THE OHIO STATE UNIVERSITY

COLLEGE OF ARTS AND SCIENCES

# SYLLABUS: STAT 6570 APPLIED BAYESIAN ANALYSIS SPRING 2024

# Course overview

## Instructor

Instructor: Dr. O.A. Chkrebtii
Email address: Chkrebtii.1@osu.edu (please add "STAT 6570" to subject line)
Phone number: 614-292-0292
Office hours: Wednesdays 4-5pm EST (CH 429)

## Grader

Rui Zhang (zhang.9473@osu.edu)

## Course description

This course provides a general introduction to Bayesian, modeling, analysis and computing. A variety of Bayesian models will be studied, and Bayesian hierarchical modeling will be discussed as a framework for modeling complex systems and incorporating multiple data sources. Simulation-based methods will be introduced to fit Bayesian models to data using the JAGS software. Students will also gain experience in programming basic MCMC algorithms in the statistical software R.

Prerequisites: STAT 6301 or STAT 6801, STAT 6450 or STAT 6950, and STAT 6302 or STAT 6802, or permission of instructor.

## Course learning outcomes

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

- Construct Bayesian statistical models, including hierarchical Bayesian models
- Perform estimation, prediction, and uncertainty quantification based on the posterior and posterior predictive distributions

- Fit Bayesian models to data using numerical techniques, including Gibbs sampling and Markov chain Monte Carlo
- Assess the appropriateness of a Bayesian model and conduct model comparison and checking

# Course materials

### Required

Bayesian Data Analysis, Third Edition, Gelman, A., Carlin, J.B., Stern, H., Dunson, D., Vehtari, A., and Rubin, D. Chapman and Hall, 2014. (Available in electronic format through the library)

# Course technology

For help with your password, university e-mail, Carmen, or any other technology issues, questions, or requests, contact the OSU IT Service Desk. Standard support hours are available at https://ocio.osu.edu/help/hours, and support for urgent issues is available 24x7.

- **Self-Service and Chat support:** http://ocio.osu.edu/selfservice
- **Phone:** 614-688-HELP (4357)
- **Email:** 8help@osu.edu
- **TDD:** 614-688-8743

### Baseline technical skills necessary for online courses

- Basic computer and web-browsing skills
- Navigating Carmen

### Technology skills necessary for this specific course

- CarmenZoom (in case of a remote class)
- Scanning and uploading a written document to Carmen

### Necessary equipment

- Computer: current Mac (OS X) or PC (Windows 10+) with high-speed internet connection
- Webcam: built-in or external webcam, fully installed
- Microphone: built-in laptop or tablet mic or external microphone
- Camera and/or scanner or tablet functionality: ability to scan, photograph, or write directly on a tablet and upload documents to Carmen

### Necessary software

- This class requires you to use the statistical software package called R (The R Project for Statistical Computing; http://www.r-project.org/). This software package is available as Free Software.
    - You can download R for Windows, Mac, and Linux, from the CRAN archive at https://cran.r-project.org.
    - An in-depth introduction to R is available at http://cran.r-project.org/doc/manuals/R-intro.pdf
    - Hands-on tutorials are available in the Swirl system, which you can learn about at http://swirlstats.com/. In particular, "R Programming: The basics of programming in R" is an appropriate first tutorial for students who have never used R.
- An easier to use interface to R is available in the software package RStudio. This package is available for Windows, Mac, and Linux and can be downloaded for free from http://rstudio.org. **Note that RStudio requires R to be installed.**
- Microsoft Office 365 ProPlus All Ohio State students are now eligible for free Microsoft Office 365 ProPlus through Microsoft's Student Advantage program. Each student can install Office on five PCs or Macs, five tablets (Windows, iPad® and Android™) and five phones.
    - Students are able to access Word, Excel, PowerPoint, Outlook and other programs, depending on platform. Users will also receive 1 TB of OneDrive for Business storage.
    - Office 365 is installed within your BuckeyeMail account. Full instructions for downloading and installation can be found https://ocio.osu.edu/kb04733.

## Course delivery

This class will take place in person. Lectures will include a mix of slides and software demonstrations. Partial slides will be provided via Carmen to be filled in by students during the lectures.

All assignments will be posted on the Carmen course page. Office hours will be held in person. Zoom meetings available upon request as well.

In case of instructor illness or other emergency, a lecture may be changed to online delivery. The instructor will provide as much notice as possible of any such changes via email and on Carmen. Every attempt will be made to provide a synchronous online lecture.

# Grading and faculty response

## Grades

| Assignment or category | Percentage |
|---|---|
| **Homework (lowest grade will be dropped)** | **30** |
| **Midterm** | **35** |
| **Final Project** | **35** |
| **Total** | **100** |

*See course schedule on Carmen for due dates*

## Assignment information

Homework will be assigned approximately weekly. It will consist of mostly textbook-style problems, problems motivated by real-world applications, and analyses requiring the use of statistical software. You may work together on assignment problems, but each student must hand in their own work, written in their own words. Do not copy any part of another student's homework including computer code or output. Use of homework solutions distributed in previous offerings of the course or available on the web constitutes academic misconduct and will be handled according to university rules. Sharing or disseminating solutions, or in any way knowingly enabling others to commit academic misconduct also constitutes academic misconduct, and will be reported. Homework must be uploaded to Carmen before the due date. The solutions may be handwritten and scanned, entered directly into a tablet, or typed. Any software output must appended to the homework file prior to submission. **All work and software output must be uploaded as a single pdf file**. Please be sure that the questions are clearly labeled, all supporting work (including software output) can be easily identified, and that all figures/tables are referenced and interpreted in the text.

