SYLLABUS

STAT 3303: Bayesian Analysis and Statistical Decision Making
(3 credit hours)

Spring Semester 2018

Instructor
Professor Kate Calder
Office: 354A Jennings Hall and 429 Cockins Hall
Email: calder@stat.osu.edu (please contact me via Carmen, if possible)
Office Hours: M 1:45-2:45PM, Th 1:45-2:45PM, and by appointment in 354A
                  Jennings Hall

TA
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Course Description
This course is an introduction to Bayesian analysis and statistical decision theory, the theory of making decisions in the presence of uncertainty. Topics covered include the formulation of decision problems and the quantification of their components, optimal decisions, Bayesian modeling, simulation-based approaches to obtaining Bayesian inferences (including MCMC algorithms), and hierarchical modeling.

Upon successful completion of the course, students will be able to
   1. Formulate the inputs to a decision problem including potential actions, losses and gains, and quantification of uncertainty.
   2. Develop Bayesian statistical models to quantify uncertainty and obtain inferences on unknown model parameters.
   3. Use posterior distributions to obtain optimal decisions based on available information.
   4. Assess the impacts of departures from model assumptions on inferences and decisions.
   5. Explain Bayesian statistical analyses to others, such as managers and other decision makers.

List of Topics
1. Probability as a measure of uncertainty
       a. Review of mathematical theory of probability
       b. Frequentist vs. subjective interpretation of probability
       c. Probability and decision making

  d. Conditional probability

  e. Bayes' theorem

2. Bayesian inference

  a. Prior and posterior distributions

  b. Inferring a binomial probability

  c. Summarizing posterior distributions via simulation

  d. Conjugate distributions

  e. Assessing the influence of a prior distribution

  f. Posterior predictive distributions

  g. Multi-parameter models

  h. Markov chain Monte Carlo and JAGS

  i. Hierarchical models

  j. Model comparison

3. Introduction to decision theory

  a. Actions, losses, and gains

  b. Risk and optimality

  c. Utility

  d. Value of information

4. Statistical decision theory

  a. Review of classical hypothesis testing and its limitations

  b. Using posterior distributions for decision making

  c. Posterior expected loss vs. Bayes risk

  d. Finding optimal Bayes actions and computation over decision trees

Prerequisites

C- or better in STAT 3202: Introduction to Statistical Inference for Data Analytics, or permission of instructor.

Class Meetings Lecture: MWF from 9:10-10:05AM in Lazenby Hall #034

Class meetings will consist of a mix of lectures, in-class exercises, and informal discussions. Students are expected to attend all class meetings and actively participate in discussions.

Course Materials

All course materials (including reading and homework assignments) will be available on the course Carmen page (http://www.carmen.osu.edu).

Textbook

Doing Bayesian Data Analysis: A Tutorial with R, JAGS, and Stan, 2nd Edition (2015)

By John K. Kruschke

ISBN: 978-0-12-405888-0

The OSU library has a e-book version of text available.

Computing

We will be primarily using the R statistical computing environment throughout the course. Prior experience with R is expected. Students needing a review of

programming using R should read Chapter 3 of the textbook carefully and consult the instructor for additional resources, if necessary. We will also be using the Just Another Gibbs Sampler (JAGS) software, accessed through an interface with R. No prior experience with JAGS is expected.

Attendence
Regular attendance and class participation is required. Please let the instructor know by via a Carmen email if you will miss any lectures.

Assignments and Assessment
Homework assignments will be given approximately every week. Students are expected to turn in hard copies of homework assignments at the beginning of class on the day the assignment is due. Submitted homework may be typed or handwritten, or some combination of the two. Figures and tables should be clearly referenced. All R/JAGS code should be submitted as an appendix or you may use R Markdown to prepare you assignment. Homework extensions of one business day will be granted with *prior permission from the instructor*. Requests for homework extensions should be sent via Carmen email. *Only in exceptional circumstances will homework extensions longer than one day be granted.* The lowest homework grade will be dropped.

There will be two midterm exams, tentatively scheduled for Friday, Feb. 9, 2018 (Midterm Exam 1) and Friday, March 30, 2018 (Midterm Exam 2). The second exam will be cumulative, but will emphasize the material covered after the first midterm exam.

An individual final project will be assigned several weeks prior to the end of the semester and will be due by 5:00PM on Friday, April 27th.

- **Homework** (25% of final grade)

- **Midterm Exam 1** (20% of final grade)

- **Midterm Exam 2** (20% of final grade)

- **Final Project** (30% of the final grade)

- **Participation** (5% of final grade)

Special Accommodations
Students with disabilities (including mental health, chronic or temporary medical conditions) that have been certified by the Office of Student Life Disability Services will be appropriately

accommodated and should inform the instructor as soon as possible of their needs. The Office of Student Life Disability Services is located in 098 Baker Hall, 113 W. 12th Avenue; telephone 614-292-3307, slds@osu.edu.

Academic Misconduct
It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct http://studentlife.osu.edu/csc/.

Diversity Statement
The Ohio State University affirms the importance and value of diversity in the student body. Our programs and curricula reflect our multicultural society and global economy and seek to provide opportunities for students to learn more about persons who are different from them. We are committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters sensitivity, understanding, and mutual respect among each member of our community; and encourages each individual to strive to reach his or her own potential. Discrimination against any individual based upon protected status, which is defined as age, color, disability, gender identity or expression, national origin, race, religion, sex, sexual orientation, or veteran status, is prohibited.