GLMs and Bayesian Analysis

Abstract

Generalized linear (mixed) models (GL(M)Ms) are extensions of the simple linear regression and are extremely important in ecological analyses. Since spatial capture-recapture models are a variation of GLMMs, in this chapter we explore the analysis of simpler GL(M)Ms in a Bayesian framework. While most of these models are readily analyzed with Frequentist methods, Bayesian analysis allows us to make direct probabilistic statements about parameters and does not rely on assumptions of asymptotic behavior.

We demonstrate the straight-forward implementation of GLM(M)s in the pseudo-code language of the programs WinBUGS and JAGS using a simple linear regression example. Examining the model output, we introduce practical issues of Bayesian analysis, such as choice of prior probability distributions for model parameters and diagnostics to evaluate the validity of model results.

With this background established we move on to implementing Poisson and binomial GL(M)Ms. We rely predominantly on the BUGS language, but we also briefly introduce the reader to writing custom algorithms to analyze GL(M)Ms in a Bayesian framework directly in R.

We finish the chapter with a brief introduction to goodness-of-fit tests and model choice. Although these issues are controversial, we show some straight-forward approaches to dealing with them in a Bayesian framework.

The principles underlying GL(M)Ms are relevant to most modeling and analysis problems and an understanding of these principles lays the foundation for understanding SCR models discussed in the remainder of this book.

Key words: Binomial distribution, convergence, Gibbs sampling, goodness-of-fit, Markov chain Monte Carlo, Metropolis-Hastings algorithm, model selection, Poisson distribution, posterior distribution, prior distribution, random effect