Department of Statistics

Stockholm University

Syllabus

for course at advanced level

Bayesian learning
Bayesiansk inlärning

7.5 Higher Education Credits
7.5 ECTS credits

Course code:	ST5301
Valid from:	Spring 2022
Date of approval:	2021-01-20
Department	Department of Statistics
Main field:	Statistics
Specialisation:	A1N - Second cycle, has only first-cycle course/s as entry requirements

Decision

This syllabus was approved by the board of the Department of Statistics on January 20, 2021.

Prerequisites and special admittance requirements

90 ECTS credits first-cycle (basic level) courses in Statistics or equivalent. Mathematics for Economic and Statistical analysis 7.5 ECTS credits, first-cycle course or equivalent.
or alternatively
Bachelor's degree in other quantitative subject, including at least 30 ECTS credits first-cycle courses in Statistics. Mathematics for Economic and Statistical analysis 7.5 ECTS credits, first-cycle course or equivalent.
or alternatively
Degree from a Civil Engineering program, including at least 7.5 ECTS credits, first-cycle courses in Mathematics.

Programming course of at least 6 ECTS credits. English 6 or equivalent.

Course structure

Examination code	Name	Higher Education Credits
12BI	Mandatory home assignment	0.5
11BX	Exam	7

Course content

The course consists of one part and is examined through two tests in accordance with the exam codes above, 11BX which is referred to as Test 1 and 12BI as Test 2.

The course provides an introduction to Bayesian learning, prediction and decision making with a focus on modern applications in statistics and machine learning. The main ideas behind Bayesian inference are first presented in a number of simpler models, and then gradually move on to the analysis of more complex models using modern simulation and approximation methods. Bayesian inference uses Bayes' theorem to combine data information with other sources of knowledge in a probabilistic approach. This so-called a priori information can consist of expert knowledge, previous studies or other data sources, but also more subjective information about the degree of softness in the relationship between predictor variables and a target variable in a flexible prediction model.

A Bayesian approach provides a quantification of uncertainty that can be used for decision-making under uncertainty. The course contains several mathematical exercises and computer labs to teach the application of Bayesian methods for: regression, classification, regularization, prediction, optimal decisions, variable and model choices. Simulation methods such as the Markov chain Monte Carlo and the Hamiltonian Monte Carlo are an important part of the course; optimization-based approximation methods such as variational inference are also addressed.

Learning outcomes

To pass the course the student should be able to:
- explain the basics of Bayesian learning,
- derive Bayesian inference results in simpler models,
- use simulation methods to perform Bayesian learning in more complex models,
- implement Bayesian methods in a programming language,
- perform Bayesian prediction and decision making under uncertainty
- compare models with Bayesian methodology

Education

The instruction consists of lectures and computer labs. The language of instruction is English.

More detailed information may be found in the course description. The course description is posted on the Department of Statistics' website www.statistics.su.se/utbildning no later than one month before the start of the course.

Forms of examination

a) The course is examined by assessing the students' mastery of the expected outcomes. Test 1 is examined by means of a written individual exam. Test 2 is examined by means of written home assignments that is done in pairs. Test 2 may be divided into sub-tasks and is then given continuously during the course in connection with the teaching. The examination is in English.

b) Test 1 is graded according to a seven-point grading scale: A = Excellent, B = Very Good, C = Good, D = Satisfactory, E = Sufficient, Fx = Insufficient, F = Completely insufficient. Both Fx and F are failed grades that require re-examination.

Test 2 is graded according to a two-point grading scale: U = Fail, G = Pass. An assessment of the individual's performance, within the working group,
must be made possible and documented.

c) The grading criteria for Test 1 and Test 2, respectively, are communicated in writing to the students at the start of the course.

d) In order to pass the entire course, a minimum grade of E on Test 1 and grade G on Test 2 is required. The final grade for the entire course is equal to the grade on Test 1. Examination assignments that are not submitted on time will not be assessed. Parts of courses that have been transferred and credited are excluded when determining the final grade.

e) For each course instance, at least two examination opportunities must be provided for all tests. During a semester when the course is not offered, at least one examination opportunity must be provided for all tests.

Students who fail either of the two tests are entitled to take additional tests as long as the course is offered in order to achieve a passing grade.

Students who have received the grade Fx or F on Test 1 or the grade U on Test 2 twice in a row by one and the same examiner have the right to have another examiner appointed at the next exam, unless there are special reasons that militate against it. A request to this effect must be sent in writing to the head of department.

Students who have received a grade of E or higher, may not retake a test in order to obtain a higher grade.

f) It is not possible for students who have received the grade Fx to increase the grade to a passing grade by submitting supplementary assignments.

Interim

When this syllabus is repealed, the student has the right to be examined once per semester according to the present syllabus during a completion period of three semesters. A request to this effect must be sent in writing

to the Head of department.

Limitations

This course may not be part of a degree together with Bayesian Statistics I (ST402A, ST422A) or any other course which fully or partially conforms with the contents of this course.

Misc

This course replaces the course Bayesian statistics I, 7.5 ECTS credits (ST422A).

Required reading

The course literature is specified separately in an attachment. The current course literature (and other teaching resources) is posted on the Department of Statistics' website, www.statistics.su.se/utbildnin, no later than two months before the start of the course.