

Bayesian Statistics, 22S:138
Fall 2008

1 General Information

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| Instructor: | Kate Cowles, 374 SH, 335-0727 kcowles@stat.uiowa.edu |
| Office hours: | T 1:30 - 2:20 p.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: | Luke Tierney, 241 SH, 335-0712 |
| Lectures: | M, W, F 11:30 - 12:20 66 SH |
| Lab: | Alternate F 11:30 - 12:20 41 SH |
| Web page: | http://www.stat.uiowa.edu/~kcowles/s138_2008 Handouts, homework assignments, datasets, etc. will be posted on the web page for you to download. |
| Textbook: | Gelman, Carlin, Stern, and Rubin, <i>Bayesian Data Analysis</i> 2nd ed., Chapman & Hall/CRC, 2004 |
| On reserve: | Berry, <i>Statistics: A Bayesian Perspective</i> Math Sciences Library 125 MacLean Hall Johnson and Albert, <i>Ordinal Data Modeling</i> http://libres.lib.uiowa.edu/math/ Lee, <i>Bayesian Statistics: An Introduction</i> Carlin and Louis, <i>Bayes and Empirical Bayes Methods for Data Analysis</i> WinBUGS manuals |

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 WinBUGS 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 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 WinBUGS
 - 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 11/03)
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 11/19)
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 12/08)
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 4 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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| Midterm 1 | Fri. 10/03 | in class |
| Midterm 2 | Fri. 10/31 | in class |
| Final | Tues. 12/16 | 12:00 |

3.4 Grading

The course components will be weighted as follows:

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| 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, 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

5.1 Administrative Home of the Course

The administrative home of this course is the College of Liberal Arts and Sciences, which governs academic matters relating to the course such as the add/drop deadlines, the second-grade-only option, issues concerning academic fraud or academic

probation, and how credits are applied for various graduation requirements. Different colleges might have different policies. If you have questions about these or other CLAS policies, visit your academic advisor or 120 Schaeffer Hall and speak with the staff. The CLAS Academic Handbook also contains important CLAS academic policies: www.clas.uiowa.edu/students/academic_handbook/index.shtml

5.2 Academic Fraud

Plagiarism and any other activities that result in a student presenting work that is not his or her own are academic fraud. Academic fraud is reported to the departmental DEO and then to the Associate Dean for Academic Programs and Services in the College of Liberal Arts and Sciences who deals with academic fraud according to these guidelines: www.clas.uiowa.edu/students/academic_handbook/ix.shtml

5.3 Making a Suggestion or a Complaint

Students have the right to make suggestions or complaints and should first visit with the instructor, then with the course supervisor if appropriate, and next with the departmental DEO. All complaints must be made within six months of the incident. www.clas.uiowa.edu/students/academic_handbook/ix.shtml#5

5.4 Accommodations for Disabilities

A student seeking academic accommodations first must register with Student Disability Services and then meet with an SDS counselor who determines eligibility for services. A student approved for accommodations should meet privately with the course instructor to arrange particular accommodations. www.uiowa.edu/~sds/

5.5 Understanding Sexual Harassment

Sexual harassment subverts the mission of the University and threatens the well-being of students, faculty, and staff. Visit www.sexualharassment.uiowa.edu/ for definitions, assistance, and the full policy.

5.6 Reacting Safely to Severe Weather

The University of Iowa Operations Manual section 16.14 outlines appropriate responses to a tornado (i) or to a similar crisis. If a tornado or other severe weather is indicated by the UI outdoor warning system, members of the class should seek shelter in rooms and corridors in the innermost part of a building at the lowest level, staying clear of windows, corridors with windows, or large free-standing expanses such as

auditoriums and cafeterias. The class will resume, if possible, after the UI outdoor warning system announces that the severe weather threat has ended.

5.7 Student Classroom Behavior

The ability to learn is lessened when students engage in inappropriate classroom behavior, distracting others; such behaviors are a violation of the Code of Student Life. When disruptive activity occurs, a University instructor has the authority to determine classroom seating patterns and to request that a student exit the classroom, laboratory, or other area used for instruction immediately for the remainder of the period. One-day suspensions are reported to appropriate departmental, collegiate, and Student Services personnel (Office of the Vice President for Student Services and Dean of Students).

5.8 University Examination Policies

5.8.1 Missed Exam Policy

University policy requires that students be permitted to make up examinations missed because of illness, mandatory religious obligations, certain University activities, or unavoidable circumstances. Excused absence forms are required and are available on the Registrar web site. www.registrar.uiowa.edu/forms/absence.pdf

5.8.2 Final Examinations

An undergraduate student who has two final examinations scheduled for the same period or more than three examinations scheduled for the same day may file a request for a change of schedule before the published deadline at the Registrar's Service Center, 17 Calvin Hall, 8-4 M-F, (384-4300).

6 Syllabus

This is an approximate schedule. I will update it as needed during the semester.

08/25 - 08/29 Review of probability and Bayes' theorem
 Lab Fri. 8/29
 Reading: Berry Chapters 4 and 5

09/03 - 09/08 Bayesian inference for proportions
 09/01 Labor Day; no class
 Reading: GCSR, Section 2.1 - 2.5

09/10 - 09/12 Summarizing posterior distributions
 Lab Fri. 09/12

09/15 - 09/19 Other 1-parameter models
 Reading: GCSR Section 2.6-2.9

09/22 - 09/26 Intro to multiparameter models
 Lab Fri. 09/26
 Reading: GCSR Ch 3

09/29 - 10/03 Bayesian computing
 Midterm 1
 Reading: GCSR Ch 10 and GCSR Sections 11.1-11.6, 11.10

10/06 - 10/10 Hierarchical models
 Lab Fri. 10/10
 Reading: GCSR, Ch. 5
 selections from WinBUGS manual

10/13 - 10/17 Hierarchical models; More Bayesian computing

10/20 - 10/24 Bayesian Regression
 Reading: GCSR Ch 14
 Lab Fri. 10/24

10/27 - 10/31 Hierarchical regression models
 Midterm 2

11/03 - 11/07 Hierarchical, continued; model checking and comparison
 Project proposals due Mon. 11/03
 Lab. Fri. 11/07
 Reading: GCSR Ch. 6

11/10 - 11/14 Hypothesis testing, etc. continued

11/17 - 11/21 Special topics
 Project interim reports due Wed. 11/19
 Lab. Fri. 11/21
 Reading: Lee Ch 7

11/24 - 11/28 No class

12/01 - 12/05 Special topics; empirical Bayes methods
 Reading: Carlin and Louis, Ch. 3

12/08 - 12/12 Project presentations and review
 Projects due 12/08
 Lab Fri. 12/12

12/16 Final exam, 12:00 noon