



Bioimage Informatics

Daniel Sage & Arne Seitz

Syllabus

Course Bioimage Informatics



General Course **Information**

Bioimage informatics is a new discipline

- Course introduced in 2019 (one of the few of its kind)
- Covers all essential aspects of the field
- Spans from basic concepts to SOTA advancements
- Built on real-world experiences of teachers
- Specially tailored for EPFL Master students

Dr. Daniel Sage

Biomedical Imaging Group

Center for Imaging

School of Engineering

daniel.sage@epfl.ch

Office hours

Thursday 11-12PM

Dr. Arne Seitz

Head of the PT-BIOP

BioImage and Optics Platform

School of Life Science

arne.seitz@epfl.ch

Office hours

Wednesday 10-11PM

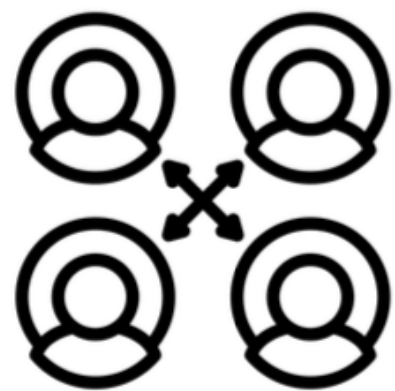
Learning outcomes

- ✓ Understand the fundamental concepts of bioimage processing and analysis
- ✓ Grasp the principles behind key algorithms (engineering and machine learning)
- ✓ Analyze, select, combine techniques for specific applications
- ✓ Learn how to use widely adopted bioimage software
- ✓ Design and code basic routines and workflows real-world applications
- ✓ Are able to produce and evaluate reliable data analysis from images

Structure

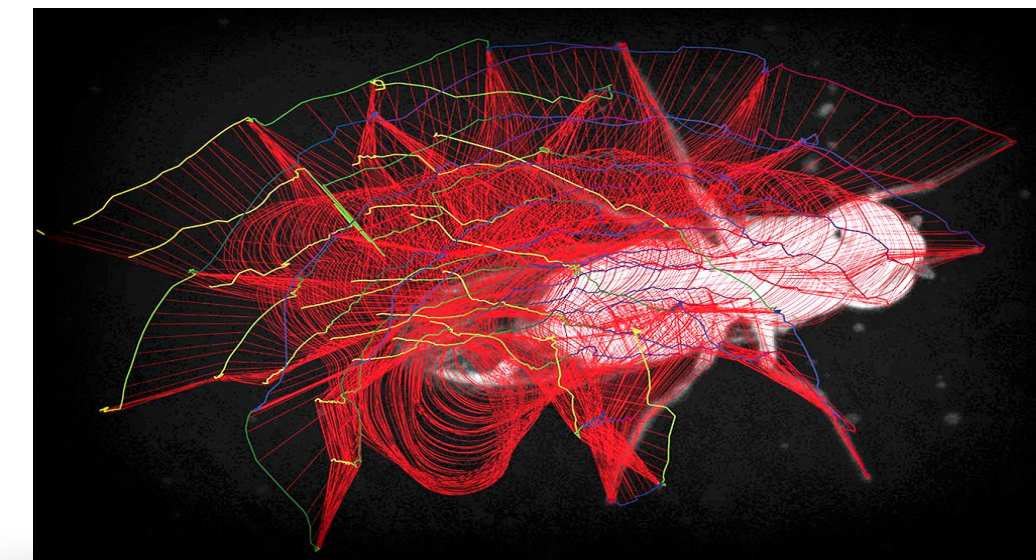
- Lectures
- Demos
- Workshops
- Exercises
- Homeworks
- Project

General Course **Information**



Personal involvement

- Be open for **interdisciplinary**: biology, microscopy, SP, coding
- Be actively **engaged**, encouraging interactivity, sharing with peers
- Be ready to write **code** as part of the learning experience
- Be **resilient** in dealing with technical issues of open-source software

