cells to circuits, the course teaches applied biophysical modeling for each of these building blocks and showcases applications thereof in modern neuroscience. Accordingly, the course covers a number of key technologies, including 1) how neuroscience data is acquired, organized and integrated, 2) data-driven modeling and validation, 3) simulation and analysis technologies. The target audience are technically adept students in the EPFL Neuroscience program and students from other programs (e.g. I&C, SB, CSE) interested in applying their domain techniques to neuroscience.
The week-by-week breakdown of the course is as follows:
w1. Introduction
Single Cells
w2. Morphologies
w3. Ion channels
w4. Single cell modeling I â## Hodgkin & Huxley & Cable Equation
w5. Single cell modeling II â## Parameter Optimization
w6. Neuroinformatics & Resources
Networks
w7. Synapses
w8. Connections
w9. Networks I â## Assembling the pieces
w10. Networks II â## In silico experimentation
w11. Simulation & Scientific Computing I
w12. Simulation & Scientific Computing II
w13. Point neural networks & Simplification
w14. Perspectives

Learning Prerequisites

Recommended courses

Neuroscience II
Introduction to programming
Projects in informatics

Important concepts to start the course

general knowledge on cellular neuroscience
experience in elementary programming (preferentially python)

Learning Outcomes

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

- Interpret discrepancies between experimental findings
- Assess / Evaluate different level of detail formulations of models
- Integrate biological facts into detailed neuron and tissue models
- Apply model concepts in simulations
- Exploit standard modelling and simulation software
- Analyze model predictions
- Explain formalisms and approaches in simulation software

Teaching methods

Due to the general COVID-19 situation, the course will be **given remotely and no physical presence on campus** is required for this course (apart from final exam)
Structure: each week there will be

- a pre-recorded 90min lecture (which students can watch Tuesdays, 8:15-10am, or beforehand); note: the lecture of the first week is given live
- 45min interactive discussion with the teachers (Tuesdays, 10:15-11am)
- 45min group work on exercises (TAs present)

Exercises

- practical programming/problem solving on topics from the lectures
- done in groups (~3 students/group), which remain for the entire semester
- are graded on a weekly basis (20% of grade)
- prepare for the final exam

Expected student activities

- Students review lecture material on their own
- Students actively participate in the discussion on the topics of the lecture in the discussion session
- Students complete weekly practical programming assignments relevant to the weekâ##s lecture in groups
- Students write final exam in exam period

Assessment methods

Written exam (80%);
Continuous control (20%)