



Course syllabus

Faculty of Technology
Department of Mathematics

4MA506 Monte Carlo-metoder, 7,5 högskolepoäng
Monte Carlo methods, 7.5 credits

Main field of study

Mathematics

Subject Group

Mathematics

Level of classification

Second Level

Progression

A1N

Date of Ratification

Approved 2015-05-22

Revised 2018-06-08 by Faculty of Technology. Content and objectives are revised.
The course syllabus is valid from spring semester 2019

Prerequisites

1MA201/1MA501 Probability Theory and Statistics 7,5 credits or the equivalent course in Mathematical statistics, and 15 credits in mathematics at G2F-level.

Objectives

After successfully completing the course, the student is anticipated to be able to:

- explain the role of the Law of Large Numbers and the Central Limit Theorem for Monte Carlo methods
- account for general situations when Monte Carlo methods are needed.
- account for and write pseudocode for generation of discrete and continuous random variables by the inverse method, the acceptance-rejection method, and the composition method
- account for and write pseudocode for one-dimensional normal variables by the polar method
- account for and write pseudocodes for binomial random variables, Poisson random variables, homogenous and non-homogenous Poisson processes
- account for and write pseudocode for multidimensional normal variables
- account for and write pseudocode for variance reducing methods: antithetic variables and control variates, conditioning, stratigic sampling, non-normalized and normalized importance sampling, latin cube hypercube sampling
- for a given simulation be able to suggest and implement a suitable variance reduction technique
- suggest and implement suitable statistical techniques to validate simulation models
- account for Markov Chain Monte Carlo methods and write pseudocode for the

Hastings-Metropolis algorithm including Gibbs sampling.

Content

The course contains:

- General generation of one-dimensional random numbers, discrete and continuous: the inverse method, the acceptance-rejection technique, the composition approach
- Generating specific one-dimensional random numbers: normal random numbers by the polar method, Poisson random variables, binomial random variables
- Generation of Poisson processes: homogenous and nonhomogenous, one-dimensional and two-dimensional
- Generation of multidimensional normal random numbers
- Generation of variables from copula models
- Variance reduction techniques: use of antithetic variables and control variates, conditioning, stratified sampling, non-normalized and normalized importance sampling, latin hypercube sampling
- Statistical analysis of simulated data: the sample mean and sample variance, interval estimates of a population mean, bootstrapping technique for estimating mean square errors
- Statistical validation techniques: goodness of fit tests
- Markov Chain Monte Carlo methods: Hastings-Metropolis algorithm including Gibbs sampling

Type of Instruction

Teaching consists of lectures, presentations, and tutoring.

Examination

The course is assessed with the grades A, B, C, D, E, Fx or F.

The grade A constitutes the highest grade on the scale and the remaining grades follow in descending order where the grade E is the lowest grade on the scale that will result in a pass. The grade F means that the student's performance is assessed as fail (i.e. received the grade F).

The student's knowledge is assessed in form of

1. Graded written assignments (4 p), grading scale AF
2. Written report of a project (1.5 hp), grading scale AF
3. Oral presentation of a project (1.5 hp), grading scale AF
4. Opposition of a another student's project (0.5 hp), grading scale UG

Course Evaluation

During the course or in close connection to the course, a course evaluation is to be carried out. The result and analysis of the course evaluation are to be communicated to the students who have taken the course and to the students who are to participate in the course the next time it is offered. The course evaluation is carried out anonymously. The compiled report will be filed at the Faculty.

Credit Overlap

The course cannot be included in a degree along with the following courses of which the content fully, or partly, corresponds to the content of this course: 4MA206 Monte Carlo methods, 7.5 credits

Other

Grade criteria for the A–F scale are communicated to the student through a special document. The student is to be informed about the grade criteria for the course by the start of the course at the latest.

Required Reading and Additional Study Material

Required reading

Sheldon M.R. Ross: Simulation, latest edition, Academic Press Inc

Reference Literature

Asmussen, S. & Glynn, P, *Stochastic simulation: algorithms and analysis*, Springer, latest edition.

Fishman, G. S, *Monte Carlo: Concepts, algorithms, and applications*, Springer, latest edition.

Glasserman, P, *Monte Carlo methods in financial engineering*, Springer, latest edition.