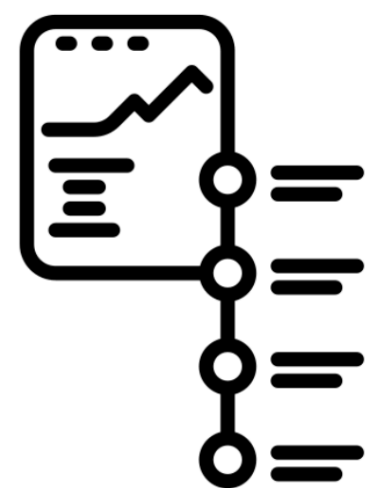


Policies

- Students are expected to attend all course activities
- Slides alone are not sufficient to master the course
- Coding are essential to fully grasp the fundamental concepts
- A fair attitude is expected when working in groups

EPFL | **MOODLE**

Course notes
Homework submission
Forum



Coding – Programming by examples

- **Macro** Scripting for automation — **ImageJ**
- **Java** Developing robust, GUI-based, and powerful applications — **Fiji**
- **Python** Prototyping, fast, enabling DL & GPU — **Napari** or **Notebook**

Full support



Limited support





Grading

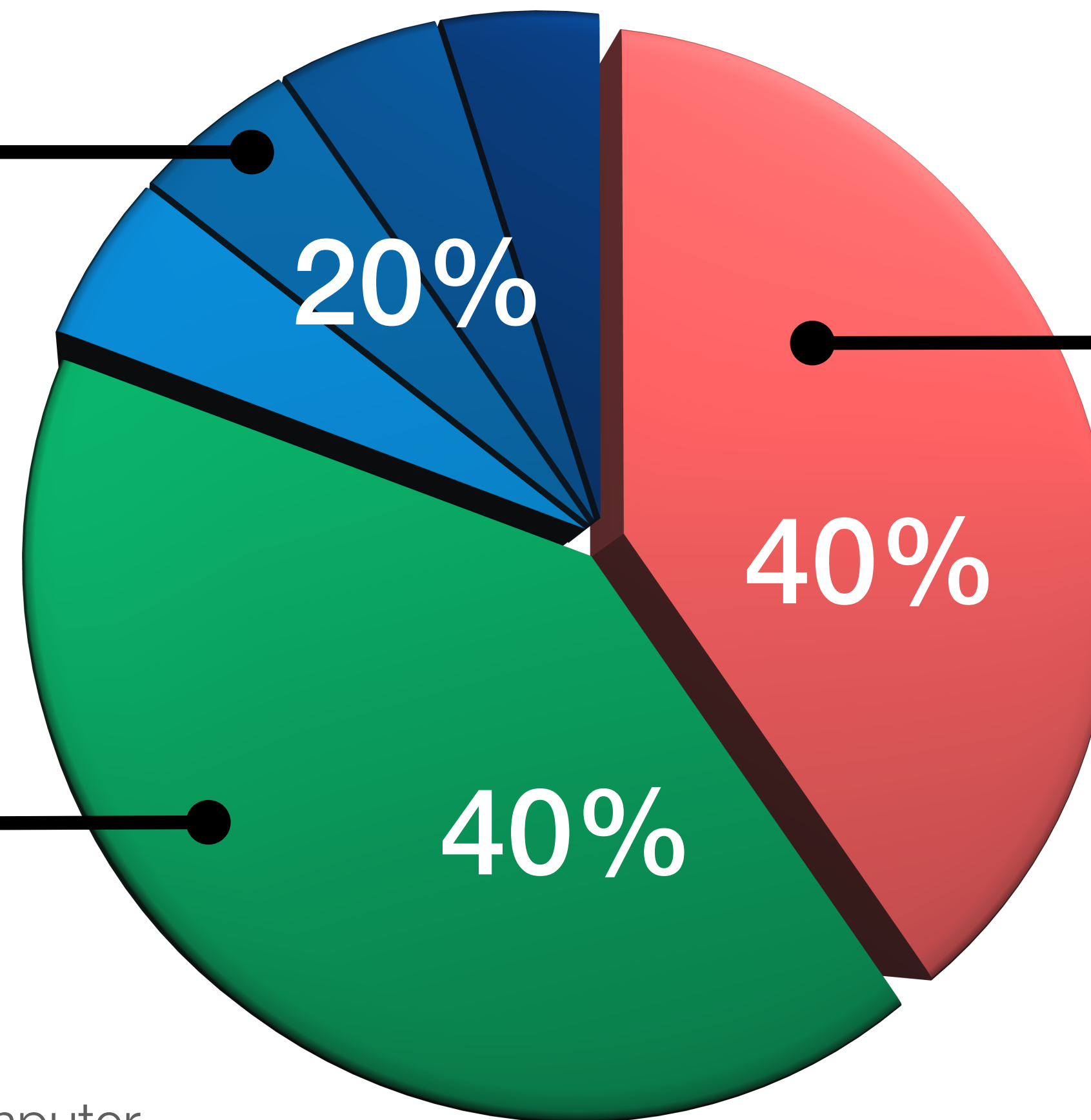
4 ETCS

Homeworks (4)

Individual
Computer hand-ons
~11 days

Exam

Individual
Written
Handwritten notes, no computer
Mock-exam
~3h in June or July



Project

Group of 2-3 students

Practical

Bioimage analysis
on real data
Methodology
implementation
Oral presentation

~7 weeks

Deadlines are strict, and late submissions will not be accepted.

