Bayesian inference

ADMB and stock assessment

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Outline

1. Overview - history, theory, statistical inference, priors
2. Application - practical Bayesian, MCMC, exercise

History

Bayes (1763) and Laplace (1774)

Bayesian inference with uniform priors

Fiercely debated in the 1930s-1960s

Dismissed by Fisher and Neyman

Widely used since the 1990s

Gelman et al. 1995, MCMC

http://cran.r-project.org/web/views/Bayesian.html

Bayesian theory

$$P(A|B) = \frac{P(B|A) \times P(A)}{P(B)}$$

$$P(\theta|Y) = \frac{P(Y|\theta) \times P(\theta)}{P(Y)}$$

$$P(\theta|Y) \propto L(Y|\theta) \times P(\theta)$$

$$f = -\log L + \text{Penalty}$$

Statistical inference

Significance tests, p values

Given that the null hypothesis is true . . . probability of getting a sample. . .
Sometimes all we need

Uncertainty, confidence intervals

Given that the estimates are the true parameter values . . .
. . . and the experiment was repeated many times. . .

Subjective probability

Probability redefined

Likelihood inference, uniform prior

Support, penalized likelihood
$f = -\log L + \text{constant}$

Prior distribution

- Uniform
- Conjugate
- Objective, empirical, meta analysis
- Assist model convergence without fixing a parameter

In practice

Frequentist and Bayesian methods address different questions

How likely is $\theta = 160$ or $\theta = 220$?
What is the probability of $B < B_{\text{lim}}$?

MCMC is practical

Evaluate uncertainty
Find global minimum
Diagnose model behavior

Hierarchical models, meta analysis, BUGS

Exercise

Use a prior for the Beverton-Holt parameter a (initial slope)

$$R = \frac{S}{a + bS}$$

Imagine that we are having model convergence problems, but know from other data-rich stocks that for this species, a tends to be around 0.12

Use normal prior distribution with $\mu = 0.12$. Try (1) $\sigma = 0.02$, (2) $\sigma = 0.06$, and (3) shrinking the dataset down to the first $n = 30$ observations.

Hint: $f \;=\; -\log L \;+\;$ Penalty