## Late assignments

Assignment solutions will be posted shortly after submission. No late assignments will be accepted, except when prior permission is given or is justified by special circumstances. The lowest homework grade will be dropped for each student. Accommodations can be made in some cases, so please notify me as soon as possible if such a situation arises.

## Grading scale

93–100: A
90–92.9: A-
87–89.9: B+
83–86.9: B
80–82.9: B-
77–79.9: C+
73–76.9: C
70 –72.9: C-
67 –69.9: D+
60 –66.9: D
Below 60: E

## Faculty feedback and response time

I am providing the following list to give you an idea of my intended availability throughout the course. (Remember that you can call **614-688-HELP** at any time if you have a technical problem.)

### Grading and feedback

For large bi-weekly assignments, you can generally expect feedback within **7 days**.

### E-mail

To contact the instructor via email, **please write "STAT 6570" somewhere in the subject line**, as this will help to quickly identify and reply to class emails. I will aim to reply to e-mails within **48 hours on school days**.

# Attendance, participation, and discussions

## Student participation requirements

Because this is a distance-education course, your attendance is based on your online activity and participation. The following is a summary of everyone's expected participation:

- **Lectures**: **BI-WEEKLY, SOME ABSENCES ALLOWED**
  Attendance of the lectures is mandatory. Frequent or extended absences must be justified.
- **Logging in**: **AT LEAST ONCE PER WEEK**
  Be sure you are logging in to the course in Carmen each week, including weeks with holidays or weeks with minimal online course activity. (During most weeks you will probably log in many times.) If you have a situation that might cause you to miss an entire week of class, discuss it with me *as soon as possible.*

- **Office hours**: **OPTIONAL OR FLEXIBLE**
  Office hours are optional.

## Discussion and communication guidelines

The following are my expectations for how we should communicate as a class. Above all, please remember to be respectful and thoughtful.

- **Writing style**: While there is no need to participate in class discussions as if you were writing a research paper, you should remember to write using good grammar, spelling, and punctuation. Informality (including an occasional emoticon) is fine for non-academic topics.
- **Tone and civility**: Let's maintain a supportive learning community where everyone feels safe and where people can disagree amicably. Remember that sarcasm doesn't always come across online.
- **Citing your sources**: When we have academic discussions, please cite your sources to back up what you say. (For the textbook or other course materials, list at least the title and page numbers. For online sources, include a link.)
- **Backing up your work**: Consider composing your academic posts in a word processor, where you can save your work, and then copying into the Carmen discussion.

# Other course policies

## Health and safety

The Ohio State University Wexner Medical Center's Cornavirus Outbreak site (https://wexnermedical.osu.edu/features/coronavirus) includes the latest information about COVID-19 as well as guidance for students, faculty and staff.

## Potential disruptions to instruction

Contingencies to be addressed:

- Student is unable to attend class because of positive diagnosis, symptoms, or quarantine required following contact tracing
- Entire class is required to quarantine following contact tracing
- In-person classes are suspended at the university
- Instructor is unable to be present in person because of positive diagnosis, symptoms, or quarantine following contact tracing

# Student academic services

Student academic services offered on the OSU main campus
http://advising.osu.edu/welcome.shtml.

# Student support services

Student support services offered on the OSU main campus http://ssc.osu.edu.

# Academic integrity policy

## Policies for this online course

- **Exams**: You must complete the exams yourself, without any external help or communication. Quizzes are included as self-checks without points attached.
- **Written assignments**: Your written assignments, should be your own original work. In formal assignments such as the final project, you should follow APA style to cite the ideas and words of your research sources.
- **Reusing past work**: In general, you are prohibited in university courses from turning in work from a past class to your current class, even if you modify it. If you want to build on past research or revisit a topic you've explored in previous courses, please discuss the situation with me.
- **Falsifying research or results**: All research you will conduct in this course is intended to be a learning experience; you should never feel tempted to make your results or your library research look more successful than it was.
- **Collaboration and informal peer-review**: The course includes many opportunities for formal collaboration with your classmates. While study groups are allowed, remember that comparing answers on a quiz or assignment is not permitted. If you're unsure about a particular situation, please feel free just to ask ahead of time.

## Ohio State's academic integrity policy

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct http://studentlife.osu.edu/csc/.

# Copyright disclaimer

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, Kellie Brennan, at titleix@osu.edu

## Accessibility accommodations for students with disabilities

**The University strives to make all learning experiences as accessible as possible. 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. SLDS contact information: slds@osu.edu; 614-292-3307; slds.osu.edu; 098 Baker Hall, 113 W. 12th Avenue.**

### Accessibility of course technology

This online course requires use of Carmen (Ohio State's learning management system) and other online communication and multimedia tools. If you need additional services to use these technologies, please request accommodations with your instructor.

- Carmen (Canvas) accessibility
- Streaming audio and video
- Synchronous course tools

## 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 through the 24/7 National Suicide Prevention Hotline at 1-800-273- TALK or at suicidepreventionlifeline.org

## Disclaimer

This syllabus should be taken as a fairly reliable guide for the course content. However, you cannot claim any rights from it and in particular we reserve the right to change due dates or the methods of grading and/or assessment if necessary. Any changes will be communicated to you through official course announcements.

# Course schedule (tentative)

| Week | Topics, Readings, Assignments, Deadlines |
|---|---|
| 1 | Introduction, Bayesian paradigm |
| 2 | Priors, conjugacy, prediction |
| 3 | Hierarchical modeling |
| 4 | Numerical methods and posterior simulation |
| 5 | Bayesian Computation |
| 6 | Markov chain Monte Carlo and JAGS |
| 7 | Model checking and selection |