Bayesian Methods and Applications in Genetics

Animal Sciences 875
Fall Semester 2007
3 cr.
TIMETABLE CODE:
AHH 006 September 4- October 28

INSTRUCTORS:

Daniel Gianola (Lectures), Dr. Xiao-Lin Wu (Laboratory) and Mr. Gustavo de los Campos (Laboratory Teaching Assistant).

COURSE MEETS:

Lecture:	2-4 PM	M-T-W-Th	432 Animal Sciences
Lab:	2-4 PM	F	152 Animal Sciences (CALS Computing Laboratory)

PREREQUISITES:

Statistics 310 or Statistics 610; Statistics 850 or course in linear statistical models; Genetics 610 or Genetics 620 or Agronomy 811 recommended.

TEXTBOOKS:

a) Required

Sorensen, D. and D. Gianola. 2002. *Likelihood, Bayesian and MCMC methods in quantitative genetics.* 740 pp. Springer, New York. (3rd Printing, March 2007).

Albert, J. 2007. *Bayesian Computation with R.* Springer, New York.

b) Recommended

Carlin, B. P. and T. A. Louis. 2000. *Bayes and Empirical Bayes Methods for Data Analysis*. 419 pp. Chapman & Hall/CRC, Boca Raton (2nd Edition).

Gelman, A., J. B. Carlin, H. S. Stern and D. B. Rubin. 2004. *Bayesian Data Analysis*. 668 pp. Chapman & Hall/CRC, Boca Raton (2nd Edition).

Lee, P. M. 2004. *Bayesian Statistics: An Introduction.* Hodder Arnold, London.

GRADING:

-Each student will present and discuss three (3) selected journal papers having Bayesian content (30% of grade, last week of class). At least one of the papers must be from a field different from that of the student's. For instance, if the student is in animal breeding, at least one of the papers could be in human or plant genetics, or in any area of applied statistics. Instructions about the format of the presentations will be provided later on.

-Laboratory assignments and laboratory report (30% of grade). All laboratory assignments must be completed timely, and will be graded as satisfactory (S) or unsatisfactory (U). All assignments classed as U will need to be redone, until an S is received. The report will be drafted as a short scientific paper (maximum length is 10 pages, plus tables and graphs) and must be prepared professionally, both in content and form.

-Comprehensive final written exam (40% of grade). Last day of class, open book.

TOPICS

a) Lecture

- Statistical problems in quantitative genetics and why the Bayesian approach.
- Bayes theorem: discrete and continuous versions.
- Joint, marginal and conditional posteriors; predictive distributions. Approximations to marginal inference: empirical Bayes.
- Nuisance parameters: comparison with classical methods.
- Bayesian evaluation of models: Bayes factors, marginal likelihoods, posterior predictive checks.
- Linear Regression model.
- Linear Mixed Effects and variance-covariance component models
- Thick-tailed linear models.
- Longitudinal data: linear and nonlinear parametric specifications
- Finite mixtures and survival (time-to-event) models
- Analytical and Monte Carlo solutions: direct, composition and importance sampling; Markov chain Monte Carlo (Gibbs sampling, Metropolis-Hastings); data augmentation.

b) Laboratory

Simulation of random variables from common distributions; Monte Carlo methods; Markov chain Monte Carlo methods for sampling from posterior distributions. WinBugs and R implementations of Bayesian models including linear regression, threshold models, variance components; multivariate linear models; longitudinal data; survival analysis; mixtures, etc. Overview of existing software for quantitative genetic applications.

August 10, 2007