LUND UNIVERSITY

Faculty of Science

MASM11, Mathematical Statistics: Monte Carlo Methods for Statistical Inference, 7.5 credits

Matematisk statistik: Monte Carlo-baserade statistiska metoder, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2007-01-31 (N 2007/148) and was last revised on 2026-05-18 by The Education Board of Faculty of Science. The revised syllabus comes into effect 2026-05-18 and is valid from the spring semester 2027.

General information

The course is an elective course for second-cycle studies for a Master of Science in Mathematical statistics.

Language of instruction: English

Main field of study	*Specialisation*
Mathematics	A1N, Second cycle, has only first-cycle course/s as entry requirements
Mathematical Statistics	A1N, Second cycle, has only first-cycle course/s as entry requirements

Learning outcomes

The purpose of the course is to give the students tools and knowledge to handle complex statistical problems and models. The aim is that students shall gain proficiency with modern computer intensive statistical methods and use these to estimate quantities and parameters in complex models that arise in different applications (e.g. economics, signal processing, biology, climate, and environmental statistics). Further, the student should be able to assess the uncertainty of these estimates. The main aim lies in enhancing the scope of statistical problems that the student will be able to solve.

The aim of the course is that students on completion of the course should have acquired the following knowledge and skills:

Knowledge and understanding

On completion of the course, the students are expected to:

- describe fundamental principles of Monte Carlo integration and random variable generation.
- explain and use the concept of statistical uncertainty from a frequentist perspective as well as from a Bayesian perspective,
- describe fundamental principles of parametric and non-parametric resampling.

Competence and skills

On completion of the course, the students are expected to:

- given a stochastic model and problem formulation, choose relevant quantities in a way that permits approximation using Monte Carlo methods,
- given a (possibly multivariate) probability distribution, suggest and implement in a computer program, a method for generation of random variables from this distribution,
- given a large number of generated random variables from a probability distribution, approximate relevant probabilities and expectations as well as estimate the uncertainty in the approximated quantities,
- given a model description and a statistical problem, suggest a simple permutation test and implement it in a computer program,
- given a model description and a statistical problem, suggest a resampling procedure and implement it in a computer program,
- present the course of action taken and conclusions drawn in the solution of a given statistical problem.

Judgement and approach

On completion of the course, the students are expected to:

- be able to identify and problematize the possibilities and limitations of statistical inference.

Course content

The course covers:

- Simulation based methods of integration and statistical analysis,
- Monte Carlo methods for sequential problems,
- Markov chain methods, e.g. Gibbs sampling and the Metropolis-Hastings algorithm, for simulation and inference,
- Bayesian modelling and inference,
- The re-sampling principle, both non-parametric and parametric,
- Methods for constructing confidence intervals using re-sampling,
- Simulation based tests as an alternative to asymptotic parametric tests.

Course design

Teaching consists of lectures, project supervision and projects. Participation in project work and thereby integrated teaching is compulsory.

Assessment

The examination are done through written project reports during the course and a final oral presentation. The first project gives 2.5 credits

and the last two projects together with the oral presentation gives 5 credits.

Students who did not pass the ordinary exam are offered a re-examination shortly after.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Grades

Grading scale includes the grades: Fail, Pass, Pass with distinction
For passing grade on the entire course passed project reports, oral presentation and participation in compulsory parts are required.

The grading scale for project reports and oral presentationfor is Fail, Pass,

The final grade is formed by weighing together the results on the part which are included the examination.

Entry requirements

For admission to the course knowledge equivalent to at least one of the courses MASC13, Markov processes, 7.5 credits or MASC14, Stationary Stochastic processes, 7.5 credits are required together with English B.

Further information

The course is given by Centre for Mathematical Sciences, Lund University.
The course is read together with FMSN50 Monte Carlo and Empirical Methods for Stochastic Inference,7.5 credits which is a course given by Lund's engineering school LTH.

The examination of the course is scheduled according to LTH:s exam schedule.