Instructor Name: Nathaniel Woodward

Course Name: Introduction to Bayesian Statistics

Course Description: (A brief description of the course content to be covered.)

This course will (1) cover probability basics (joint, marginal, conditional probability), common continuous/discrete probability distributions, likelihood functions, and Bayes' rule (prior, likelihood, posterior); and (2) apply these concepts to real statistical scenarios that arise in many areas of research. Because analytical solutions are not often possible, numerical estimation using grid approximations will be used to build up to MCMC sampling techniques (e.g., Gibbs sampling). Participants will gain understanding of what is going on under the hood of MCMC techniques and will see how to use them to perform estimation and analyses in R/Jags. We will work from basic examples up through linear/logistic regression and on to hierarchical models.

Day 1:
Why Bayes? Brief history; foundational ideas of Bayesian inference; basic differences between Bayesian and Frequentist approaches; Bayes rule practice; overview of distributions (prior, likelihood, posterior); Bayes rule applied to discrete distributions (grid approximations); analytical solutions with continuous distributions; problems → MCMC

Day 2: Markov Chain Monte Carlo: Gibbs/Metropolis and extension, demonstration, and hands-on example; realistic example (Bayesian t-test comparing two groups) using Highest Density Interval, analogous to a confidence interval; MCMC diagnostics; Bayes Factor, Marginal Likelihood, Predictive.

Day 3: Hierarchical/multilevel models; shrinkage; linear regression (hands-on example), multiple regression, ANOVA (hands-on example), logistic regression (possible extensions: multivariate logistic, mixture models)

Day 4: Mini-lecture taking stock of all that we've learned by briefly revisiting the high points of the previous days' material. All-day hands-on choose your own adventure (conduct a Bayesian of your own data to answer questions relevant to you); group up by type of analysis and trouble-shoot each other's analyses; finally, discuss how to report a Bayesian analysis, e.g., for the methods section of a journal article.