STAT 7630: BAYESIAN STATISTICS
Course Syllabus

CONTACT INFORMATION:

Instructor	Elvan Ceyhan
Office	203 Extension Hall
Office Hours	Tuesday 11:00 am – 12:00 pm or by appointment
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TIME & PLACE: Tu-Th 9:30 am - 10:45 am Parker Hall 246

Description and Objectives: This is a course in Bayesian statistics. Bayesian inference is a powerful and increasingly popular statistical approach, which allows one to deal with complex problems in a conceptually simple and unified way. The recent introduction of Markov Chain Monte Carlo (MCMC) simulation methods has made possible the solution of large problems in Bayesian inference that were formerly intractable. This course will introduce the student to the basic methods and techniques of modern Bayesian inference, including parameter estimation, MCMC simulation, hypothesis testing, and model selection/model averaging in the context of practical problems. Additional topics may vary. Coursework will include computer coding as well.

After taking this course, successful students should be able to • Understand the philosophy of Bayesian statistical modeling • Understand Bayesian models for numerous common data analysis situations, including prior elicitation • Understand basic principles of both conjugate analyses and MCMC-based Bayesian analyses • Simulate values from posterior distributions and make appropriate Bayesian inference. • Use a statistical computer package to implement the procedures covered in the course.

Credit Hours: This course is a 3-credit course, which means that students are expected to do at least 9 - 9.5 hours of course-related work or activity each week during the semester. This includes (where applicable) scheduled class lecture/discussion meeting times as well as time spent completing assigned readings, studying for tests and examinations, participating in lab sessions, preparing written assignments, and other course-related tasks.

TEXT:
Required: *Bayes Rules! An Introduction to Applied Bayesian Modeling*, by Alicia A. Johnson, Miles Q. Ott, Mine Dogucu. CRC Press, 2022. Online version available at: https://www.bayesrulesbook.com

Recommended (i.e., Optional):
Bayesian Computation with R, 2nd ed. (Springer), by Albert, J.

Introducing Monte Carlo Methods with R (Springer), by Robert, C.P. and Casella, G.

Doing Bayesian Data Analysis, Second Edition, by Kruschke, John K. Academic Press, 2015.

Introduction to Statistical Thought (Michael Lavine), available as a free web download at https://people.math.umass.edu/~lavine/Book/book.html.

PREREQUISITE: STAT 3600 or STAT 3610 (Minimum Grade of C in either of them)

COURSE WEBSITE: posted under *Canvas*

SOFTWARE: The *R* software will extensively be used in this class; however, you are free to use any software of your choice. *R* can be downloaded for free from http://www.r-project.org or *RStudio* from https://www.rstudio.com.

HOMEWORK: At least one homework will be assigned at the conclusion of each chapter. Due to the computational nature of HW in this course, it is highly encouraged to prepare HW assignments in *R markdown*,

or some similar software.

EXAMS (tentative): There will be one midterm and one final exam. MT is scheduled to be in mid-October. If MT is during the class time in the regular classroom, one 8.5×11 formula sheet (both sides) is allowed for each midterm (MT) exam and two such sheets (both sides for each) are allowed for the final exam. Exams can also have an in-class and take-home component.

GRADING: Homework (20%), MT (40% each), Final (40%).

COURSE CONTENT (Tentative): Topics covered include:
Introduction to Bayesian Thinking: a. Prior and Posterior Distributions b. Prediction
Single-Parameter Models: a. Inference about proportion and mean b. Conjugate priors c. Prediction intervals
Multiparameter Models: a. Normal data with both parameters unknown b. Comparing two proportions.
Bayesian Computation: a. Rejection Sampling b. Importance Sampling c. Sampling Importance Resampling
Markov Chain Monte Carlo Methods: a. Discrete Markov Chains b. Metropolis-Hastings Algorithms c. Gibbs Sampling
Hierarchical Model: a. Modeling a Prior belief of Exchangeability b. Simulating from the Posterior c. Posterior Inferences
Model Comparison: a. Comparison of Hypothesis b. Test of a Normal Mean c. Comparing Two Models d. A Test of Independence in a Two-Way Contingency Tables

Course Policies

Attendance: You are strongly encouraged to attend classes on a regular basis. You will be held responsible for all the material that is covered in class.
Working Together: You may work together on homework, and are encouraged to do so, unless otherwise instructed. You must, however, write up and submit your own work.
Makeup: You will not be allowed to make-up missed exams except under extraordinary circumstances. If you know that you will miss an exam, please let me know in advance.
Late Work: Late homework/lab has a half-life of 24 hours; that is, you receive 50% credit if work is submitted within 24 hours of the due time. You will not receive credit after that.

