Fall 2013 Course Announcement
Stat 591: Advanced Topics—Bayesian Analysis

INSTRUCTOR. Dr. Ryan Martin
Department of Mathematics, Statistics, and Computer Science
Email: `rgmartin@uic.edu`
URL: `www.math.uic.edu/~rgmartin`

LECTURES. MWF 12:00–1:00 p.m.—probably.

TARGET AUDIENCE. Graduate students in biostatistics, computer science, economics, mathematics, statistics, etc.

PREREQUISITE. Stat 411 and familiarity with computational statistics at the level of our Stat 451. Having taken Stat 511 or something equivalent would also be a plus.

TEXTBOOK. Ghosh, Delampady, and Samanta, *An Introduction to Bayesian Analysis*, Springer 2006. Free electronic access to this book is available from the UIC library and SpringerLink. One can also purchase a paperback copy of the book from SpringerLink for $25. The required links will be provided on the course webpage in due time. Other good references include:

- Robert, *The Bayesian Choice*, Springer 2007;
- Marin and Robert, *The Bayesian Core*, Springer 2007;
- Gelman, Carlin, Stern, and Rubin, *Bayesian Data Analysis*, Chapman–Hall 2004.

Lecture notes (hopefully with references to literature) will also be provided.

GRADES. Grades will be assigned based on homework and class participation. There may also be some kind of "final project," but I haven't decided yet.

TENTATIVE COURSE OUTLINE.

1. The course will begin with a careful description of the Bayesian program, starting from *why* parameters are treated as random, to *how* the prior is updated to a posterior, to making inferences from the posterior. A variety of results (likelihood principle, complete-class theorems, coherence and rationality, exchangeability, etc) will be presented to give further motivation.
2. Once the motivation for and mechanics of Bayesian analysis are in place, focus will turn to the choice of the prior, arguably the most difficult challenge. The definition and construction of "objective" priors will be carefully fleshed out.

3. Large-sample theory (posterior consistency and normality) will be established to show, among other things, that the choice of prior is often not as critical as one might think. The fundamental Laplace approximation will also be introduced. All theoretical results will be put into perspective, so that students will understand *why* these results are important.
4. Now that we can choose a prior, it comes down to calculating the posterior for inference. This often requires numerical methods, and we will discuss some of the fundamental tools, including the Gibbs sampler, Metropolis–Hastings, and other Markov chain Monte Carlo methods. Familiar, but non-trivial examples will be used to illustrate the modeling and computational methods.
5. Modern statistical problems often involve lots of parameters. In a Bayesian setting, this is usually handled via hierarchical models. The advantage of the hierarchical Bayes framework, in its ability to automatically penalize models for having too many parameters, will be illustrated conceptually and by examples. The empirical Bayes framework, now widely used, will also be introduced in this context.