LAB 6: INTRODUCTION TO JAGS

The goal of this lab is to familiarize you with the JAGS software (Just Another Gibbs Sampler).To do so, you will first work through Tom Hobbs' user manual. Once you have a grasp of the basics of JAGS, continue to the following exercises. Marty Plummer's JAGS user manual is also available in courseworks.

Exercise 1. Modifying the logistic problem

(a) Recode the regression that you started in the primer such that $\mu_i = r\text{-}bx_i$. In this case, μ_i is population growth, x_i is population size (N) and $b = r/K$. Plot posterior distributions of r, K, and σ. Save the coda or JAGS object you created.

(b) Next, apply a trick that is extremely useful in Bayesian regression–centering the predictors. This is done by subtracting the mean of the predictor from each individual value, i.e., x_i *–mean (x)* and using this centered data. The slopes will not change, but you will need to back transform the intercept, i.e, $r = r_{centered} - b*mean(x)$. You should use this as an opportunity to learn how to calculate a mean in JAGS from the data. Save the coda or JAGS object.

(c) Centering the data is handy because it reduces autocorrelation in the MCMC chain, making each iteration more useful and dramatically accelerating convergence. I have had problems that would not converge at all with un-centered data that converged rapidly when the data were centered. To demonstrate this and to practice manipulating coda and JAGS objects, make a plot of the autocorrelation in the chains for *b* for the two objects you created above (centered and uncentered). Prepare your own plot from the coda or JAGS object [hint—plot(acf(object.name))]

(d) One of the most useful features of MCMC, is that any quantity that is a function of estimated parameter becomes itself a function of the parameters. As such it has a distribution from which we can estimate means, quantiles, etc. Go back the original population model in the JAGS primer. Consider two quantities of interest that are functions of our estimates of the random variables r and K: the rate of population growth, $dN/dt = rN(1 - \frac{N}{K})$ and the maximum rate of population growth, *K/2.* Estimate the posterior distribution of the maximum rate of growth and plot its density. Plot the median population growth rate and 95% credible intervals as a function of N. [Hint–you will need to use a vector of N's that you provide to JAGS as data to get a smooth curve.] What does this curve tell you about the difficulty of sustaining harvest of populations?

Exercise 2. Lizards on islands [Courtesy of McCarthy (2007)]

Polis et al. (1998) analyzed the probability of occupancy of islands (p) by lizards as a function of the ratio of the islands' perimeter to area ratio. The data from this investigation are available in *island-data.csv*. The response data, as you will see, are 0-1, 0 if there were no lizards found on the island, 1 if one or more lizards were observed.

(a) Please construct a simple Bayesian model that represents the probability of occupancy as $logit(p_i)=a + bx_i$ where x_i is the perimeter to area ratio of the i^{th} island. So, you have the deterministic model, the challenge is to choose the proper likelihood to link the data to the model. What parameter are you trying to estimate? How do the data arise? What likelihood function is needed to represent the data? Draw a Bayesian network diagram (a DAG) and use it to write out the joint distribution of full data set. Use the joint distribution as a basis for JAGS code needed to estimate the posterior distribution of *a* and *b*. You may assume uninformative priors.

(b) Plot the median and 95% credible intervals of the predicted probability of occurrence as a function of island perimeter to area ratios ranging from 1-60. Hint– create a vector of 1-60 in R, and use it as x values for an equation making predictions in your JAGS code. Use a JAGS object for plotting.

REFERENCES

McCarthy, M. A. (2007) Bayesian Methods for Ecology. Cambridge University Press, Cambridge, U.K.

Polis, G. A., S. D. Hurd, C. T. Jackson, and F. Sanchez-Piñero (1998) Multifactor population limitation: Variable spatial and temporal control of spiders on gulf of California islands. *Ecology* 79:490–502.