Computer & Software



Personal computer

8Gb RAM at least

Disk space ~4Gb

Java 1.8

Python 3.9

Backup

Open-source software for this course

Fiji

Complete software package for life science. Distribution of ImageJ

ImageJ

Standard software for bioimage analysis Vanilla version (NIH)

Napari

Multidimensional image viewer. Python-based bioimage platform

Ilastik

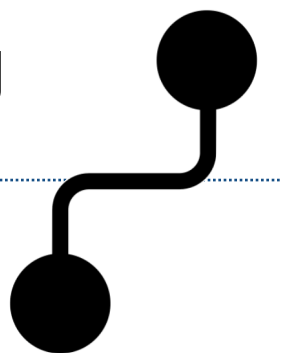
Software for machine learning pixel classification and more

QuPath

Java-based platform, user-friendly software for digital pathology

ICY

Java-based, open community platform for bioimage analysis


















































































Open-source coding environment for this course

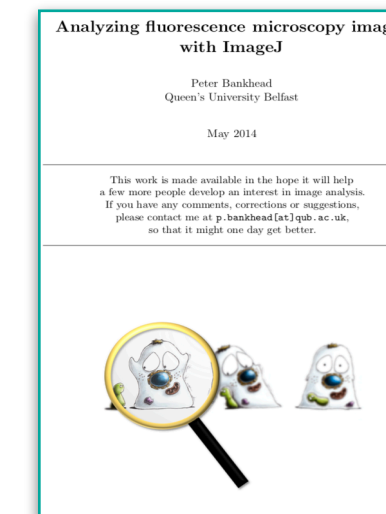
IntelliJ IDEA Community Edition Integrated development environment (IDE) for Java

Python environment

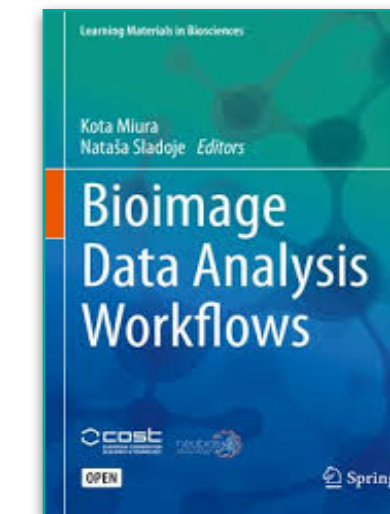
Visual Studio code / Conda / Jupyter Notebook

