UNIVERSITY OF GOTHENBURG

DEPARTMENT OF PHYSICS

NFFY314 Advanced Machine Learning Techniques applied to Microscopy Data Analysis, 10 credits

Avancerade maskininlärningstekniker applicerade på analys av mikroskopidata, 10 högskolepoäng

Third-cycle level / Forskarnivå

Confirmation

This syllabus was confirmed by the Department of Physics on 2022-12-04, and is valid from Spring semester 2023.

Responsible Department
Department of Physics, Faculty of Science

Entry requirements

Basic Python knowledge

Learning outcomes

After completion of the course, the student will be able to

Knowledge and understanding

- be aware of advanced machine learning techniques and their respective range of applications.

Competence and skills

- apply advanced machine learning techniques to their own research problem

Judgement and approach

- discuss the interpretability of machine learning results, and possible implications for scientific work.

Course content

Microscopy images, irrespective of the specific imaging technique, e.g. optical, electron or atomic force microscopy, are an extremely rich source of quantitative data. With the ever increasing push to enhance spatial and temporal resolution, as well as with the increase of storage and computing power, very large amounts of data are easily generated and require automation for data extraction. From the familiar case of particle tracking, to more complex tasks in image segmentation and feature recognition, machine-learning (ML) methods are rapidly taking the scene. This course, aimed at doctoral students, has the goal to guide attendees through a progression from basic ML methods, through the extension of those to increasingly complex analyses all the way to offering the students the possibility to directly apply the concepts learned during the course to their own data. The course will combine lectures with hands-on exercises in concentrated blocks across the semester.

The course will cover the following subjects:

-Deep Learning and Dense Neural Networks

-Recurrent Neural Networks and Transformers

-Convolutional Neural Networks

-Image Classification

-Semantic Segmentation

-Particle detection and tracing

-Generative Models

-Cross-?modality Transformations

Types of instruction

The course is given as 9 modules, one full day each, with lecture around a specific theme in the morning and laborative work in the afternoon. The course ends with project presentations and discussions.

Language of instruction
The course is given in English.

Grades

The grade Pass (G) or Fail (U) is given in this course.

Types of assessment

Evaluation of students will be based upon: (1) participation in lectures; (2) completion of exercises; and (3) completion of project.

Course evaluation

The course evaluation is carried out together with the Ph.D. students at the end of the course, and is followed by an individual, anonymous survey. The results and possible changes in the

course will be shared with the students who participated in the evaluation and to those who are beginning the course.