Bayesian Statistics, 22S:138 (STAT 4520)
Fall 2011

1 General Information

Instructor: Kate Cowles, 374 SH, 335-0727
kate-cowles@uiowa.edu
Office hours: T 1:00 - 1:50 p.m.
    W 11:30 - 12:20 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: Luke Tierney, 241 SH, 335-0712
luke-tierney@uiowa.edu
Lectures: M, W, F 12:30 - 1:20 112 MH
Lab: Some W & F 12:30 - 1:20 41 SH
Web page: www.stat.uiowa.edu/~kcowles/s138_2011
Handouts, homework assignments, datasets, etc.
will be posted on the web page for you to download.
ICON (www.icon.uiowa.edu) will be used for confidential postings.
Textbook: Cowles, Applied Bayesian Statistics (draft available on ICON webpage)
Albert, Bayesian Computation with R
(free electronic access at http://infohawk.uiowa.edu)

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 commu-
nicating the results. Students will learn to use software packages including OpenBUGS
and BOA 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 in class the following Fri. Exceptions to this schedule will be
announced in class.
Show your work when solving written homework problems. For computer problems, turn
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 BOA
  - 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 10/31)**
  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 11/16)**
  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 12/05)**
  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:

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<tbody>
<tr>
<td>Midterm 1</td>
<td>Wed. 10/05</td>
<td>in class</td>
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<tr>
<td>Midterm 2</td>
<td>Fri. 11/04</td>
<td>in class</td>
</tr>
<tr>
<td>Final</td>
<td>Thurs. 12/15</td>
<td>noon</td>
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3.4 Grading

The course components will be weighted as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
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</thead>
<tbody>
<tr>
<td>Homework</td>
<td>10%</td>
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<tr>
<td>Midterms</td>
<td>35% (17.5% each)</td>
</tr>
<tr>
<td>Project</td>
<td>20%</td>
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<tr>
<td>Final</td>
<td>35%</td>
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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, located in 202 CC, gives free tutorial assistance to students in 22S:2, 8, 25, and 39. In addition, several graduate students have volunteered to independently tutor students in various 22S: 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 Procedures

The CLAS policies and procedures are stated at the following link:
http://www.clas.uiowa.edu/faculty/teaching/policies.shtml

6 Syllabus

This is an approximate schedule. I will update it as needed during the semester. “Cowles” in reading assignments refers to my draft textbook, available on the ICON web page.

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
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<tbody>
<tr>
<td>08/22 - 08/26</td>
<td>Review of probability and Bayes’ theorem</td>
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<tr>
<td>Lab Fri. 8/27</td>
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<tr>
<td>Reading: Cowles, Chapters 1 and 2</td>
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<tr>
<td>08/20 - 09/02</td>
<td>Bayesian inference for proportions</td>
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<tr>
<td>Reading: Cowles, Chapter 3</td>
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<tr>
<td>09/07 - 09/09</td>
<td>Summarizing posterior distributions</td>
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<td>09/05 Labor Day; no class</td>
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<tr>
<td>Lab Fri. 09/09</td>
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<tr>
<td>Reading: Cowles, Chapters 4 and 5</td>
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09/12 - 09/16  Other 1-parameter models  
Reading: Cowles, Chapters 5 and 6
09/19 - 09/23  Intro to multiparameter models  
Lab Fri. 09/23  
Reading: Cowles, Chapter 7
09/26 - 09/30  Bayesian computing  
Reading: Cowles, Chapter 8
10/03 - 10/07  Hierarchical models  
Lab Fri. 10/07  
Midterm 1  
Reading: Cowles, Chapter 9; selections from OpenBUGS manual
10/10 - 10/14  Hierarchical models; More Bayesian computing  
Albert, selected sections
10/17 - 10/21  Bayesian Regression  
Reading: Cowles, Chapter 10  
Lab Fri. 10/21
10/24 - 10/28  Hierarchical regression models  
Reading: Cowles, Chapter 11
10/31 - 11/04  Hierarchical, continued; model checking and comparison  
Project proposals due Mon. 10/31  
Lab. Wed. 11/02  
Midterm 2  
Reading: Cowles, Chapter 12
11/07 - 11/11  Hypothesis testing, etc. continued
11/14 - 11/18  Special topics  
Project interim reports due Wed. 11/16  
Lab. Fri. 11/18  
Reading: Cowles, Chapter 13
11/21 - 11/25  No class
11/28 - 12/02  Special topics; nonparametric Bayes methods
12/05 - 12/09  Project presentations and review  
Projects due 12/05  
Lab Fri. 12/09
12/15  Final exam, noon