Ph.D. in Economics and Statistics of the University of Milan Bicocca

Bayesian Statistics I

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Course Material

The course material, slides and notes are available in free open eclass: https://free.openeclass.org.

Course Link: https://free.openeclass.org/courses/SC461/

All students should be registered in the free open eclass before the beginning of the course.

Overview

This course will provide the introduction to the Bayesian approach in statistics. More focus is given in the modeling approach and model comparison and computational aspects of the course.

Key Outcomes

By completing the course, the students will understand the fundamental differences between the Frequentist and Bayesian approach to statistics, know how to implement them in practice and be able to perform statistical analysis from a purely Bayesian perspective.

Requirements and Prerequisites

The students should have a good quantitative background. Specifically, knowledge in the fields of calculus, probability/distribution theory and statistics will be necessary for this course. Also basic knowledge of regression and generalized linear models is required.

Bibliography

Books:

- Ntzoufras, I. (2009). Bayesian Modeling Using WinBUGS. Wiley. Hoboken. USA.
- Carlin B. and Louis T. (2008), Bayes and Empirical Bayes Methods for Data Analysis. 3rd Edition, London: Chapman and Hall.

- Gelman A., Carlin J.B., Stern H.S., Dunson, D.B., Vehtari, A. and Rubin D.B. (2013). Bayesian Data Analysis. Third Edition. Chapman and Hall/CRC.

Grading

The main examination will be via a large assignment/project of Bayesian modelling using WinBUGS or other computational tools. Implementation of Bayesian variable selection will be also asked in this assignment.

There will also be

- Two in-class electronic tests. (max 20% of the course).
- One minor homework (to keep you going) that will award additional 5% to the total grade.

Course Syllabus

The course comprises of 5 sessions (3 Sessions of 4hrs and 2 Sessions of 3 hrs). The timetable is only indicative based on the empirical evidence of previous years.

Lecture 1: Introduction to Bayesian Statistics and MCMC (3 hrs)

Introduction to Bayesian Inference. Prior and Posterior. Conjugate Analysis. Introduction to MCMC (Gibbs Sampling and Metropolis Hastings). Illustration of MCMC mobility using R animations. Motivation about Bayesian models.

Lecture 2: Conjugate analysis and regression (4 hrs)

Conjugate Analysis (with simple example). Bayesian regression analysis using conjugate Analysis. Using R for Regression and GLMs.

Lecture 3: Introduction to WinBUGS, DIC & Simple Models (4hrs)

Scripting with WinBUGS. The Deviance Information Criterion. Details about the Syntax of WinBUGS. Simple Examples. Running WinBUGS from R (R2WinBUGS). Deviance Information Criteria (and BIC and AIC), Predictive distribution, Prediction and Handling of missing data, Normal regression, ANOVA using dummies

Lecture 4: Introduction to Bayesian Model Comparison (4hrs)

Posterior odds, Posterior model probabilities and Bayes Factors; marginal likelihood; The Lindley-Bartlett paradox, Variable Selection Indicators, Prior distributions for Variable Selection in GLMs, Criteria for Objective Priors, Hyper-g priors, Using BAS package in R for variable selection, Marginal likelihood computation (short discussion), Model Search using Gibbs variable selection methods, GVS in WinBUGS (with independent priors and g-priors), Implementing GVS using hyper-g priors in WinBUGS. Other packages in R. Variable Selection using JASP.

Lecture 5: Hierarchical Models (3 hrs)

Introduction, reasons for using hierarchical models, exchangeability, simple examples, more realistic applications.