Syllabus

Course Description

Welcome to Advanced Bayesian Modeling! This course explores practical methods and models for Bayesian data analysis. The major topics include Bayesian fundamentals, prior selection, posterior inference tools, hierarchical models, methods of Bayesian computation, model evaluation, and ordinary and generalized regression models. In particular, there will be an emphasis on computational implementation. To be successful in this course, we recommend that you have taken STAT 420 and are comfortable using R.

Course Goals and Objectives

Upon successful completion of this course, you will be able to:

- Comprehend the implications of Bayes' rule and summaries of a Bayesian posterior distribution.
- Formulate appropriate Bayesian models, including data and prior distributions.
- Use R and JAGS for Bayesian Monte Carlo simulation.
- Assess Bayesian models through posterior predictive checking.
- Evaluate and compare Bayesian models.
- Apply hierarchical modeling and regression in a Bayesian framework.

Required Textbook

Andrew Gelman, John B. Carlin, Hal S. Stern, David B. Dunson, Aki Vehtari, and Donald B. Rubin. *Bayesian Data Analysis*, Third Edition, 2013, CRC Press.

This textbook will be used throughout the course, and it will commonly be referred to as BDA3 in the lectures.

Course Outline

This 4-credit hour course has 15 weeks of activities. You should invest 10-12 hours every week in this course.

Week	Duration	Topics
1		Orientation, Bayesian Fundamentals and Tools
2		Bayesian Analysis for Normal Samples

3	Hierarchical Models, Part I
4	Hierarchical Models, Part II
5	Monte Carlo Approximations to Bayesian Tools
6	Exam 1
7	Principles of Markov Chain Monte Carlo
8	Markov Chain Monte Carlo in Practice
9	*Spring Break*
10	Model Checking
11	Bayesian Linear Regression
12	Model Evaluation and Comparison
13	Exam 2
14	Hierarchical Linear Models
15	Generalized Linear Models, Part I
16	Generalized Linear Models, Part II

Assignment Deadlines

For all assignment deadlines, please refer to the **Course Deadlines, Late Policy, and Academic Calendar** page.

Elements of This Course

The course is comprised of the following elements:

- **Lecture Videos.** In each week, the concepts you need to know will be presented through a collection of short video lectures. You may stream these videos for playback within the browser by clicking on their titles or download the videos. You may also download the slides that go along with the videos. **The videos usually total 1 to 1.5 hours each week.** You generally should spend at least the same amount of time digesting content in the video. The actual amount of time needed to digest the content will vary based on your background.

- **Readings.** Each week has a list of required and optional readings from the textbook. The required readings contain information essential for successfully completing the quizzes, exams, and course assignments. Optional readings may add useful context or further details on a required topic, but you will not be assessed on material in the optional readings. The actual amount of time needed to digest the readings will vary based on your background.
- **Orientation Quiz.** The purpose of the orientation quiz is to ensure that you have gone through the orientation module and acquired the necessary information about the course before you start it. The orientation quiz is a required activity, but it's not part of the course grading. You have unlimited attempts on the orientation quiz. You need to answer all questions correctly in order to pass the orientation quiz.
- **Pre-requisite Quiz.** The purpose of the pre-requisite quiz is to ensure that you are up-to-speed on the knowledge you're expected to have prior to taking this course. You have unlimited attempts to take the pre-requisite quiz, and though it is not required or part of your final grade, we recommend that you understand the content covered in all of the quiz questions. Videos from STAT 420 will be provided for your review when possible.
- **Graded Quizzes**. Each week that has required content concludes with a graded quiz. You have unlimited attempts for each graded quiz with your highest attempt score used toward your final grade. There is no time limit on how long you take to complete each attempt at the quiz. Graded quizzes will be used when calculating your final score in the class.
- **Problem Sets.** There are 5 total problem sets in this course, each of which you can expect to invest 4-6 hours toward completing. Please be aware that you have **1 attempt** to submit the assignment for staff grading. For more information about these assignments, please read the instructions for each assignment in their respective weeks.
- **Proctored Exams**. There are 2 proctored exams in this class. The exams will be proctored via a proctoring service called ProctorU. For more information about ProctorU and the proctored exams, read the lesson named **ProctorU Exams**.
- **Paper Presentation**. You are required to work on your own (no collaboration allowed) for the paper presentation. In the paper presentation, you will be randomly assigned a published research paper. You are required to produce a video (voice-over slideshow) detailing certain specified essentials of the paper. The video is limited to 5 to 10 minutes. Your presentation will be reviewed by your peers, and graded based on peer's evaluation.
- **Data Analysis Report**. You are required to work on your own (no collaboration allowed) for the data analysis report. In the data analysis report, you will be provided with a given data set. You are required to perform a specified analysis (on your own), and provide results and code. The report will be graded by course staff.