 **image.sc** <https://forum.image.sc>

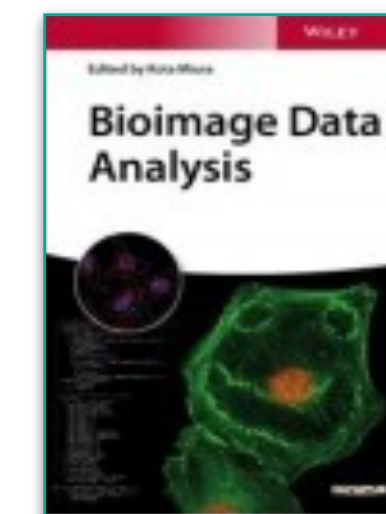
| | | | | | |
|---|--|--|---|--|---|
|  All Topics |  AGAVE |  AICSImageIO |  Arkitekt |  Aydin |  BAND |
|  BIAFLOWS |  BiaPy |  BIII |  BiofilmQ |  Bio-Formats |  Biolma |
|  BoneJ |  BrainGlobe |  CAREamics |  Cell-ACDC |  Cellpose |  CellPrc |
|  CLIJ |  CytoMAP |  Cytomine |  DAIM |  DeepLabCut |  Fiji |
|  FLIMLib |  GerBI |  GloBIAS |  Icy |  IDR |  ilastik |
|  ImageJ |  ImageJ2 |  ImgLib2 |  ImJoy |  ImSwitch |  iRODS |
|  JIPipe |  JuliaImages |  Mars |  MCMICRO |  MIA |  MIB |
|  µManager |  MoBIE |  ModularImageAnalysis |  MorphoGraphX |  MorphoNet |  napari |
|  NEUBIAS |  NFDI4BIOIMAGE |  OME |  OMERO |  OmeSliCC |  OpenIF |
|  OpenSPIM |  Orbit |  Piximi |  PolusAI |  PYME |  Python |
|  QUAREP-LiMi |  QuPath |  scenery |  SCIFIO |  scikit-image |  sciview |
|  SmartMicroscopy |  SpotMAX |  SR-Tesseler |  StarDist |  TeamTomo |  TissUU |
|  vedo |  VVDViewer |  webKnossos |  ZeroCostDL4Mic |  ... Your Icon Here |  Dorma |



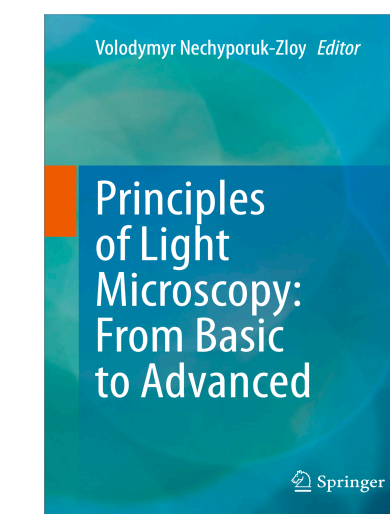
Analyzing fluorescence microscopy images
P. Bankhead
open access



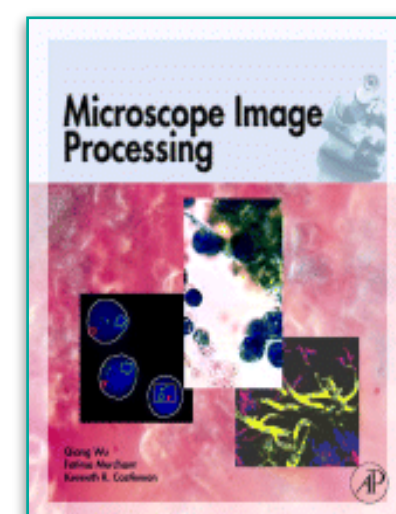
Bioimage Data Analysis Workflow
K. Miura, N. Sladoje
Springer 2019
open access



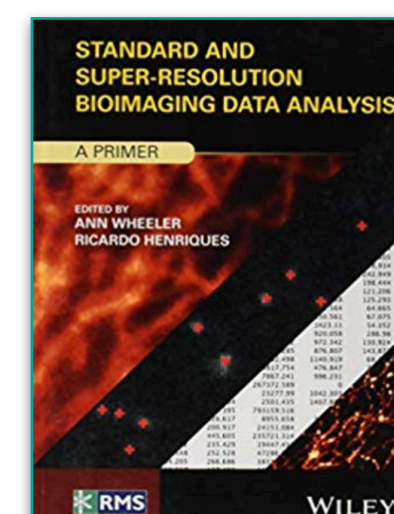
Bioimage Data Analysis
K. Miura
Wiley 2016
open access



