POLI:7002:0001 Bayesian Statistics
in 3 Schaeffer Hall
Tues & Thurs 9:30-10:45 am
Spring 2021

Course Information

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Course Description

This course covers the theoretical and applied foundations of Bayesian statistical analysis. First, we will begin with discussing the Bayesian approach and how it differs from Frequentist analyses, learning how to estimate simple Bayesian models. Second, we will discuss model checking, assessment, and comparison, with an emphasis on computational approaches. Third, the course will cover Bayesian stochastic simulation (Markov chain Monte Carlo) in depth with an orientation towards understanding common algorithms used beyond Bayesian methods. The fourth section will focus on applications of Bayesian statistics in social science data analysis. The topics could include Bayesian Hierarchical models, IRT and other measurement models, and latent space models. Throughout the course, estimation with modern programming software will be emphasized.

Class meetings will typically have two of the following three components: (1) lecture on the main technical points of the weekly reading (often statistical/mathematical), (2) computational demonstration using software such as packages in R, (3) discussion of substantive applications. Initial readings are listed in the schedule below, although additional articles may be added. When working with statistical software in class, I strongly encourage you to bring your laptops so you can write (and annotate) your own code.

Prerequisites

While there are no formal requirements, students should feel comfortable learning mathematical statistics. It is assumed that students have a background in linear and generalized linear models (e.g. logit/probit/Poisson). Some knowledge of R is useful, but not mandatory. Tutorials and sample code will be shared for students with a more limited R background.

Course Materials

In this course, we will use a variety of in-print and on-line resources. The following book is required:

- Gill, J. (2014). *Bayesian Methods: A Social and Behavioral Sciences Approach*, 3rd edition. Chapman & Hall/CRC.

Any other readings assigned will be available through the UIowa library or on the class ICON site.

Software

We will be using statistical software in this course as we learn how to implement/interpret different analyses. R is a free, open-source program. Instructions for downloading R and setting up R are available on the course website. We will also be using Jags and Stan (and the R packages R2Jags and Rstan) to specify more complex models. These

software are also free and a guide for installing them is on ICON.

In addition to the resources on ICON, the Political Science Department has a Collaboratory on the 3rd floor of Schaeffer Hall. The Collab is staffed with a Technology TA who can help you with data/computing/R challenges. Yufan Yang (yufan-yang@uiowa.edu) and Jeongho Choi (jeongho-choi@uiowa.edu) are sharing this responsibility this semester. I strongly encourage you to take advantage of this resource if you find R challenging or frustrating.

Course Requirements and Grading

Your grade for the course will be determined by performance in four areas: class participation, problem sets, an article critique, in-class presentations, and a final paper/presentation. All assignments are due a the beginning of class unless otherwise stated. Any late assignments will have points deducted at the rate of 10% of the total available points per calendar day unless arrangements are made *prior* to the due date.

Course Grade Breakdown:

- Participation: 5%
- Problem Sets: 25%
- Written Article Critique/Response: 10%
- Substantive Application Presentation: 10%
- Methods Extension Presentation: 10%
- Final Paper & Presentation: 40%

Participation:

Everyone is expected to keep up with the course material and actively engage in class. You cannot participate if you are not present. Therefore attendance is expected. Please contact me as soon as possible if you must be absent. Evaluation of your participation will be based on: evidence that you are well-prepared for class; respectful contributions to discussion, especially questions and comments that advance the conversation; asking relevant questions during lecture/software demonstrations; actively participating in software demonstrations; and engaging your colleagues during their presentations by asking thoughtful (constructive) questions. This should be the easiest 5% of your grade. While it is easy to earn these points they are not automatic.

Problem Sets:

There will be a few assignments throughout the semester ($\sim$4). These problem sets will focus on executing topics discussed in class. Often they will require a computing component as well as discussion or interpretation. These assignments will typically be due two weeks after they are posted to ICON. You are welcome to work together on these assignments, but you are each expected to write up and turn in your own answers. All assignments should be uploaded to ICON by the due date. All assignments for this class must be typed. If you dislike using Word to write math equations and create tables, I recommend using LaTeX. If a question involved a lot of calculations or work, handwritten work may be attached at the end of your submission, but the answers/interpretations must all be typed.

Answer keys will be posted when an assignment is returned. Once the answer key is posted, late homework will no longer be accepted.

2 questions throughout the semester will be flagged as **practice comp questions**. These should be completed **on your own** consulting no one other than me. They are to give you an idea of the type of question that would show up on the methods comp from this class.

Written Article Critique:

For each class in which substantive articles are listed on the syllabus, students can sign up to write a critique. Students will sign up on the first day of class for their topic, and the schedule will be posted to ICON. Students can critique the article(s) listed on the syllabus, or if they find different article(s) suitable for the topic they may critique those instead (with permission of the instructor). The critique should consider both the strengths and weaknesses of the article(s) in question. Be sure to address the role of Bayesian analysis in the articles(s). This role can be theoretical, substantive, or methodological (or often all three). Questions to ask as you read (and answer in your critiques) include but are not limited to: Is the complexity of Bayes worth it? What does this framework add to the literature? Do we learn something we couldn't have learned otherwise? Are the authors transparent in their decisions (priors/convergence/etc) or are you left with questions? What is the article's greatest contribution? What is its greatest weakness? How could this weakness be addressed in future work?

Each student must write 1 critique. The critiques should be 2-4 pages (longer is not necessarily better) and are due at the beginning of class on Thursdays (via ICON). The purpose is to get you engaging with scholarship that uses Bayesian methods and thinking critically about the use of Bayes in social science settings. My articles are just suggestions. You are welcome to suggest different articles. If you would like to critique different articles, you must get them approved by me first. They must be on the topic of the day, but can be from any social science field. If I like the articles you found more than the ones on the syllabus, extra credit points will be awarded! (Encouraging you to find good articles helps me diversify/update my syllabus as well).

