



Syllabus

STAT 6570

Applied Bayesian Analysis

Spring 2025 (second half semester)

2 Credit Hours

Course overview

Instructor

- Steve MacEachern
- maceachern.1@osu.edu
- Office – Cockins Hall (CH), room 440D
- Office Hours, Monday 10-11, Friday 9-10, and by appointment

Note: My preferred method of contact is email. Notes through CARMEN may go unanswered.

Teaching Assistant

- Yuxuan Xin
- xin.155@osu.edu
- There are no recitations for this course. Yuxuan's main role will be as a grader and to provide online support as needed. Stay tuned for an office hour posting on CARMEN. You can, of course, contact her with any of the usual course-related questions.

Course description

The course catalog description of the course is this:

Introduces various aspects of Bayesian modeling (including conditionally specified models and models for non-normal data) and simulation-based model-fitting strategies. Prereq: 6301 (610) or 6801 (621 and 622), or permission of instructor. Prereq or concur: 6450 (645) or 6950, and 6302 (623) [with 6301 prerequisite] or 6802 [with 6801 prerequisite]; or permission of instructor. Not open to students with credit for 625.

As an expanded description, this course is about the practice of building, fitting, and using Bayesian models. The starting point for Bayesian modelling is traditional,



classical statistical modelling – the kind of modelling that you have been exposed to in a course on experimental design, regression, or “research methods”. From this starting point, Bayesian methods add much, for example, allowing us to incorporate information external to the study at hand; allowing us to pool information across a number of studies; and providing a clear methodology for making predictions. We will cover the big ideas that underlie Bayesian methods with the goal of getting you to the point where you can use these methods to analyze data – ideally, for your own research projects.

Given the half-semester, two credit hour, format, the course will cover a limited amount of detail, especially on the mathematical side. You will notice that there is scope for much greater depth for much of the material in the course. You’re right! There is a large and active research community that is busy creating new Bayesian models and methods and examining the properties of proposed modelling strategies. While statistics has long been at the heart of this community, the community extends far beyond statistics. If you are interested in more, let me know.

For prerequisites, I will assume that you have some familiarity with the basics of statistics. We will make (very modest) use of some statistical theory – mainly in the form of probability calculations. If this is a weak spot for you, fear not. Following a few results and capturing them for use in modelling and computation will be sufficient. We will make stronger use of applied models such as the model that underlies a t-test, a one-way ANOVA model or a linear regression model. By the end of the course, the models will be a bit fancier. We will spend time developing and understanding the models as well as using them.

Course expected learning outcomes

By the end of this course, you should be able to:

- Create a Bayesian model that matches your scientific problem and data, and that matches the goal of your analysis.
- Fit the model computationally, most likely with a simulation-based method.
- Critique your model through basic model diagnostics.
- Make inference about parameters and future (as-yet unobserved) data.
- Convey the results of your analysis to a general audience, both in writing and as a presentation.

Course details

Mode of delivery



This course will meet in person for the second half semester. Our scheduled meeting time is 12:40 – 2:30, Tuesdays and Thursdays. We will not meet during spring break.

In addition to the regular meeting times, final projects will be presented during the regularly scheduled final exam period. This is Thursday, April 24, from 2:00 pm – 3:45 pm. We will discuss details of the project presentations in class.

Pace of online activities

This course will move fast! The tail end of this syllabus contains a tentative course plan. The plan is to cover one chapter of the text in each lecture, with modest adjustments to the schedule, as needed. I expect that some adjustments will be needed.

Credit hours and work expectations

This is a **2-credit-hour course**, but it runs for only a half semester. With this in mind, it operates as if it were a four credit hour course. According to Ohio State policy (go.osu.edu/credithours), students should expect around 12 hours of engagement with the class each week. Actual hours spent will, of course, vary by student and by week.

Participation requirement

Full participation in class is expected. This includes attendance and participation in in-class discussions and activities. It also includes participation in additional activities on CARMEN. Your project will be a group project. Participation in your group's effort is mandatory.

Course communication guidelines

As mentioned above, the best ways to get in touch with me are either by email or during my office hours. The course will move at a fast pace. My advice is to keep up with the work. If you fall behind, it will be difficult to catch up. If you find yourself struggling, stop by my office for a chat.

Writing style

For online communications (e.g., comments and responses on projects), please adhere to standard usage, paying attention to such things as grammar, spelling, and division of commentary into paragraphs.



Tone and civility

When communicating with others, it is important to speak and write in a civil tone. This is especially true for your interactions with other students in the class, including those in your group for the project. Please be respectful of others.

Dual use of material

Many of you are already engaged in research. As far as I am concerned, for this course, you may make use of data that you have collected or analyzed for other purposes. It is your responsibility to make sure that others who may be tied to data and analysis are comfortable with its use in this course. If in doubt as to whether or not you need to check, check!

Citing your sources

Your course project will naturally make reference to other work and may make use of published or unpublished data. When writing your project, make sure to cite your sources. This is expected whenever you do research.

For some parts of the course, you will make use of resources that I provide (e.g., code to fit a model). You may make free use of these resources. You do not need to cite the source for these resources.

