George Mason University
College of Education and Human Development
Educational Psychology and Research Methods

EDRS 897 001– Specific Topic: Bayesian Data Analysis
3 Credits, Fall 2021
Thursdays, 4:30-7:10 PM
Thompson Hall L014

Faculty

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Prerequisites/Corequisites

B or higher and satisfactory completion of EDRS 811 (or equivalent).

University Catalog Course Description

Develops knowledge and skills of the Bayesian perspective on data analysis and inference for researchers and practitioners in the social and behavioral sciences.

Course Overview

This is a course that introduces a Bayesian perspective on data analysis and inference for researchers and practitioners in the social and behavioral sciences. We discuss the fundamental concepts of the Bayes theorem, differences between Bayesian and frequentist reasoning, and the choice of prior beliefs to integrate the subjective knowledge in the data analysis. Next, we talk about Bayesian computational algorithms (MCMC) and statistical software to easily do MCMC. Then the course will be devoted to the applications of the Bayesian methodology to solve real-life research questions from education and social sciences.

Course Delivery Method

The class sessions will include lecture, small group discussion, and presentation of final projects. Questions are encouraged. The lab portion of the class will provide time for hands-on computer work that is directly related to the homework and course goals.

Learner Outcomes or Objectives

By the end of the course, students should be able to:

1. Articulate historical and theoretical background of Bayesian approach as compared to frequentist approach.
2. Understand the reporting of Method & Analysis sections of empirical articles that utilize Bayesian data analysis in their area of interest.
3. Analyze data and fit models using R and JAGS by themselves.
4. Interpret findings from the perspective of an applied Bayesian statistician.
5. Determine under what circumstance it is beneficial to use Bayesian methods to solve their research questions in real-life setting.

Computing

Primarily, this course will use R (https://www.r-project.org/), a free software environment for statistical computing, R package "BRMS" (Bayesian Regression Models using 'Stan') (https://cran.r-project.org/package=brms), and JAGS (Just Another Gibbs Sampler) (http://mcmc-jags.sourceforge.net/), a programming language specialized for Bayesian modeling. Prior experience in R is desired but not required.

Professional Standards

Not applicable

Required Texts

Kruschke, J. (2015). *Doing Bayesian Data Analysis: A Tutorial with R, JAGS, and Stan*. (Second edition.). Academic Press is an imprint of Elsevier.

Course Performance Evaluation

Students are expected to submit all assignments on time in the manner outlined by the instructor.

1. **Online Quizzes (5%):** There will be a short quiz posted on Blackboard after the meetings. The quizzes are composed of short answer (and multiple-choice) items which will cover the basic concepts presented in class and in the textbook. These quizzes are designed to provide you (and me) with feedback about your course progress. Your quiz score cannot lower your overall course grade (unless you have received 0's on quizzes due to failure to complete them). You must complete the online quiz by Wednesdays at midnight.

2. **Homework Assignments (20%):** There will be 6 homework assignments. Assignments will be posted on Thursdays. All assignments need to be completed by Wednesdays at midnight. No late assignments will be accepted. Some questions will ask you to explain Bayesian concepts, some will ask you to work out problems, and others will require you to run analyses using Bayesian software (e.g., JAGS) and interpret results. You should show all of your work for any problem that you complete and include appropriate computer printouts (please cut and

paste to Word). You may work together on your assignments; however, students should submit their own independent write-up of results. You may work together on your assignments; however, you should submit your own independent write-up of results.

3. **Mid-term Exam (30%):** A Mid-term exam will cover the materials from the class, textbook, and empirical journal articles that report the results of Bayesian data analysis.

4. **Final Project (30%):** A team project will be due at the end of the semester. Specifications about the project topics, format, and evaluation criteria will be distributed in a separate handout. The final project presentations will be held in our last meeting.

5. **Understanding Research Article: Bayesian Methods/Analysis (10%)**: Students will complete an article summary with a particular emphasis on the research questions, methods, analysis, and results within the Bayesian framework. Each student may select from options provided by the instructor or identify an empirical journal in the student's area of interest that includes Bayesian data analyses. Students will read the entire article, identify key components of the methods/analysis and write a short commentary/critique (3 pages maximum) of the Methods & Analysis section.

6. **Class Participation (5%):** Students are expected to come to class on time and actively participate in class discussions.

