Bayesian Methods

LABORATORY

Lesson 2: Jan 31 2002

Software: BUGS

An introduction to BUGS and Bayesian updating, inference and prediction in 2 standard data models: Normal and Poisson

BUGS

Bayesian inference Using Gibbs Sampling

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- is a piece of computer software for the *Bayesian analysis* of *complex statistical models* using *Markov chain Monte Carlo* (MCMC) methods.
- It grew from a statistical research project at the MRC BIOSTATISTICS UNIT in Cambridge, but now is developed jointly with the IMPERIAL COLLEGE SCHOOL OF MEDICINE at St Mary's, London.

Software

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- The Classic BUGS program uses text-based model description and a command-line interface, and versions are available for major computer platforms (Sparc, Dos).
- A Windows version, WinBUGS, has an option of a graphical user interface, the standard ‘point-and-click’ windows interface, and has on-line monitoring and convergence diagnostics.

  CODA and BOA are a suite of $S-plus/R$ functions for convergence diagnostics.

software version: WinBUGS 1.3

The last WinBUGS has a number of new features which are not part of Classic BUGS. These include a more general Metropolis sampler (Slice sampling and current point Metropolis) and simplifications to the sintax.

a reference text: Bayesian Statistical Modelling by *Peter Congdon*

The book reviews several major areas of statistical application and modelling with a view to implementing Bayesian perspective and to developing the wide range of possibilities opened up by the BUGS software.

BUGS, in fact, offers a large programming flexibility and does make a great demand on the researcher's own initiative.

Examples

Two educational BUGS examples for ONE-DIMENSIONAL *parameter models*

1. The univariate Normal model with unknown mean μ, but known variance σ^2
2. The Poisson model for event counts

UNIVARIATE NORMAL

Congdon 's book, pag. 17, Example 2.1

Program 2.1 Systolic Blood Pressure

- Suppose we take a random sample of 20 systolic blood pressure readings y_i from a subpopulation of adult men, that might be a particular diagnostic group.
- We know from national surveys that $\sigma = 13$.
- We are interested in estimating μ, the mean blood pressure in our group, and predicting its likely level in a typical new patient in the same group.
- Suppose we select a non informative prior for μ.

normal example continues ...

- Suppose we know the typical blood pressure for all adult males is 125, and we wish to test whether the particular diagnostic group has above or below average pressure
- These questions may be answered directly from normal probabilities ...
  As the likelihood $p(y|\theta) \equiv L(\mu; y)$ is $\propto exp(-1/2\tau\,(y-\mu)^2)$ if the prior is of the same form, e.g., $p(\theta)$ is $\propto exp(-1/2\tau_0\,(y-\mu_0)^2)$, then the posterior will also keep this form. In fact, $p(\theta|y)$ is $\propto\; exp(-1/2\,\{\tau_0\,(\mu-\mu_0)^2\;+\;\tau\,(y-\mu)^2\})$

  -> the Normal prior distribution is a coniugate family for the Normal likelihood ...
- but a sampling perspective is equally possible.

Bugs: model specification

- Construction of a Directed Acyclic Graph

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- Nodes:

  Constants
  Stochastic nodes
  Deterministic nodes

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- Arrows:

  stochastic dependence
  logical function

The lesson continues opening WINbugs, clicking on the User Manual at the Help menu (to be read !!), and simulating the bugs model in norm1.b at the course web page.

Poisson

Congdon 's book, pag. 36, Example 2.15

Program 2.15 Trent Leukaemia Mortality

- Comparing mortality between areas after standardizing for age, factor affecting mortality risk.
- Data consist in myeloid leukaemia deaths (1989) in Derby, denoted y_1, and in the remainder of the Trent region of England, y_2, of which Derby is a part.
- Let $y_{i,j}$ denote observed deaths, and n_{ij} populations in area i for age groups j. where $p^*_j = n_{Ij}/(n_{Ij} + n_{Sj})$ is the share of the total

poisson example continues ...

by you !! simulating the bugs model in pois.b at the course web page.

There are 2 models: A) (simple) extracted from B) that is the one written by Congdon in *Program 2.15*