Course materials and technologies

Textbooks

Our textbook -- **required**

A First Course in Bayesian Statistical Methods, by Peter D. Hoff. Published by Springer.

Two other good books on Bayesian data analysis – **not** required

- Bayesian Data Analysis, 3rd edition, by Andrew Gelman, John B. Carlin, Hal S. Stern, David B. Dunson, Aki Vehtari, and Donald B. Rubin. Published by the CRC Press.
- Bayesian Ideas and Data Analysis, by Ronald Christensen, Wesley Johnson, Adam Branscum, and Timothy E Hanson. Published by CRC Press.



Course technology

Computing will be done in the R computing environment. RStudio is available for free download. Many find this to be a convenient environment, especially for organizing projects. In class examples will be done in R, although my personal preference is to sidestep RStudio.

You will need access to the CARMEN site for this course. The site will be the clearinghouse for assignments and out-of-class activities.

Grading

How your grade is calculated

Assignment Category	Points and/or Percentage
Attendance and in-class participation	20%
CARMEN participation	10%
Homework assignments	10%
Course project	60%
Total	100%

Academic policies

Academic integrity policy

- Don't cheat! If in doubt about whether something is allowed, ask me.

Note that you may speak with one another about homework assignments. It is fine to ask others in the class (or the TA or me) for help getting started with R,



getting your MCMC to work, etc. It is good for you to write your own homework up for submission.

The group project is a major part of your course grade. It's a group project, so work with your group on it. You may also wish to speak with others – perhaps the source of your data or your advisor. You may draw upon existing literature to formulate your problem and get a start on modelling your data. This is fine. Simply include references to your outside sources.

Copyright for instructional materials

The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

Statement on title IX

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at <http://titleix.osu.edu> or by contacting the Ohio State Title IX Coordinator at titleix@osu.edu

Commitment to a diverse and inclusive learning environment

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.

Land acknowledgement

We would like to acknowledge the land that The Ohio State University occupies is the ancestral and contemporary territory of the Shawnee, Potawatomi, Delaware, Miami, Peoria, Seneca, Wyandotte, Ojibwe and Cherokee peoples. Specifically, the university



resides on land ceded in the 1795 Treaty of Greenville and the forced removal of tribes through the Indian Removal Act of 1830. I/We want to honor the resiliency of these tribal nations and recognize the historical contexts that has and continues to affect the Indigenous peoples of this land.

More information on OSU's land acknowledgement can be found here:

<https://mcc.osu.edu/about-us/land-acknowledgement>

Your mental health

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614-292-5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on-call counselor when CCS is closed at 614-292-5766 and 24 hour emergency help is also available 24/7 by dialing 988 to reach the Suicide and Crisis Lifeline.

Accessibility accommodations for students with disabilities

Requesting accommodations

The university strives to maintain a healthy and accessible environment to support student learning in and out of the classroom. If you anticipate or experience academic barriers based on your disability (including mental health, chronic, or temporary medical conditions), please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion.

If you are isolating while waiting for a COVID-19 test result, please let me know immediately. Those testing positive for COVID-19 should refer to the [Safe and Healthy Buckeyes site](#) for resources. Beyond five days of the required COVID-19 isolation period, I may rely on Student Life Disability Services to establish further reasonable



accommodations. You can connect with them at slds@osu.edu; 614-292-3307; or slds.osu.edu.

Religious accommodations

It is Ohio State's policy to reasonably accommodate the sincerely held religious beliefs and practices of all students. The policy permits a student to be absent for up to three days each academic semester for reasons of faith or religious or spiritual belief.

Students planning to use religious beliefs or practices accommodations for course requirements must inform the instructor in writing no later than 14 days after the course begins. The instructor is then responsible for scheduling an alternative time and date for the course requirement, which may be before or after the original time and date of the course requirement. These alternative accommodations will remain confidential. It is the student's responsibility to ensure that all course assignments are completed.

Course Schedule

This is a tentative course schedule. I expect that we will drift from it as the course progresses. Refer to the Carmen course page for up-to-date assignment due dates. The chapters below are all from the text by Hoff. In addition to the planned reading, there will be selected exercises (traditional homework assignments), waystages for the projects, and activities on CARMEN.

2/27	Thu	Chapter 1 – Introduction and examples
3/4	Tue	Chapter 2 – Belief, probability and exchangeability
3/6	Thu	Chapter 3 – One-parameter models
3/10 – 3/14		Spring break, no class
3/18	Tue	Chapter 4 – Monte Carlo approximations
3/20	Thu	Chapter 5 – The normal model
3/25	Tue	Chapter 6 – Posterior approximation with the Gibbs sampler
3/27	Thu	Chapter 7 – The multivariate normal model
4/1	Tue	Chapter 8 – Group comparisons and hierarchical modelling
4/3	Thu	Chapter 9 – Linear regression



- 4/8 Tue Chapter 10 – Nonconjugate priors and Metropolis-Hastings algorithms
- 4/10 Thu Catch-up day / more on MCMC
- 4/15 Tue Chapter 11 – Linear and generalized linear mixed models
- 4/17 Thu Catch-up day / more on modelling

I expect to be away from campus on 4/10. We will arrange to make up the missing class time.