UNIVERSITY OF GOTHENBURG

DEPARTMENT OF PHYSICS

FYM360 Advanced machine learning with neural networks, 7.5 credits

Avancerad maskininlärning med neurala nätverk, 7,5 högskolepoäng

Second Cycle

Confirmation

This course syllabus was confirmed by Department of Physics on 2020-05-04 and was last revised on 2023-05-08 to be valid from 2024-01-15, spring semester of 2024.

Field of education: Science 100%
Department: Department of Physics

Position in the educational system

The course is part of the master program in complex adaptive systems

The course can be part of the following programmes: 1) Complex Adaptive Systems, Master's Programme (N2CAS) and 2) Physics, Master's Programme (N2PHY)

Main field of studies	*Specialization*
Physics	A1N, Second cycle, has only first-cycle course/s as entry requirements

Entry requirements

A bachelor's degree in physics, mathematics, computer science, or similar including 30 credits of mathematics, and programming.

A basic course in artificial neural networks or deep learning is recommended.

Applicants must prove their knowledge of English: English 6/English B from Swedish Upper Secondary School or the equivalent level of an internationally recognized test, for example TOEFL, IELTS.

Learning outcomes

This course introduces students to recent developments and state-of-the-art methods in machine learning using artificial neural networks. This advanced course builds on

Machine learning with neural networks (FFR135) and provides an in-depth analysis of many of the concepts and algorithms that were briefly introduced in that course, with particular emphasis on applications in the natural and engineering sciences. The goal is to become familiar with several advanced machine-learning methods, and to code them efficiently in Python using current neural-network packages. An essential part of the course are projects in deep learning and reinforcement learning.

Learning outcomes (after completion of the course the student should be able to)

Knowledge and understanding
Describe the different available neural network models with their advantages and disadvantages
Find relevant literature to keep up with this quickly advancing field

Competence and skills
Implement a broad range of state-of-the-art neural network models
Train and validate these models
Optimize these models for a specific task
Plan, manage and execute a small scale project in the field
Write a report of their results of the project

Judgement and approach
Critically analyse the advantages and disadvantages of the available neural network models
Benchmark the results of a neural network models against other models
Critically evaluate and discuss advances in the field of neural networks

Course content
This course is project based and focus on state-of-the-art applications of neural networks which are of relevance to research and industry.

Focus:

Which model should be employed for a given task?
How should models be benchmarked?
What are the tradeoffs between complexity, accuracy and risk of overtraining in practical settings?
How does one evaluate the quality of the predictions made by the model?

Form of teaching

1 initial class to give the students an overview of the course
3 homeworks to be done by each student with peer-review and followed by a lecture that explains the context of these homeworks
A series of lectures on current topics where machine learning is applied in cutting edge research and industry applications given by local and international experts
A group project

Assessment

The examination is based on

30% homeworks (10% for each)
20% final project presentation
50% final project report

A necessary (but not sufficient) requirement for passing grade is that 5/10 points are achieved in each homework.

A student who has taken two exams in a course or part of a course without obtaining a pass grade is entitled to the nomination of another examiner. The student needs to contact the department for a new examiner, preferably in writing, and this should be approved by the department unless there are special reasons to the contrary (Chapter 6 Section 22 of the Higher Education Ordinance).

If a student has received a recommendation from the University of Gothenburg for special educational support, where it is compatible with the learning outcomes of the course and provided that no unreasonable resources are required, the examiner may decide to allow the student to sit an adjusted exam or alternative form of assessment.

In the event that a course has ceased or undergone major changes, students are to be guaranteed at least three examination sessions (including the ordinary examination session) over a period of at least one year, but no more than two years, after the course has ceased/been changed. The same applies to placements and professional placements (VFU), although this is restricted to just one additional examination session.

Grades

The grading scale comprises: Pass with Distinction (VG), Pass (G) and Fail (U).

Course evaluation

The results of and possible changes to the course will be shared with students who participated in the evaluation and students who are starting the course.