Grading Scale

Grades will be assigned based on the following:

A+	98-100%	B+	88-89%	C	70-79%
A	93-100%	B	83-87%	F	below 70%
A-	90-92%	B-	80-82%		

Professional Dispositions

See https://cehd.gmu.edu/students/polices-procedures/

Class Schedule

Date	Session	Topic	Reading and Assignments
8/26	1	▪ Historical overview ▪ Probability theory	▪ Chapters 2, 4 ▪ Quiz posted
9/2	2	▪ Bayes' law ▪ Priors, likelihoods, and posteriors ▪ Introduction to R	▪ Chapters 3, 5 ▪ Quiz posted
9/9	3	▪ Choice of priors ▪ Conjugate priors and (non-)informative priors ▪ Inferring a Binomial probability	▪ Chapter 6 ▪ Quiz posted ▪ Homework 1 posted
9/16	4	▪ Bayesian inference: One sample	▪ Chapters 16.1, 16.2 ▪ Quiz posted
9/23	5	▪ Bayesian inference: Two samples	▪ Chapters 16.3, 16.4 ▪ Quiz posted ▪ Homework 2 posted
9/30	6	▪ Bayesian inference: Correlation and Regression	▪ Chapters 17, 18 ▪ Quiz posted ▪ Homework 3 posted ▪ Guideline for article summary posted (due: session 11/11)
10/7	7	▪ Review & midterm prep	
10/14	8	***Midterm Exam***	
10/21	9	▪ Introduction to Markov chain Monte Carlo ▪ Convergence diagnostics, model checking and evaluation ▪ JAGS	▪ Chapters 7, 8 ▪ Quiz posted ▪ Homework 4 posted
10/28	11	▪ Bayesian approach to significance tests and credible intervals	▪ Chapters 11, 12 ▪ Quiz posted ▪ Homework 5 posted
11/4	10	▪ Analysis of Variance	▪ Chapters 19, 20 ▪ Quiz posted ▪ Your final project abstract (due)
11/11	12	▪ R package "BRMS" for Bayesian analyses with Stan	▪ pdf file on BB ▪ Quiz posted
11/18	13	▪ Logistic & Poisson regression models	▪ Chapters 21, 24 ▪ Quiz posted ▪ Homework 6 posted
12/2	14	▪ Other advanced topics	
12/9	15	***Final Project Presentation***	

Note. Faculty reserves the right to alter the schedule as necessary, with notification to students.

Core Values Commitment

The College of Education and Human Development is committed to collaboration, ethical leadership, innovation, research-based practice, and social justice. Students are expected to adhere to these principles: http://cehd.gmu.edu/values/.

GMU Policies and Resources for Students

Policies

- Students must adhere to the guidelines of the Mason Honor Code (see https://catalog.gmu.edu/policies/honor-code-system/).

- Students must follow the university policy for Responsible Use of Computing (see https://universitypolicy.gmu.edu/policies/responsible-use-of-computing/).

- Students are responsible for the content of university communications sent to their Mason email account and are required to activate their account and check it regularly. All communication from the university, college, school, and program will be sent to students **solely** through their Mason email account.

- Students with disabilities who seek accommodations in a course must be registered with George Mason University Disability Services. Approved accommodations will begin at the time the written letter from Disability Services is received by the instructor (see https://ds.gmu.edu/).

- Students must silence all sound emitting devices during class unless otherwise authorized by the instructor.

Campus Resources

- Support for submission of assignments to VIA should be directed to viahelp@gmu.edu or https://cehd.gmu.edu/aero/assessments . Questions or concerns regarding use of Blackboard should be directed to https://its.gmu.edu/knowledge-base/blackboard-instructional-technology-support-for-students/.

- For information on student support resources on campus, see https://ctfe.gmu.edu/teaching/student-support-resources-on-campus

Notice of mandatory reporting of sexual assault, interpersonal violence, and stalking:

As a faculty member, I am designated as a "Responsible Employee," and must report all disclosures of sexual assault, interpersonal violence, and stalking to Mason's Title IX Coordinator per University Policy 1202. If you wish to speak with someone confidentially, please contact one of Mason's confidential resources, such as Student Support and Advocacy Center (SSAC) at 703-380-1434 or Counseling and Psychological Services (CAPS) at 703-993-2380. You may also seek assistance from Mason's Title IX Coordinator by calling 703-993-8730, or emailing titleix@gmu.edu.

For additional information on the College of Education and Human Development, please visit our website https://cehd.gmu.edu/students/ .