

## Advanced Machine Learning

Avancerad maskininlärning

6 credits

Single subject and programme course

732A96

Valid from: 2025 Autumn semester

<b>Determined by</b>	<b>Main field of study</b>	
The Quality Board at the Faculty of Arts and Sciences	Statistics	
<b>Date determined</b>	<b>Course level</b>	<b>Progressive specialisation</b>
2016-04-13	Second cycle	A1F
<b>Revised by</b>	<b>Disciplinary domain</b>	
Chairman of the Course and Programme Syllabus Board at the Faculty of Arts and Sciences	Technology	
<b>Revision date</b>	<b>Subject group</b>	
2024-09-30; 2024-12-18	Statistics	
<b>Offered first time</b>	<b>Offered for the last time</b>	
Autumn semester 2017		
<b>Department</b>	<b>Replaced by</b>	
Institutionen för datavetenskap		

## Course offered for

- Master's Programme in Statistics and Machine Learning

## Entry requirements

- Bachelor's degree equivalent to a Swedish Kandidatexamen of 180 ECTS credits in one of the following subjects:
  - statistics
  - mathematics
  - applied mathematics
  - computer science
  - engineering
- Completed courses in
  - calculus
  - linear algebra
  - statistics
  - programming
- English corresponding to the level of English in Swedish upper secondary education (Engelska 6)  
Exemption from Swedish
- At least 24 ECTS credits passed in the main field of Statistics at second cycle and at least 5 ECTS credits passed in the main field of Computer Science at second cycle

## Intended learning outcomes

After completing the course, the student shall be able to :

- account for the principles of machine learning used in the Bayesian tradition of machine learning,
- construct a suitable probabilistic model describing the data structure and the prior,
- compare between models in order to select the best one,
- implement machine learning models in a programming language and also use standard machine learning libraries in order to perform the model inference, make predictions based on these models and estimate the uncertainty of these predictions.

## Course content

The course covers some advanced methods in machine learning that allow for modelling complex phenomena and predicting the outcomes of these phenomena.

The following topics are included in the course:

- Introduction to Bayesian Learning: likelihood, prior, posterior, marginal likelihood, posterior predictive distribution.
- Generative and discriminative models,
- Gaussian process,
- State-space models,
- Kalman filtering and smoothing,
- particle methods,
- Markov models and hidden Markov models,
- graphical models, such as Bayesian networks and Markov random fields.

## Teaching and working methods

The teaching comprises lectures, seminars, and computer exercises complemented by self-studies. Lectures are devoted to presentations of theories, concepts and methods. Computer exercises provide practical experience of data analysis in some machine learning software. The seminars comprise student presentations and discussions of computer assignments.

Language of instruction: English.

## Examination

Written reports on the computer assignments. Active participation in the seminars. One final written 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.