Principles of Light Microscopy
V. Nechyporuk-Zloy
Springer 2024
open access



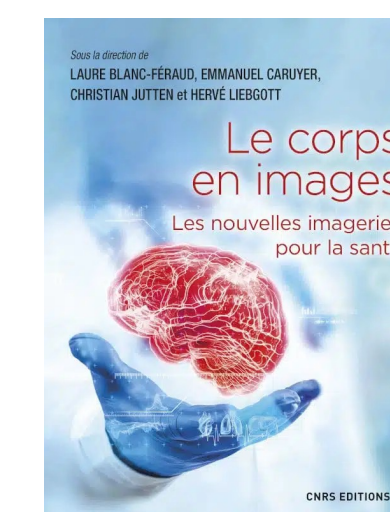
Microscopy Image Processing
Qiang et al.
Castleman 2010



Standard and Super-Resolution Bioimaging Data Analysis
A. Wheeler, R. Henriques
Wiley 2019



ImageJ User Guide
T. Ferreira, W. Rasband
2012
open access



Le corps en images
Les nouvelles imageries pour la santé
CNRS Edition 2022



External Online Resources

| | |
|---|---|
| ➡ Cell Biology and Molecular Biology | |
| iBiology | https://www.ibiology.org/online-biology-courses/cell-biology-flipped- |
| ➡ Microscopy | |
| Molecule Expressions | https://micro.magnet.fsu.edu/primer/ |
| MicroscopyU | https://www.microscopyu.com/microscopy-basics |
| iBiology | https://www.ibiology.org/online-biology-courses/microscopy-series/ |
| ➡ Imaging | |
| iBiology | https://www.ibiology.org/techniques/image-acquisition/ |
| Lice Cell Imaging, KI | https://www.youtube.com/@Livecellimagingfacility |
| iBiology | https://www.ibiology.org/playlists/imaging-in-biology/ |
| ➡ Methods | |
| Pete Bankhead | https://petebankhead.gitbooks.io/imagej-intro/content/ |
| Robert Haase | https://haesleinhuepf.github.io/BioImageAnalysisNotebooks/intro.html |
| iBiology | https://www.ibiology.org/online-biology-courses/bioimage-analysis-course/ |
| ➡ Tools | |
| Neubias Academy @ Home | https://eubias.org/NEUBIAS/training-schools/neubias-academy-home/ |
| Johanna Dela Cruz | https://www.youtube.com/@johanna.m.dela-cruz |
| ➡ Coding in Java | |
| Introduction to Java Programming | https://math.hws.edu/javanotes/ |
| Thinking in Java | https://github.com/BruceEckel/TIJ4-code |
| ➡ Code in Python | |
| Python for Everybody | https://www.py4e.com/lessons |
| Learn Python | https://www.learnpython.org/ |



