Bayesian Statistics, STAT 4520
Fall 2019

1 General Information

Instructor:	Kate Cowles, 374 SH, 335-0727 kate-cowles@uiowa.edu
Office hours:	M 10:30 - 11:20 a.m. W 12:30 - 1:20 p.m. Th 1:30 - 2:20 p.m. Please feel free to make appointments to see me outside of office hours, and to send me questions by e-mail.
Department:	Statistics and Actuarial Science, 241 SH
DEO:	Kung-Sik Chan, 241 SH, 335-0712 kung-sik-chan@uiowa.edu
Lectures:	M, W, F 11:30 - 12:20 S307 PBB
Lab:	Some M & F 11:30 - 12:20 41 SH
Web page:	icon.uiowa.edu
Textbook:	Cowles, *Applied Bayesian Statistics* (free electronic access at `https://login.proxy.lib.uiowa.edu/login?url=https://link.` Albert, *Bayesian Computation with R* (in UI Engineering library)

2 Course goals and objectives

Through hands-on experience with real data from a variety of applications, students will learn the basics of designing and carrying out Bayesian analyses, and interpreting and communicating the results. Students will learn to use software packages including OpenBUGS and R to fit Bayesian models.

3 Evaluation of students

3.1 Homework

Homework assignments will consist of data analysis on the computer, written interpretation of computer output, and other written questions. In general, homework will be assigned each Fri. and will be due by electronic submission the following Fri.

Exceptions to this schedule will be announced in class.

Show your work when solving written homework problems. For computer problems, turn in printouts of your commands or programs and their output.

You are encouraged to study with others. However, if you do work with others on homework assignments, please: a) write up your own assignment and make sure you completely understand all solutions that you submit, and b) write the names of the others in your study group on your assignment.

Late homework will not be accepted except as required by university policy, i.e. because of "illness, mandatory religious obligations, or other unavoidable circumstances or University activities."

3.2 Projects

Students will work in groups of three to carry out projects involving application of Bayesian methods to problems of their own choosing. Some examples are:

- Carry out a complete Bayesian analysis of a real dataset. This might involve:
  - description of the research question and dataset
  - specifying an appropriate Bayesian model
  - determining appropriate values for prior parameters
  - fitting the model using OpenBUGS
  - checking convergence
  - analyzing the output using OpenBUGS and/or the R package CODA
  - reporting and interpreting the results
- Compare different methods of fitting the same model to the same dataset
  - normal approximations
  - MCMC
  - other simulation methods
  - analytical computation (if feasible)
  - etc.
- Carry out a Bayesian analysis of a dataset for which a classical analysis has been reported in a journal. Compare and contrast the results obtained by the two approaches.
- Fit a Bayesian model to a dataset using several different choices of prior (hyperparameters and/or functional form). Discuss the meaning of the different results, and the robustness of the model to prior specifications.
- Fit several different plausible Bayesian models to the same dataset. Carry out a check of model adequacy and model fit. Discuss the results.
- There are endless other possibilities. Find something that interests you, or see me for ideas.

I will expect more sophisticated projects from graduate students.

Projects will be carried out in three phases. Please meet with me at least once while you are working on each phase.

- Project proposal (due 11/04)

  This is a detailed description of what you plan to do, including question(s) to be addressed, dataset to be used, methods to be applied. Also specify the method of presentation that you intend for the final project. (See below.)

- Project interim report (due 11/18)

  This informal report will indicate that your project is "on track." All computing should be done at this time. The report will include results obtained thus far and a brief summary (hand-written is O.K.) of what they mean and what remains to be done. In addition, the report will include a list of the tasks performed by each member of the project team.

- Project presentation (papers or presentation materials must be posted or submitted by 12/09)

  Projects must be finalized in a form that can be shared with the entire class, such as:

  - posting a document on the course web page
  - preparing a poster
  - giving an oral presentation with overheads, slides, or computer images

  Posters and oral presentations will be given in class during the final week of classes.

3.3 Exams

There will be two 1-hour midterm exams and one comprehensive 2-hour final. Students may bring one 8-1/2 x 11 in. sheet of paper with notes to each midterm, and 3 sheets to the final.

Missed exams may be made up only with documentation of reasons required by university policy (see "Late Homework" above).

Exam dates and times:

Midterm 1	Fri. 09/27	in class
Midterm 2	Fri. 11/08	in class
Final	TBA	

3.4 Grading

The course components will be weighted as follows:

Homework	10%
Midterms	35% (17.5% each)
Project	20%
Final	35%

Grading will be on a curve, with +/− grades used. A grade of $A+$ represents exceptional work and rarely is awarded.

4 Extra Help

The Statistics Tutorial Lab gives free tutorial assistance to students in some elementary Statistics courses. In addition, several graduate students have volunteered to independently tutor students in various Statistics courses at mutually- arranged times and fees. Please check the web site `www.stat.uiowa.edu/courses/tutoring.html` for tutoring details.

5 College of Liberal Arts and Sciences: Policies and Resources

The CLAS policies and procedures are stated at the following link:

`http://clas.uiowa.edu/faculty/teaching-policies-resources-syllabus-insert`

6 Syllabus (may be updated)

08/26 - 08/30	Review of probability and Bayes' theorem Reading: Cowles, Chapters 1 and 2
09/02 - 09/06	Bayesian inference for proportions Reading: Cowles, Chapter 3 09/02 Labor Day; no class Lab Wed. 09/04
09/09 - 09/13	Summarizing posterior distributions Reading: Cowles, Chapters 4 and 5
09/16 - 09/20	Other 1-parameter models Reading: Cowles, Chapters 5 and 6 Lab Mon. 09/16
09/23 - 09/27	Intro to multiparameter models Reading: Cowles, Chapter 7 Midterm 1, Fri. 09/27
09/30 - 10/04	Bayesian computing Reading: Cowles, Chapter 8 Lab Mon. 09/30
10/07 - 10/11	Hierarchical models Reading: Cowles, Chapter 9; selections from OpenBUGS manual
10/14 - 10/18	Hierarchical models; More Bayesian computing Reading: Cowles, Chapter 9; Albert, selected sections Lab Mon. 10/14
10/21 - 10/25	Bayesian Regression Reading: Cowles, Chapter 10
10/28 - 11/01	Hierarchical regression models Reading: Cowles, Chapter 10 Lab Mon. 10/28
11/04 - 11/08	Hierarchical, continued; model checking and comparison Project proposals due Mon. 11/04 Midterm 2, Fri. 11/08 Reading: Cowles, Chapter 11
11/11 - 11/15	Hypothesis testing, etc. continued Lab Mon. 11/11
11/18 - 11/22	Special topics Project interim reports due Mon. 11/18 Lab. Wed. 11/20
11/25 - 11/29	No class Happy Thanksgiving!
12/02 - 12/06	Special topics; Review
12/09 - 12/16	Project presentations Projects due 12/09 Lab Wed. 12/11
Finals week	Final exam, TBA