CS-502

Deep learning in biomedicine

Brbic Maria

Cursus	Sem.	Type
Computational biology minor	E	Opt.
Computer science	MA2, MA4	Opt.
Data Science	MA2, MA4	Opt.
Data science minor	E	Opt.
Life Sciences Engineering	MA2, MA4	Opt.
Minor in life sciences engineering	E	Opt.
Neuro-X minor	E	Opt.
Neuro-X	MA2, MA4	Opt.
SC master EPFL	MA2, MA4	Opt.

Language of teaching	English
Credits	6
Withdrawal	Unauthorized
Session	Summer
Semester	Spring
Exam	During the semester
Workload	180h
Weeks	14
Hours	**5 weekly**
Courses	2 weekly
Exercises	2 weekly
Project	1 weekly
Number of positions	**150**

It is not allowed to withdraw from this subject after the registration deadline.

Summary

Deep learning offers potential to transform biomedical research. In this course, we will cover recent deep learning methods and learn how to apply these methods to problems in biomedical domain.

Content

The goal of this course is to cover recent deep learning methods and demonstrate how they can be applied to biomedical data. The course will cover ongoing advances in deep learning research for different input data types (e.g., convolutional neural networks for images, graph convolutional neural networks for graph-structured data, transformers for sequence data). We will start with a standard supervised learning setting and then cover ongoing developments in unsupervised learning, transfer learning and building foundation models. Here, we will discuss specific challenges in adapting these paradigms to different varieties of biomedical data (e.g., genomics, transcriptomics, proteomics, medical image processing). Additionally, we will cover LLM-based agentic systems that can interact with data to automate biomedical research. We will cover and discuss recent papers from the literature that apply these methods to problems in biomedicine. Note that topics are tentative and will be explored at different depths. Material discussed in previous years is an indication of what may be covered but not a guarantee as the AI field is moving fast. In class participation is strongly recommended.

Learning Prerequisites

Required courses

CS-433 Machine Learning

Recommended courses

CS-233 Introduction to Machine Learning

Important concepts to start the course

- Python programming
- Probability and statistics
- Linear Algebra
- Machine learning

Learning Outcomes

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

- Understand and implement deep learning methods covered in the course
- Understand benefits and shortcomings of the methods covered in the course
- Understand common problems in the biomedical domain and know which methods are suitable for solving these problems
- Review academic research papers and understand their contributions according to concepts covered in the course
- Complete a project that applies learned algorithms to a real-world problem in the biomedical domain
- Understand and implement deep learning methods covered in the course
- Understand benefits and shortcomings of the methods covered in the course
- Understand common problems in the biomedical domain and know which methods are suitable for solving these problems
- Review academic research papers and understand their contributions according to concepts covered in the course
- Complete a project that applies learned algorithms to a real-world problem in the biomedical domain

Teaching methods

- Lectures
- Paper reading
- Course project

Expected student activities

- Attend lectures and participate in class
- Complete in-class quizzes
- Complete a deep learning project in a group. This includes preparing a project proposal, implementing the method, submitting final project report and presenting project results

Assessment methods

- In-class quizzes during the semester
- Project
- Final exam

Supervision

Office hours	Yes
Assistant.e.s	Yes
Forum	Yes

Resources

Bibliography

Goodfello, Bengio, Courville. Deep Learning. MIT Press (2016)

Ressources en bibliothèque

- Find the references at the Library