iBIOLOGY



Neubias Academy
neubias.academy.org
Series of open webinars

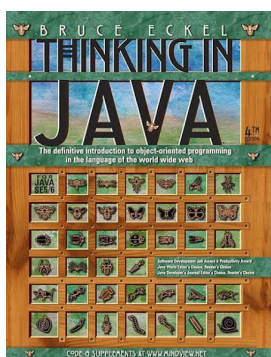


Bio-image Analysis
Notebooks of R. Haase

DOI 10.5281/zenodo.10465773



Video tutorials (Fiji)
Dela Cruz

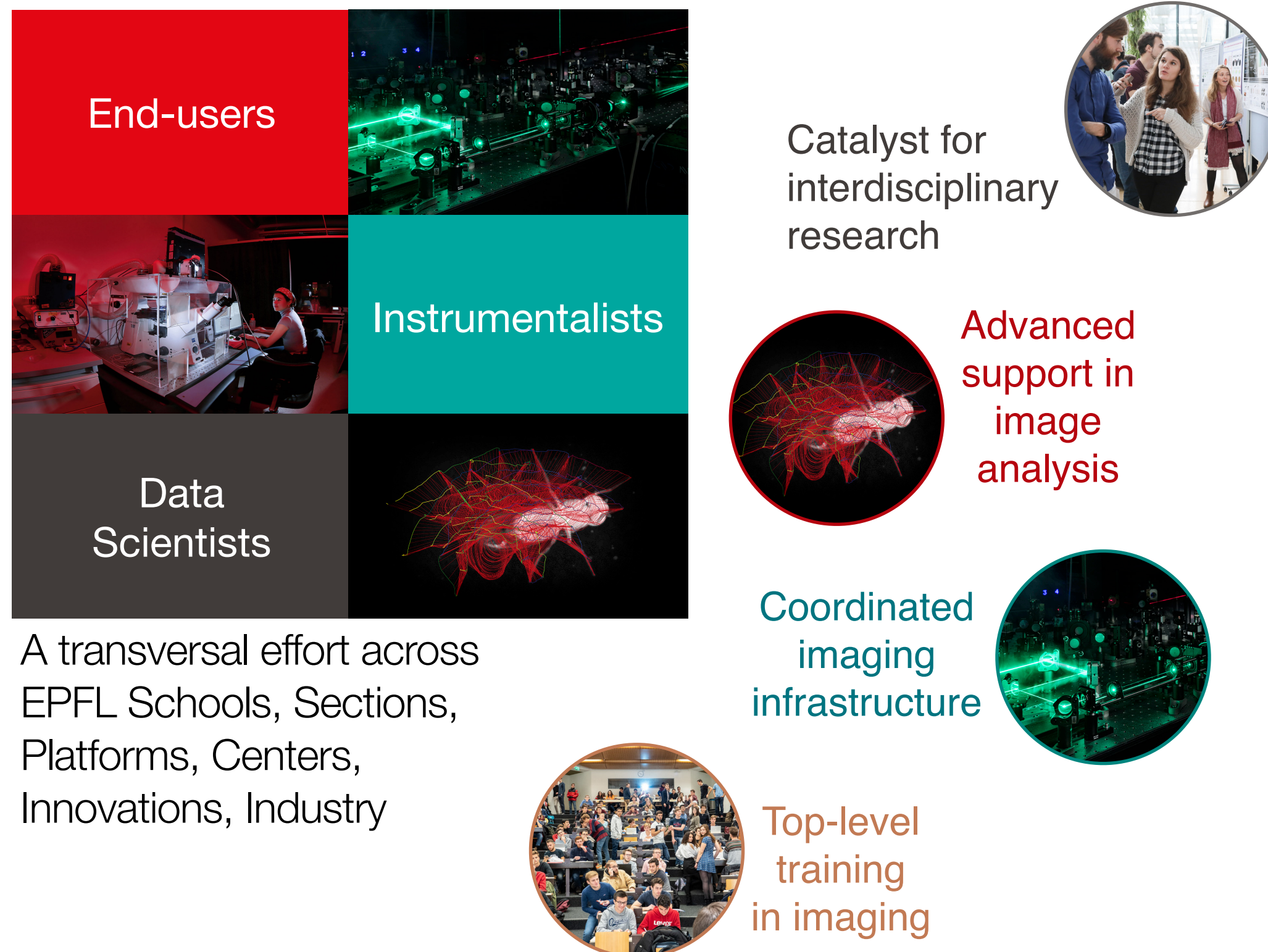


Thinking in Java
Bruce Eckel

EPFL Center for Imaging

<https://imaging.epfl.ch/>

EPFL's exceptional concentration of academic strengths in imaging



Minor in Imaging

<https://imaging.epfl.ch/minor-in-imaging>

A holistic program in imaging from sensors to AI
Open to all EPFL master students — 30 ECTS



Transversal program

Transversal program that covers theoretical and practical aspects in imaging



Interdisciplinary

Imaging is the interdisciplinary field par excellence



Increasing demand

Imaging skills are in increasing demand by the industry and academic world

Student Project

Practice image analysis in a lab immersion, master semester project, or master project