COURSE DETAILS
Course Code: F71BI
Full Course Title: Bayesian Inference and Computational Methods
SCQF Level: 11
SCAF Credits: 15
Available as Elective: No

DELIVERY LEVEL
Undergraduate: No  Postgraduate Taught: Yes  Postgraduate Research: No
Additional Information:

COURSE AIMS
To provide students with knowledge of modern Bayesian Statistical inference, an understanding of the theory and application of computational methods in statistics and stochastic simulation methods including MCMC, and experience of implementing the Bayesian approach in practical situations.

LEARNING OUTCOMES – SUBJECT MASTERY
After studying this module, students should be able to:

- Understand and use computational programming in statistics
- Understand the philosophy of Bayesian inference and implement it in the solution of practical problems
- Understand and implement the theory of stochastic simulation
- Understand and implement the theory of Markov processes as applied to MCMC
- Understand and implement solutions to the practical problems (burn-in, mixing, etc) involved in the use of MCMC
- Understand and use MCMC in a range of practical applications.

LEARNING OUTCOMES – PERSONAL ABILITIES
At the end of the module, students should be able to:

- Demonstrate the ability to learn independently
- Manage time work to deadlines and prioritise workloads
- Present results in a way which demonstrates that they have understood the technical and broader issues of Bayesian inference and computational methods in statistics and its applications

SYLLABUS
1. Statistical programming. This will include an introduction to the use of R (and/or, potentially, other languages and packages) for simple probabilistic and statistical calculations, including the use of built-in simulation capabilities, iterative procedures, solution of equations and maximisation of functions.
2. Philosophy of Bayesian inference. This will include treatment of subjective and frequentist probability; the role
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3. Implementing the Bayesian approach. This will include: the formulation of likelihood for a range of statistical models and sampling designs; the incorporation of prior knowledge through prior density selection; conjugacy; the use of non-informative and non-subjective priors (including Jeffrey's prior); the interpretation of the posterior distribution as the totality of knowledge; predictive distributions.


5. Markov-chain and other stochastic methods for investigating target distributions. Ideas covered will include: construction of MCMC methods using standard recipes - Metropolis (and Metropolis-Hastings) algorithm, Gibb's sampler, implementation of methods using R computing package; investigation of properties through simulation. Simpler simulation methods using transformations, distribution function inversion and rejection sampling will also be covered.

6. Application of MCMC methods in Bayesian inference. Ideas covered will include: formulation of samplers for inferential problems in e.g. pattern recognition, signal classification, population dynamics; implementation of methods using R; application to problems involving missing data; informative methods of summarising posterior densities.

COURSE RELATIONSHIPS

N/A

LOCATION AND ASSESSMENT METHODS

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Reassessment in next academic year.