MATH48121 - 2008/2009

General Information

- Title: Computationally Intensive Statistics
- Unit code: MATH48121
- Credits: 15
- Prerequisites: MATH20701, MATH38001 *Statistical Inference*
- Co-requisite units: None
- School responsible: Mathematics
- Members of staff responsible: Dr. Peter Neal

Specification

Aims

To introduce the student to computational statistics, both the underlying theory and the practical applications.

Brief Description of the unit

Computers are an invaluable tool to modern statisticians. The increasing power of computers has greatly increased the scope of inferential methods and the type of models which can be analysed. This has led to the development of a number of computationally intensive statistical methods, many of which will be introduced in this course.

Learning Outcomes

On successful completion of this module students will

- appreciate the usefulness of computational methods in modern statistics;
- understand the basic ideas underpinning the theory;
- be able to apply the methodology to standard problems.

Future topics requiring this course unit

None.

Syllabus

1. Introduction: motivation; applications. [1 lecture]
2. Simulation methods: Integral evaluation (estimating mean); generation of random variables (inverse cdf, transformations, rejection sampling); Monte Carlo tests and integration (importance sampling). [4]
3. Non parametric methods. Resampling: Bootstrap and jackknife. Density estimation: kernel smoothing. [6]
4. Optimisation. EM algorithm. Missing data; convergence; global-local maxima; Monte-Carlo EM; Applications. [4]
5. MCMC.
    - Revision. Bayesian statistics; Markov chains (irreducible, aperiodic; stationary distribution.
    - Introduction to MCMC; Metropolis-Hastings algorithm.
    - The Gibbs sampler.
    - Random-walk metropolis.
    - Application issues: burn-in period, multi-modal distributions, reparameterisation. [8]

Textbooks

- B. Efron, *The Jackknife, the Bootstrap and other Resampling Plans*, SIAM.
- W. R. Gilks, S. Richarson and D. Spiegelhalter, *Markov chain Monte Carlo methods in Practice*, Chapman and Hall.
- B. Morgan, *Elements of Simulation*, Chapman and Hall.
- B. D. Ripley, Stochastic Simulation, Wiley.

Teaching and learning methods

Two lectures and a two-hour computer workshop each week. In addition students should expect to spend at least six hours each week on private study for this course unit.

Assessment

Weekly courseworks: 40%
End of semester written examination: two hours 60%

Arrangements