

BIO-410

Bioimage informatics

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Cursus	Sem.	Type
Biomedical technologies minor	E	Opt.
Biotechnology minor	E	Opt.
Computer science	MA2, MA4	Opt.
Electrical Engineering		Opt.
Life Sciences Engineering	MA2, MA4	Opt.
Microtechnics	MA2, MA4	Opt.
Minor in Imaging	E	Opt.
SC master EPFL	MA2, MA4	Opt.

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

Summary

The course provides a comprehensive overview of methods, algorithms, and computer tools used in bioimage analysis. It exposes fundamental concepts and practical computer solutions to extract quantitative information from multidimensional images, both using engineering methods and deep learning.

Content

To investigate biological processes, bioimage informatics emerges as a growing field on the interface between microscopy, signal-processing, and computer science. The recent microscopes are producing large volumes of high-resolution multidimensional data (up to 5D). Therefore, algorithms and software tools are needed to automatically extract quantitative data from these images.

The course gives the theoretical concepts and practical aspects of the most common image reconstruction and image analysis techniques. It explains how to code algorithms and to deploy software tools to build an automatic analysis workflow using the most common used software, Fiji/ImageJ (Java-based) and Jupyter Notebook (Python-based). The lecture is tailored to the needs of life sciences and driven by biological questions.

Addressed topics include (but not restricted to): presentation of microscopy modalities, digital images, multi-dimensional data (3D, time, multiple channels) manipulation, 3D image-processing algorithms, 5D visualization, image metrics, reconstruction, deconvolution, denoising, stitching, visual feature detection, segmentation, active contours, image analysis workflow, pixel classification, machine learning, deep learning for image analysis, large datasets, tracking of particles, and super-resolution localization microscopy.

The course is composed of lectures, workshops, practices, and a mini-project.

A personal laptop is recommended to run (open-source) image analysis software and to develop short scripts.

Keywords

Bioimage, microscopy, image processing, image reconstruction, image analysis, visualization, multidimensional data analysis, machine learning, deep learning

Learning Prerequisites**Required courses**

- Basic knowledge in programming

Important concepts to start the course

- Basic knowledge in signal or image processing
- Basic knowledge in programming

Learning Outcomes

- Identify quality of images in life science and expectation of the analysis
- Define the fundamental concepts of the computational bioimaging methods
- Select appropriately and compare methods and tools for common bioimage analysis tasks
- Design implements and experiment algorithms to solve specific tasks
- Develop a workflow for customized application
- Assess / Evaluate strategies for image-based experiments in life science

Transversal skills

- Demonstrate the capacity for critical thinking
- Use a work methodology appropriate to the task.
- Use both general and domain specific IT resources and tools

Assessment methods

20% Homework, individual

- In the first half of the semester: 4 homeworks on computer (2 weeks)

40% Mini-project by groups of 2-3 students

- In the second half of the semester: Development of an image analysis tool for a real application in biology

40% End-term exam, individual

- written exam with handwritten notes

Resources

Moodle Link

- <https://go.epfl.ch/BIO-410>