Bayesian Analysis of the Mixed Models for Repeated Binary Response and Time-Dependent Missing Covariates

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Abstract:

Biologists have long been interested in phenomena that exhibit cyclical patterns and predator-prey cycles. In many species of plants, individuals exhibit endogenous cyclical patterns of reproductive expenditures. External conditions such as the weather and damage by herbivores can greatly affect the level of resources available to a plant for allocation to reproduction. External conditions may thus be the initial cause of synchrony among individuals exhibited by some species of plants. Here, we are particularly interested in some external factors that affect the reproductive expenditures of Tilia americana (American basswood), a tree with a two-year cycle in the intensity of flowering, but that does not exhibit a strong level of population synchrony.

Determining how these factors might bring synchrony to group of unsynchronized individuals will greatly increase our understanding of the evolution of species with population wide cyclical patterns. The intensities of flowering of 24 trees were collected over a 29 year period. The potential factors that may affect the cyclical patterns of flowering are defoliation by gypsy moths and various weather conditions. In order to assess the effects of these factors on the flowering intensity, two additional data sets, namely, defoliation by gypsy moths data and monthly weather conditions data, were obtained from different sources. As in many studies of ecological phenomena, there were a large number of instances of missing data in monthly weather condition variables, which further complicated our analysis.

To analyze such complex data, we propose the generalized linear mixed logistic regression model for the repeated binary responses and then propose a joint model for time-dependent missing covariates using information from different sources. An efficient Gibbs sampling algorithm is developed for computing Bayesian Posterior estimates. Moreover, a Bayesian model comparison criterion, DIC, is used to identify factors such as defoliation by gypsy moths (Lymantria dispar) and weather conditions that may disrupt the cyclical pattern of flowering.