Introduction to Bayesian methods and WinBUGS, fall 2009

Lecturer
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Scope
10 cu

Type and outline of the course
The course gives a practical introduction to Bayesian inference and WinBUGS. (Also R software will be modestly used). This is an intensive course over 2 weeks with daily lectures and computer (or other) practical sessions. Some practicals consist of homework assignments of 5-10 exercises to be presented at the session. Part of these homework assignments will be after the 2-week period.

If you could not register from the link below, you probably are a student in some other institution in which case you should check from your home department how/if you could transfer credits. There may be ‘JOO-sopimus’ between this and your institution, which makes it easier.

Outline of the course:
1. Preliminaries: some useful math for background.
2. Introduction: probability, Bayes, prior, posterior, binomial problems, decisions.
3. Other distributions and conjugate priors.
4. Uses of posterior distributions: hypotheses, CIs, predictions, approximations.
5. Monte Carlo simulation, MCMC methods.
6. WinBUGS.
8. Bayesian linear regression.
10. Model assessment.

Prerequisites
There are no pre-requirements other than reasonable familiarity with basic differential and integral calculus and functions (mostly taught at high school advanced courses), although it is an advantage to have knowledge of basic probability theory and statistics.

Also students from other disciplines interested in Bayesian applications are welcome.

Lectures
31.8.-4.9. (Monday to Friday) 9-14 room B120, 14-16 computer class C128.
7.-11.9. (Monday to Friday) 9-14 room C129, 14-16 computer class C128.

After the two week intensive period the course continues during the I period with Jukka Siren (exercises) on Tuesdays, room B120, 14-16.

Exams
To pass successfully, there is an exam (with 5 questions) and 1/3 of the homework exercises should be done, attending at least in 6 different sessions out of 8. (A fair attempt is enough, exactly correct answers are not required in exercises). If more than 1/3 of the assignments are done, some extra credit is added to the exam points. Maximum extra is equivalent to one exam question.

Exam: Tue 13.10. 14:00-17:00, B120.

Make sure you have >1/3 marked exercises from the sessions!
The exam can include basically three types of questions: (1) theoretical questions with mathematical content in which some mathematical manipulations are needed to derive a mathematical expression of something, or to give a mathematical proof of something. These may involve the typical tricks and formulations that we had in the 'preliminaries' section, and used elsewhere in lecture notes. But you don't need to remember the exact expression for all density functions (as given in the list of distributions). If needed, they are given in the question. But you need to know how to manipulate them in a given problem, and how to use the typical tricks and other common rules of probability, as those in the lecture notes or exercise examples. (2) Questions related to explaining the interpretation or definition of some terminology. (3) Questions related to WinBUGS, e.g. writing a correct code for some model, or explaining the code, etc. In total, there are 5 questions which can have parts a,b,c. Maximum points per question is 6, so the total is 30.

Note also that during the course, some corrections and additions were done in the lecture notes.

There were 15 who had >1/3 exercises marked, 13 who took the exam, and 4 passed.

Exam solutions

2nd Exam date is 17.12. (general examination day of the department).

For this, you need to fill in a form at the department office (C329), latest 9.12., to indicate that you are planning to attend.

Exam2 solutions

Lecture material

Some preliminary material .
List of distributions from Gelman et al: Bayesian data analysis, 2nd ed.

A provocative, intensive and entertaining text on the interpretation of probability as a degree of uncertainty, by E.T. Jaynes. Physics of random experiments .

Introduction .
Exercise1 . Time: Thu 14-16. At the session, a list is circulated in which you can tick which exercises you have done to get points for them. Random volunteers are kindly asked to present their solutions. Remember: perfect solutions not required, a fair attempt is ok. There may even be several relevant approaches to the same problem. The aim is to discuss what ideas you had about the problems. If you cannot come then, you can send your homework by e-mail (or give it written on paper), if you want to get points.

Exercise2 . Time Mon 14-16.

Papers about 'objective bayes' and 'subjective bayes'

Some other posteriors with conjugate priors.

Some common uses of posterior distributions.

Monte Carlo approach. MC.

WinBUGS

Exercise3 . Time Wed 14-16.
Exercise4 . Time Fri 14-16.

All exercises up to this point (1,2,3,4): in all numerical computational problems the idea is to use R (or something equivalent) to perform calculations. WinBUGS is not needed for this (although you might check how that could be done too). In the remaining exercises, the focus of calculations is in WinBUGS.

Hierarchical models .
Bayesian linear regression.

Recommendations on choosing priors for variance parameters: Gelman

Example of dose estimation demonstrating non-bayesian and bayesian techniques Dose estimation .

Diagnostic problems .

Bayesian model assessment

Exercise5 . Time Tue 14-16. (15.9.). (Jukka Siren). Some of these are still to be done e.g. in R, but some could be possible also in WinBUGS. A related paper to sample size problems here .

Exercise 6 . Time Tue 14-16. (22.9.). (Jukka Siren). A bunch of WinBUGS exercises this time.

Of some interest: a recent paper about BUGS, from the developers of BUGS .


Registration

Did you forget to register? What to do.