Course syllabus

Monte Carlo-baserade statistiska metoder
Monte Carlo and Empirical Methods for Stochastic Inference

FMSN50, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED I
Date of Decision: 2023-04-14

General Information

Main field: Machine Learning, Systems and Control.
Elective Compulsory for: MMSR1
Elective for: BME4, D4, E4-ae, F4, F4-bm, F4-fm, I4-fir, Pi4-bs, Pi4-fm, Pi4-bam, R4
Language of instruction: The course will be given in English

Aim

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 intencive 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.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- 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.

Competences and skills
For a passing grade the student must

- 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
For a passing grade the student must

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

Contents

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.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Written and oral project presentation. The final grade is given by a summary of the results of the different parts of the examination.

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.

Parts
Code: 0117. **Name:** Project Part 1.
Credits: 2,5. **Grading scale:** UG. **Assessment:** Written report on the first project
Code: 0217. **Name:** Project Part 2.
Credits: 5. **Grading scale:** UG. **Assessment:** Written and oral report on the rest of the projects

Admission

Admission requirements:

- FMSF10 Stationary Stochastic Processes or FMSF15 Markov Processes or FRTF25 Introduction to Machine Learning, Systems and Control

Assumed prior knowledge: Programming experience. FMSF05 Probability theory helps.
The number of participants is limited to: No
The course overlaps following course/s: FMS091, MASM11

Reading list

- Goef H. Givens & Jennifer A. Hoeting: Computational Statistics, 2 ed. Wiley, 2013, ISBN: 978-0-470-53331-4.

Contact and other information

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Course homepage:
https://www.maths.lu.se/utbildning/civilingenjoersutbildning/matematisk-statistik-paa-civilingenjoersprogram/
Further information: The course is also given at the faculty of science with the code MASM11.