Department of Physics

Stockholm University

Syllabus

for course at advanced level

Machine Learning for Physicists and Astronomers
Maskininlärning för fysiker och astronomer

7.5 Higher Education Credits
7.5 ECTS credits

Course code:	FK7068
Valid from:	Autumn 2019
Date of approval:	2019-05-13
Department	Department of Physics
Main field:	Physics
Specialisation:	A1N - Second cycle, has only first-cycle course/s as entry requirements

Decision

This course plan has been established by the Board of Science at Stockholm University on 2019-05-13.

Prerequisites and special admittance requirements

Admission to the course requires knowledge equivalent to passed courses (excluding introductory courses) of 45 credits in mathematics and 60 credits in physics, where the courses Programming, Numerical Methods and Statistics for Physicists, 15 credits (FK4026), and Mathematics II - Linear Algebra, 7.5 credits (MM5012) should be included. Additionally, requires knowledge equivalent to upper secondary school English B/English 6.

Course structure

Examination code	Name	Higher Education Credits
PROJ	Project	3
TEOR	Theory	4.5

Course content

Machine learning is one of the fastest growing and most dynamic areas of modern physics research and data application. This course gives an introduction to the core concepts, theory and tools of machine learning as required by physicists addressing practical data analysis tasks. Topics covered include supervised learning, such as linear models for regression and classification, or nonlinear models such as neural networks, and unsupervised learning such as clustering. Use cases and limitations of machine learning algorithms will be discussed. The implementation and use of machine learning in practical applications will be exemplified, and realistic scenarios will be studied in applications relevant to physics research. Popular software libraries and data-sets publicly available will be used to illustrate the application of machine learning algorithms. The practicals will concern the application of machine learning to a range of real-world problems.

Learning outcomes

It is expected that the student after taking the course will be able to:
unit TEOR, Thery, 4.5 credits:
• describe fundamental concepts and tools used in machine learning.
• apply the underlying mathematical description of machine learning algorithms
• discuss and describe the advantages and limitations of different machine learning models with respect to a given task
• report and motivate which machine learning methods/algorithms are suitable for which type of learning

problems.
unit PROJ, Project, 3 credits:
• implement and apply machine learning toolkits in applications relevant to physics data analysis problems
• prepare data and train machine learning models
• apply evaluation methods to assess the quality of a machine learning system

Education

Instruction consists of lectures, group education and supervision of projects.Participation in group educations in mandatory. In the event of special circumstances, the examiner may, after consultation with the teacher concerned, grant a student exemption from the obligation to participate in certain compulsory instruction.

The course will be given in English if requested by any student enrolled.

Forms of examination

a. The course is examined as follows: Unit TEOR is examined through written and oral exam and unit PROJ through written and oral presentation of project work.

If the instruction is in English, the examination may also be conducted in English.

b. Grades will be set according to a seven-point scale related to the learning objectives of the course:
A = Excellent
B= Very good
C = Good
D = Satisfactory
E = Adequate
Fx = Fail, some additional work required
F = Fail, much additional work required
The course unit PROJ will be graded according to a two-point scale: Pass (G) or Fail (U).

c. The grading criteria will be distributed at the beginning of the course.

d. In order to pass the course, students must receive a passing grade on all course units

e. Students who receive a failing grade on a regular examination are allowed to retake the examination as long as the course is still provided. The number of examination opportunities is not limited. Other mandatory course elements are equated with examinations. A student who has received a passing grade on an examination may not retake the examination to attain a higher grade. A student who has failed the same examination twice is entitled to have another examiner appointed, unless there are special reasons to the contrary. Such requests should be made to the department board.

The course includes at least two examination opportunities per year when the course is given. At least one examination opportunity will be offered during a year when the course is not given.

f. Students awarded the grade Fx are given the opportunity to improve their grade to E. The examiner decides the supplementary assignments to be performed and the pass mark criteria. The supplementary assignments will take place before the next examination session.

Interim

Students may request that the examination be conducted in accordance with this course plan even after it has ceased to be valid. However, this may not take place more than three times over a two year period after course instruction has ended. Requests must be made to the departmental board. The provision also applies in the case of revisions to the course plan (and the revisions of the course literature).

Misc

The course can be included as part of the master's programs offered at the Physics department, but is also offered as a separate course or as a PhD course.

Required reading

The course literature is decided by the department board and published on the Department of Physics’s website at least two months before the start of the course.