Grading Distribution and Scale

Grading Distribution

Your final grade will be calculated based on the activities listed in the table below. Your official final course grade will be listed in Self-Service. The course grade you see displayed in Coursera may not match your official final course grade.

Assignment	Occurrence	Percent of the Final Grade
Weekly Quizzes	13	10%
Problem sets	5	30% (6% each)
Exams	2	40% (20% each)
Paper Presentation	1	6%
Data Analysis Report	1	14%

Grading Scale

Letter Grade	Percent Needed	Letter Grade	Percent Needed	Letter Grade	Percent Needed
A+	**95%**	**B+**	**85%**	**C**	**70%**
A	**90%**	**B**	**80%**	**D**	**60%**
A-	**88%**	**B-**	**78%**	**F**	**Below 58%**

Student Code and Policies

A student at the University of Illinois at the Urbana-Champaign campus is a member of a University community of which all members have at least the rights and responsibilities common to all citizens, free from institutional censorship; affiliation with the University as a student does not diminish the rights or responsibilities held by a student or any other community member as a citizen of larger communities of the state, the nation, and the world. See the University of Illinois Student Code for more information.

Academic Integrity

All students are expected to abide by the campus regulations on academic integrity found in the Student Code of Conduct. These standards will be enforced and infractions of these rules will not be tolerated in this course. Sharing, copying, or providing any part of a homework solution or code is an infraction of the University's rules on academic integrity. We will be actively looking for violations of this policy

in homework and project submissions. Any violation will be punished as severely as possible with sanctions and penalties typically ranging from a failing grade on this assignment up to a failing grade in the course, including a letter of the offending infraction kept in the student's permanent university record.

Again, a good rule of thumb: *Keep every typed word and piece of code your own*. If you think you are operating in a gray area, you probably are. If you would like clarification on specifics, please contact the course staff.

Use of Generative Artificial Intelligence

While use of artificial intelligence (AI) tools is not always prohibited in your course work, it is subject to regulations. In particular:

- During the Exams, you are not allowed to use any AI tools.
- You must follow all policies regarding AI that appear in the instructions of any course assessment.
- Whenever you use AI contributions in submitted course work, you must document and attribute them in your submission.
- You should check the accuracy of all informational items generated by AI, including factual statements, data, citations, and quotations. You are responsible for all aspects of the work you submit, even if you used generative AI as a source.
- If you fail to abide by any course guidelines regarding AI use, that may be a violation of academic integrity, and it will be subject to investigation and sanction in accordance with the Illinois Student Code.
- You are strongly encouraged to keep records of your use of AI tools in connection with this course, including the services that you use and the prompts you submit.

More information can be found in the University of Illinois System Generative AI Guidance for Students.

Disability Accommodations

Students with learning, physical, or other disabilities requiring assistance should contact the instructor as soon as possible. If you're unsure if this applies to you or think it may, please contact the instructor and Disability Resources and Educational Services (DRES)

as soon as possible. You can contact DRES at 1207 S. Oak Street, Champaign, via phone at (217) 333-1970, or via email at disability@illinois.edu.