- **Policies on Class Attendance, Submission of Late Written Assignments, Missed In-Class Work and Missed Examinations:**
  - **Excused Absences:** Students are granted excused absences from class for the following reasons: Illness of the student or serious illness of a member of the student's immediate family, death of a member of the student's immediate family, trips for student organizations sponsored by an academic unit, trips for University classes, trips for participation in intercollegiate athletic events, subpoena for a court appearance and religious holidays. Students who wish to have an excused absence from this class for any other reason must contact the instructor in advance of the absence to request permission. The instructor will weigh the merits of the request and render a decision. When feasible, the student must notify the instructor prior to the occurrence of any excused absences, but in no case shall such notification occur more than one week after the absence. Appropriate documentation for all excused absences is required.
  - **Make-Up Policy:** We jointly will decide to take the proper action and/or make up missed major examinations (e.g., hour exams, mid-term exams) due to properly authorized excused absences. Except in unusual circumstances, such as continued absence of the student or the advent of University holidays, a make-up exam will take place within two weeks from the time the student initiates arrangements for it. Except in extraordinary circumstances, no make-up exams will be arranged during the last three days before the final exam period begins. The format of the make-up exam will be (as specific by the instructor).
- **Email and Canvas Use:** Students have control of the notification settings in their Canvas accounts. You should set up their notifications to alert them when an Announcement is posted, an Assignment is

due, a grade is released, etc. For students new to Canvas, save time (and emails) by sharing this link to a 7 minute "Getting Started with Canvas" video (and transcript) (Links to an external site.) created by Canvas LMS. In order to protect your privacy, all course e-mail correspondence must be done through a valid AU account.

- **Provisions of the Americans with Disabilities Act:** Students who need accommodations are asked to electronically submit their approved accommodations through AU Access and to make an individual appointment with the instructor during the first week of classes – or as soon as possible if accommodations are needed immediately. If you have not established accommodation through the Office of Accessibility, but need accommodation, make an appointment with the Office of Accessibility, 1228 Haley Center, 844-2096 (V/TT).

- **Classroom Behavior:** The Auburn University Classroom Behavior Policy is strictly followed in the course; please refer to the Student Policy eHandbook for details of this policy and the Policy on Classroom Behavior.
- **Emergency Contingency Plan:** If normal class and/or lab activities are disrupted due to illness, emergency, or crisis (such as an H1N1 flu outbreak), the syllabus and other course plans and assignments may be modified to allow completion of the course. If this occurs, an addendum to your syllabus and/or course assignments will replace the original materials.
- **Students with Disabilities:** Students who need accommodations are asked to electronically submit their approved accommodations through AU Access and to arrange a meeting during office hours the first week of classes, or as soon as possible if accommodations are needed immediately. If you have a conflict with my office hours, an alternate time can be arranged. To set up this meeting, please contact me by e- mail. If you have not established accommodation through the Office of Accessibility, but need accommodation, make an appointment with the Office of Accessibility, 1228 Haley Center, 844-2096.
- **Academic Dishonesty:** Auburn University expects that all students have read and understood the University's Code of Student Conduct and that all students will complete all assignments with fairness and honesty. Failure to follow the rules in the University's Code of Conduct may result in academic misconduct and being reported to the appropriate committee. If the committee determines an academic misconduct happened, the sanctions for the act can include a failing grade in the course and suspension or dismissal from the University.
- **AI Policy:** *Permitted in this Course with Attribution:* In this course, students are allowed to use Generative AI Tools like ChatGPT to support their work. To maintain academic integrity, students must disclose any AI-generated material they use and properly attribute it, including in-text citations, quotations, and references (such attribution and acknowledgement is also required any other online tool or book or written work). Students should exercise caution and avoid sharing any sensitive or private information when using these tools. Examples of such information include personally identifiable information (PII), protected health information (PHI), financial data, intellectual property (IP), and any other data that might be legally protected.

  A student should include the following statement in assignments to indicate use of a Generative AI Tool: "The author(s) would like to acknowledge the use of [Generative AI Tool Name], a language model developed by [Generative AI Tool Provider], in the preparation of this assignment. The [Generative AI Tool Name] was used in the following way(s) in this assignment [e.g., brainstorming, grammatical correction, citation, which portion of the assignment]."