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		Obl.
Life Sciences Engineering	MA2, MA4	Opt.
SC master EPFL	MA2, MA4	Opt.

Language of teaching	English
Credits	4
Withdrawal	Unauthorized
Session	Summer
Semester	Spring
Exam	During the semester
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Project	2 weekly
Number of positions	**30**

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

Summary

The course provides a comprehensive overview of methods, algorithms, and computer tools used in in computational bioimaging and bioimage analysis. It exposes the fundamental concepts and the practical computer solutions to extract quantitative information from multidimensional images.

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 (mainly in ImageJ/Fiji). 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, reconstruction, deconvolution, denoising, stitching, visual feature detection, segmentation, active contours, image analysis workflow, pixel classification, machine learning, and tracking for building a cell lineage.
The course is composed of lectures, workshops with the state-of-the-art software packages, computer sessions (programmation) and a mini-project. A personal laptop is recommended to run (open-source) bioimage software packages.

Keywords

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

Learning Prerequisites

Important concepts to start the course

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

Learning Outcomes

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

- 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

Teaching methods

Lecturing with demonstration, workshops, computer laboratories, hands-on

Assessment methods

Continuous: mid-term and end-term exams and a mini-project