# Introduction to Machine Learning

Introduktion till Maskininlärning
9 credits

Single subject course

732A68

Valid from: 2024 Autumn semester

| **Determined by** | **Main field of study** | |
|---|---|---|
| The Quality Board at the Faculty of Arts and Sciences | Statistics | |
| **Date determined** | **Course level** | **Progressive specialisation** |
| 2017-10-27 | Second cycle | A1N |
| **Revised by** | **Disciplinary domain** | |
| Course and Programme Syllabus Board at the Faculty of Arts and Sciences | Technology | |
| **Revision date** | **Subject group** | |
| 2024-05-14 | Statistics | |
| **Offered first time** | **Offered for the last time** | |
| Autumn semester 2017 | | |
| **Department** | **Replaced by** | |
| Institutionen för datavetenskap | | |

# Entry requirements

- 180 ECTS credits including 90 ECTS credits within one of the following subjects:
    - statistics
    - mathematics
    - applied mathematics
    - computer science
    - engineering
- Passed courses in
    - calculus
    - linear algebra
- Passed basic course in statistics of at least 6 ECTS credits
- Passed course in programming of at least 6 ECTS credits
- English corresponding to the level of English in Swedish upper secondary education (Engelska 6)
  Exemption from Swedish

# Intended learning outcomes

After completion of the course the student should at an advanced level be able to:

- use relevant concepts and methods from machine learning in order to formulate, structure and solve practical problems that involve large or complex data,
- apply an inference for the parameter values for commonly used machine learning models,
- use machine learning models for prediction and decision making,
- estimate the quality of the machine learning models,
- critically evaluate given task in order to select a suitable model in situations with a limited or no information about the underlying dependencies in the data,
- implement machine learning models in a programming language and use existing machine learning software in order to analyze large and/or complex datasets, make predictions and estimate the uncertainty of these predictions.
- reflect on ethical and societal aspects relevant to machine learning,
- reflect on the possibilities and limitations of machine learning, its role in society and people's responsibility for how it is used,
- plan and carry out course work within given time frames.

# Course content

The course focuses on the main concepts and tools in probabilistic machine learning that are necessary for professional work and research in data analysis.

The course covers the following topics:

• introduction and overview of machine learning (including regression, classification, supervised and unsupervised learning) and its application areas,

• Nearest Neighbors, logistic regression and decision trees,

• binary classification: precision, recall, F1 score and ROC curves.

• model selection and uncertainty estimation: holdout method, cross-validation, degrees of freedom, bias-variance tradeoff and confidence intervals,

• linear regression and regularization methods (Ridge, LASSO),

• latent variables and principal component analysis (PCA)

• kernel smoothers, kernel trick and support vector machines,

• neural networks,

• bagging, boosting and random forests,

• mixture models,

• optimization for machine learning: gradient descent and stochastic gradient descent,

• implicit regularization: early stopping.

# Teaching and working methods

The teaching consists of lectures, seminars and computer exercises.
In addition to this, independent study is a necessary complement to the course.

Language of instruction: English.

# Examination

The course is examined through:

- written report on computer assignments in groups, grading scale: EC P/F
- active participation in seminars, grading scale: EC P/F
- individually written computer examination, grading scale: EC

The final grade for the course is based on grade from the written examination and requires Pass on other parts of examination.

Detailed information about the examination can be found in the course's study guide.

If special circumstances prevail, and if it is possible with consideration of the nature of the compulsory component, the examiner may decide to replace the compulsory component with another equivalent component.

If the LiU coordinator for students with disabilities has granted a student the right to an adapted examination for a written examination in an examination hall, the student has the right to it.

If the coordinator has recommended for the student an adapted examination or alternative form of examination, the examiner may grant this if the examiner assesses that it is possible, based on consideration of the course objectives.

An examiner may also decide that an adapted examination or alternative form of examination if the examiner assessed that special circumstances prevail, and the examiner assesses that it is possible while maintaining the objectives of the course.

Students failing an exam covering either the entire course or part of the course twice are entitled to have a new examiner appointed for the reexamination.

Students who have passed an examination may not retake it in order to improve their grades.

# Grades

ECTS, EC

# Other information

Planning and implementation of a course must take its starting point in the wording of the syllabus. The course evaluation included in each course must therefore take up the question how well the course agrees with the syllabus.

The course is conducted in such a way that there are equal opportunities with regard to sex, transgender identity or expression, ethnicity, religion or other belief, disability, sexual orientation and age.

If special circumstances prevail, the vice-chancellor may in a special decision specify the preconditions for temporary deviations from this course syllabus, and delegate the right to take such decisions.

### About teaching and examination language

The teaching language is presented in the Overview tab for each course. The examination language relates to the teaching language as follows:

- If teaching language is “Swedish”, the course as a whole could be given in Swedish, or partly, or as a whole, in English. Examination language is Swedish, but parts of the examination can be in English.
- If teaching language is “English”, the course as a whole is taught in English. Examination language is English.
- If teaching language is “Swedish/English”, the course as a whole will be taught in English if students without prior knowledge of the Swedish language participate. Examination language is Swedish or English depending on teaching language.