Statistics 225 Bayesian Statistical Analysis Fall 2018

Contact: Professor Hal Stern
Department of Statistics
2216 Bren Hall ZOT 1250
ph: 824-1568
email: sternh@uci.edu
course web: www.ics.uci.edu/~sternh/courses/225/

When: Tu Th 12:30pm-1:50pm
Where: DBH 1423

Office Hours: W 2:00pm-3:00pm (and by appointment)

Course description: Introduction to the Bayesian approach to statistical inference. Topics include univariate and multivariate models, choice of prior distributions, hierarchical models, computation including Markov chain Monte Carlo, model checking, and model selection.

Prerequisites: Listed prerequisites include Statistics 205 (Introduction to Bayesian Data Analysis) and Statistics 230 (Statistical Computing). Strictly speaking I will not be assuming that students have Statistics 230; but I will be assuming students are comfortable with statistical computation (using R, Python, MATLAB, or other language/package). Students are also assumed to have some background in probability and statistical inference (approximately two quarters of upper division/graduate coursework at the level of Statistics 200AB) and some background in statistical methods (roughly equivalent to our Statistics 210).

Grading and Course Requirements: There will be approximately 4 homework assignments. There will be a single exam about ¾ of the way through the course, tentative date is November 20, 2018. Students are also expected to do a project (data analysis, discussion of topic in Part V). The project can be an individual exercise or preferably a group (up to 3 students) project. The projects will be due during finals week (Friday December 14, 2018). The grade is determined by performance on this work, roughly as follows: homework (30%), project (20%), exam (50%).

Software: Assignments will include some problems that require computation. Early on problems can be done easily in R/Python/MATLAB. Later we will introduce Stan (through its R implementation RStan).

Academic Integrity: Students are responsible for adhering to UCI expectations regarding academic integrity, see, e.g., the website https://aisc.uci.edu/students/academic-integrity/index.php. You are permitted to **discuss** homework assignments with other students (and the reader and instructor) but **the work you turn in must be your own work**. Academic dishonesty includes, but is not limited to, copying answers from another student, allowing another student to copy your answers, communicating exam answers to other students during an exam, and using notes or aids during an exam. Penalties for academic honesty can include getting zero credit for an assignment or receiving a failing grade in the class.

Topical Outline for Lectures:

Sept 27 – Oct 4 Introduction and univariate models: Review of probability; introduction of notation and terminology for Bayes Theorem; consideration of univariate models with common distributions (binomial, normal); strategies for prior distributions. (Chapters 1-2)

Oct 9 – Oct 11 Multivariate models: Extension of the ideas to problems with more than one unknown parameter. Examples include the normal distribution and simple logistic regression. Some basic computation and large sample theory is discussed. (Chapters 3-4)

Oct 16 – Oct 18 Introduction to hierarchical models: Development of hierarchical models; Model building and computation; Examples include normal random effects models and beta-binomial models. (Chapter 5)

Oct 23 – Nov 1 Bayesian computation: Basic simulation ideas; approximations; Markov chain Monte Carlo methods. (Chapters 10-13)

Nov 6 NO CLASS

Nov 8 – Nov 13 Model checking and model selection: Ideas for checking the fit of a model to data; methods for choosing between models including Bayes factors. (Chapters 6-7)

Nov 15 – Nov 29 Linear models: Bayesian approach to the linear model. (Chapters 14-16)

Nov 20 EXAM - inclass

Dec 4 – Dec 6 Selected topics: Selected topics from the remainder of the book. Possibilities include: robust models (Ch 17), missing data. (Ch 8, 18), Bayesian nonparametrics (Ch 23).

REFERENCES

Primary Course Textbook: *Bayesian Data Analysis* by A. Gelman, J. B. Carlin, H. S. Stern, D. B. Dunson, A. Vehtari, and D. B. Rubin. Chapman and Hall/CRC, 2013 (3rd edition).
See also the book website www.stat.columbia.edu/~gelman/book.

There are many other wonderful books

Like ours:

Bayes Methods for Data Analysis - B. P. Carlin, T. A. Louis; Chapman and Hall/CRC, 2008 (3rd edition)
Bayesian Ideas and Data Analysis – R. Christensen, W. Johnson, A. Branscum, T.E. Hanson; Chapman and Hall/CRC, 2010.
Doing Bayesian Data Analysis: A Tutorial with R, JAGS, and Stan – J. Kruschke; Academic Press, 2014 (2nd edition).
The Bayesian Choice - C. P. Robert; Springer-Verlag, 2007 (2nd edition).
Bayesian Computation with R – J. Albert; Springer, 2009 (2nd edition)
A First Course in Bayesian Statistical Methods – P.D. Hoff; Springer, 2009.
Bayesian Statistics: An Introduction - P. M. Lee; Wiley, 2012 (4th edition).

Oldies:

Bayesian Inference in Statistical Analysis - G. E. P. Box and G.C. Tiao; John Wiley, 1992 (written 1973)
Statistical Decision Theory and Bayesian Analysis - J. O. Berger; Springer-Verlag, 1993 (2nd edition)