

# Bayesian Statistics, STAT 4520 (22S:138)

## Fall 2016

### 1 General Information

Instructor: Kate Cowles, 374 SH, 335-0727  
kate-cowles@uiowa.edu

Office hours: T 1:30 - 2:20 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: Joe Lang, 241 SH, 335-0712  
joseph-lang@uiowa.edu

Lectures: M, W, F 12:30 - 1:20 112 MH  
Lab: Some M & F 12:30 - 1:20 41 SH  
Web page: icon.uiowa.edu  
Textbook: Cowles, *Applied Bayesian Statistics*  
Albert, *Bayesian Computation with R*  
(free electronic access for both 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 communicating 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 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 home-

work 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 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 11/14)

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:

Midterm 1	Fri. 09/23	in class
Midterm 2	Fri. 11/04	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](http://www.stat.uiowa.edu/courses/tutoring.html) for tutoring details.

## 5 College of Liberal Arts and Sciences: Policies and Resources

### Administrative Home

The College of Liberal Arts and Sciences is the administrative home of this course and governs matters such as the add/drop deadlines, the second-grade-only option, and other related issues. Different colleges may have different policies. Questions may be addressed to 120 Schaeffer Hall, or see the CLAS Academic Policies Handbook at <http://clas.uiowa.edu/students/handbook>.

### Electronic Communication

University policy specifies that students are responsible for all official correspondences sent to their University of Iowa e-mail address (@uiowa.edu). Faculty and students should use this account for correspondences (Operations Manual, III.15.2, k.11).

### Accommodations for Disabilities

The University of Iowa is committed to providing an educational experience that is accessible to all students. A student may request academic accommodations for a disability (which include but are not limited to mental health, attention, learning, vision, and physical or health-related conditions). A student seeking academic accommodations should first register with Student Disability Services and then meet with the course instructor privately in the instructor's office to make particular arrangements. Reasonable accommodations are established through an interactive process between the student, instructor, and SDS. See <http://sds.studentlife.uiowa.edu/>.

## Academic Honesty

All CLAS students or students taking classes offered by CLAS have, in essence, agreed to the College's Code of Academic Honesty: "I pledge to do my own academic work and to excel to the best of my abilities, upholding the IOWA Challenge. I promise not to lie about my academic work, to cheat, or to steal the words or ideas of others; nor will I help fellow students to violate the Code of Academic Honesty." Any student committing academic misconduct is reported to the College and placed on disciplinary probation or may be suspended or expelled (CLAS Academic Policies Handbook).

## CLAS Final Examination Policies

The final examination schedule for each class is announced by the Registrar generally by the fifth week of classes. Final exams are offered only during the official final examination period. No exams of any kind are allowed during the last week of classes. All students should plan on being at the UI through the final examination period. Once the Registrar has announced the date, time, and location of each final exam, the complete schedule will be published on the Registrar's web site and will be shared with instructors and students. It is the student's responsibility to know the date, time, and place of a final exam.

## Making a Suggestion or a Complaint

Students with a suggestion or complaint should first visit with the instructor (and the course supervisor), and then with the departmental DEO. Complaints must be made within six months of the incident (CLAS Academic Policies Handbook).

## Understanding Sexual Harassment

Sexual harassment subverts the mission of the University and threatens the well-being of students, faculty, and staff. All members of the UI community have a responsibility to uphold this mission and to contribute to a safe environment that enhances learning. Incidents of sexual harassment should be reported immediately. See the UI Office of the Sexual Misconduct Response Coordinator for assistance, definitions, and the full University policy.

## Reacting Safely to Severe Weather

In severe weather, class members should seek appropriate shelter immediately, leaving the classroom if necessary. The class will continue if possible when the event is over. For more information on Hawk Alert and the siren warning system, visit the Department of Public Safety website.

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

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

## 6 Syllabus

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

08/22 - 08/26 Review of probability and Bayes' theorem  
 Lab Fri. 8/26  
 Reading: Cowles, Chapters 1 and 2

08/29 - 09/02 Bayesian inference for proportions  
 Reading: Cowles, Chapter 3

09/05 - 09/09 Summarizing posterior distributions  
 09/05 Labor Day; no class  
 Lab Fri. 09/09  
 Reading: Cowles, Chapters 4 and 5

09/12 - 09/16 Other 1-parameter models  
 Reading: Cowles, Chapters 5 and 6

09/19 - 09/23 Intro to multiparameter models  
 Reading: Cowles, Chapter 7  
 Midterm 1, Fri. 09/23

09/26 - 09/30 Bayesian computing  
 Reading: Cowles, Chapter 8  
 Lab Mon. 09/26

10/03 - 10/07 Hierarchical models  
 Lab Fri. 10/07  
 Reading: Cowles, Chapter 9; selections from OpenBUGS manual

10/10 - 10/14 Hierarchical models; More Bayesian computing  
 Reading: Cowles, Chapter 9; 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 10

10/31- 11/04 Hierarchical, continued; model checking and comparison  
 Project proposals due Mon. 10/31  
 Midterm 2, Fri. 11/04  
 Reading: Cowles, Chapter 11

11/07 - 11/11 Hypothesis testing, etc. continued  
 Lab Mon. 11/07

11/14 - 11/18 Special topics  
 Project interim reports due Mon. 11/14  
 Lab. Fri. 11/18

11/21 - 11/25 No class  
 Happy Thanksgiving!

11/28 - 12/02 Special topics; Review

12/05 - 12/09 Project presentations  
 Projects due 12/05  
 Lab Fri. 12/09

Finals week Final exam, TBA