SF2955 Computer Intensive Methods in Mathematical Statistics 7.5 credits

Datorintensiva metoder inom matematisk statistik

This is a translation of the Swedish, legally binding, course syllabus.

If the course is discontinued, students may request to be examined during the following two academic years

Establishment

Course syllabus for SF2955 valid from Autumn 2007

Grading scale

A, B, C, D, E, FX, F

Education cycle

Second cycle

Main field of study

Mathematics

Specific prerequisites

SF1906 (5B1506) Mathematical statistics, basic course or equal.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

To pass the course, the student should be able to do the following:

- Simulate data from one-dimensional probability distributions and multidimensional normal distributions.
- State the principles behind bootstrap and jackknife.
- Use bootstrap and jackknife to estimate biases and standard errors for estimates based on independent identically distributed data.
- Use bootstrap in more complicated situations such as several independent samples, regression models and time series.
- Calculate confidence intervals with bootstrap using both simple percentile intervals and based on (approximate) pivotal quantities.
- State the principles behind Bayesian statistics
- State the principles behind Markov Chain Monte Carlo and why this method can be used to generate samples from complicated distributions.
- Apply Markov Chain Monte Carlo to practical problems and use packages such as BUGS.
- State the principles behind model selection especially prediction error as a measure of the precision of a model.
- Relate and compare different methods for model selection such as cross validation, Akaike Information Criterion and Bayesian Information Criterion.

To receive the highest grade, the student should in addition be able to do the following:

- Combine all the concepts and methods mentioned above in order to solve more complex problems.

Course contents

Simulation is a technique to analyze complicated functions of stochastic variables by generating samples. This makes it possible to avoid complicated analytical calculations e g to obtain the distribution of estimators.

Markov Chain Monte Carlo (MCMC) is the name of a collection of methods which use cleverly selected Markov Chains to generate samples from complicated distributions. These methods have extensive applications in Bayesian statistics but also areas like optimization and statistical mechanics.

Bayesian methods in mathematical statistics makes it possible to include prior knowledge about the values of parameters in the statistical analysis.

Bootstrap and jackknife are two modern general methods making it possible to estimate the uncertainty of an estimate of a parameter. This can be done without having any idea

about the exact (or even approximate) distribution. The idea is to generate a large number of artificial datasets from the original dataset. By studying how the estimates vary between these artificial datasets information

is obtained as to the uncertainty of the estimate. The repeated generation of datasets and calculating the estimates based on these require extensive calculations which require computers, The characteristic feature is that you do not have to worry so much about the probability distributions of estimates and their properties.

Model selection concerns the important problem of selecting the "best" of a number of proposed models for data.

Course literature

Englund, Gunnar. Datorintensiva metoder i matematisk statistik. Compendium from KTH.

Material from the department of Mathematics.

Examination

- TEN1 - Examination, 7.5 credits, grading scale: A, B, C, D, E, FX, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

Other requirements for final grade

A written examination. Computer assignments

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.