Substantive Application Presentation:

On a **different** week from your article critique, you will give a short (10 minute) presentation to the class. This presentation will focus on how scholars have used the topic of the week to study social/political questions. This presentation is not a critique so much as evidence you can read and engage with scholars using new methodologies. Presentations will always be given on Tuesdays at the beginning of class. Students will sign up on the first day of class and the schedule will be posted to ICON.

In your presentation you should explain/identify the research question, the theoretical argument (if a theory-testing paper), the empirical approach, and interpret the conclusions. Connect it to the broader literature and how this paper builds on what was already known/contributes new knowledge. Then identify core gaps/strengths/limitations/future directions. More details will be found on ICON. For this presentation you should find a paper relevant to your work. Ideally one you plan to cite in your final paper! The only requirement is that it uses/discusses/engages with the topic of the week.

Methodological Extension Presentation:

Certain topics in this class involve a large number of options. For example, there are dozens of possible priors in any given situation and some really creative ways of using past work to create a prior. You will never have enough time to learn all of these in the classroom. This means that being able to take what you've learned and build upon it is crucial! Bayesian methods are still evolving and thus this skill will become even more valuable as you move through your career. So, on certain weeks students will sign up to do a presentation on Thursdays. These presentations will present a measure/statistic/extension/alternative approach directly related to those discussed on Tuesday but that hasn't been directly taught. You will explain the new measure/statistic/approach to the class, explain how it relates to those we already know, and show how to execute the measure/statistic in R. More details will be posted to ICON. Students will sign up on the first day of class and the schedule will be posted to ICON.

As these presentations are intended to be short-ish, you will have to make choices! Focus on what your classmates need to know in order to know when to use what you are teaching them, how it will improve their work, and where to go to get more information.

Final Paper/Presentation:

Write a paper and make sure it includes Bayesian methods. The best papers will be ready to present at a conference. The paper should be no more than 25 pages (not including Appendices if you have convergence tests or other diagnostics you need to report). All papers are expected to be formatted professionally (please double-space). The focus of the paper can be substantive (using techniques we learned in class to address an unanswered question in your field), methodological (developing a new network technique), or anything in between.

During finals week, you will give a conference-style presentation/poster session to the class and invited faculty/graduate students. The exact format will be selected by the class.

You are strongly encouraged to help each other with the papers and presentations, talk over ideas, and edit for each other. You are expected to turn in a paper that represents solo-authored original research unless given explicit permission otherwise.

Mid-Semester Paper Deadlines:

Paper Topic & Initial Bibliography: Bring a proposal for your paper to class on February 25 (also, upload a copy to ICON before class). Describe the research question, the contribution you're making to the literature, and how Bayesian analysis will enhance the project (this should be no longer than 2 pages). Attach an initial bibliography of at least 10 sources with 1 or 2 sentence summaries of how the source relates to your research question. Five of these sources should explicitly incorporate Bayes *if at all possible*. In addition to looking for sources within the specific substantive literature, also consider work in other literatures that use similar approaches to the one you intend to use. If you cannot find relevant Bayes sources, indicate where you looked/what literatures you looked at. This proposal will count for 5% of your final paper/presentation grade. You'll briefly share your research ideas with your classmates with the goal of finding others interested in similar topics or methodological approaches!

Data & Research Design: Bring a brief description of the data you will use to explore your research question as well as the type of analyses you intend to run on the data to class on March 23. This description should be 2-3 pages (incorporate brief descriptions of how you will operationalize the main concepts, whether the data is already in useable form or will require restructuring, etc). If you have updated or modified your topic since the last deadline, you should briefly include a description of the new topic and contribution as well (in this case you can run longer than 3 pages). This assignment will be 5% of your final paper/presentation grade.

Paper Workshop: On the week of April 19 in place of a typical class, we will hold a paper workshop. Details on the workshop design will be announced as the date nears; for now know that a draft of your paper will be due on April 15. You will provide/receive written comments to/from a few of your colleagues. The draft itself will not be graded, take advantage of this opportunity to incorporate good feedback. The quality of the comments you provide your peers, however, will count for 5% of your final participation grade. Failure to submit a draft will result in your inability to participate in the workshop (and, therefore, a grade of 0 for your comments). The more complete and polished the draft the more useful your colleagues comments will be. I strongly encourage you to take this deadline seriously.

Important Dates

- Critiques, Methods Extension, & Substantive Application: Varies by student. See schedules on ICON.
- Paper Topic & Initial Bibliography: Feb. 25
- Data & Research Design: March 23
- Paper Draft: April 15
- Final Paper Due: Monday, May 10, 5pm
- Final Presentation/Poster Session: TBD (during finals week)

Grading Scale

The grading scale for the course is as follows. Note that grades of A+ are reserved for exceptional circumstances when a student demonstrates exceptional intellectual capacity and rigorous scholarship.

Letter Grade	Percentage
A+	99-100
A	93-98
A-	90-92
B+	87-89
B	83-86
B-	80-82
C+	77-79
C	73-76
C-	70-72
D+	67-69
D	63-66
D-	60-62
F	59 or below

Other Expectations

Technology: Please turn your mobile phones off or to silent mode before class. Laptops are permitted for class purposes only. If you are using your laptops for notes or readings, sign out of everything else so you can focus on mastering the material at hand.

Email: Email is a useful way to ask quick questions. However, replying to complicated questions is highly inefficient for both you and me. If you want to talk about something you don't understand, come by my office hours. In general, while I respond to student emails, I prefer to talk in person. Come see me during office hours!

Ask Questions! Often if you have a question one of your classmates does too. Relevant questions are strongly encouraged.