BIOSTAT 725 Syllabus

Spring 2026

Course info

Class meetings

Lecture	Tue & Thu 11:45am - 1pm	Hock 10089

Teaching team

Name	Role	Office Hours	Location
Prof. Sam Berchuck	Instructor	Mon 4-6pm *or by appointment*	Hock 9028
Christine Shen	TA	Mon 1:30 - 3:30pm	Old Chemistry 203A
Jiang Shu	TA	Wed 4:45 – 6:45pm	Hock (Room TBD)

Course description

This course will teach students how to analyze biomedical data from a Bayesian inference perspective with a strong emphasis on using real-world data, including electronic health records, wearables, and imaging data. The course will begin by introducing the machinery of Bayesian statistics through the lens of linear regression, giving enough context for students with no prior experience with Bayesian statistics. A history of computational approaches used in Bayesian statistics will be given before ultimately landing on Stan, a state-of-the-art probabilistic programming language that makes Bayesian inference accessible as a viable data science tool. The course will then branch out from regression and introduce Bayesian versions of machine learning tools, including regularization and classification. The course will then emphasize Bayesian

hierarchical models, including Gaussian process models for temporal and spatial data; and clustering. Additional topics may be discussed from the Bayesian perspective, including causal inference, and meta-analysis. While an applied course, the methods will be introduced from a mathematical perspective, allowing students to obtain a fundamental understanding of the introduced models. Students will learn computational skills for implementing Bayesian models using R and Stan. By the end of this course, students will be well-equipped to tackle complex problems in biomedical research using Bayesian inference.

Prerequisites

BIOSTAT 724 (Introduction to Applied Bayesian Analysis) or equivalent course with instructor permission. Interested students with different backgrounds should seek instructor consent.

Course learning objectives

By the end of the semester, you will be able to...

- understand fundamental concepts of Bayesian statistics, including prior and posterior, and predictive distributions,
- implement the Bayesian workflow, including model building, checking, and refinement,
- use probabilistic programming software for Bayesian analysis (e.g., Stan),
- apply Bayesian techniques to real-world health data,
- communicate Bayesian analysis results effectively to both technical and non-technical audiences, and
- identify opportunities for using Bayesian statistics in your research and/or job.

Course materials

While there is no official textbook for the course; readings will primarily be made available as they are assigned. We will use the statistical software R. Students will be encourage to download the required software on their own laptops. As a courtesy, students will also be able to access R and the required software through Docker containers provided by Duke Office of Information Technology. See the computing page for more information.

Course community

Inclusive community

It is my intent that students from all diverse backgrounds and perspectives be well-served by this course, that students' learning needs be addressed both in and out of class, and that the

diversity that the students bring to this class be viewed as a resource, strength, and benefit. It is my intent to present materials and activities that are respectful of diversity and in alignment with Duke's Commitment to Diversity and Inclusion. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally, or for other students or student groups.

Furthermore, I would like to create a learning environment for my students that supports a diversity of thoughts, perspectives and experiences, and honors your identities. To help accomplish this:

- If you feel like your performance in the class is being impacted by your experiences outside of class, please don't hesitate to come and talk with me. If you prefer to speak with someone outside of the course, your academic dean or director of graduate studies (DGS) are excellent resources.
- I (like many people) am still in the process of learning about diverse perspectives and identities. If something was said in class (by anyone) that made you feel uncomfortable, please let me or a member of the teaching team know.

Pronouns

Pronouns are meaningful tools to communicate identities and experiences, and using pronouns supports a campus environment where all community members can thrive. Please update your gender pronouns in Duke Hub. You can find instructions to do so here. You can learn more at the Center for Sexual and Gender Diversity's website.

Accessibility

If there is any portion of the course that is not accessible to you due to challenges with technology or the course format, please let me know so we can make appropriate accommodations.

The Student Disability Access Office (SDAO) is available to ensure that students are able to engage with their courses and related assignments. Students should be in touch with the Student Disability Access Office to request or update accommodations under these circumstances.

Communication

All lecture notes, assignment instructions, an up-to-date schedule, and other course materials may be found on the course website, biostat725-sp26.netlify.app.

Links to Zoom meetings may be found in Canvas. Periodic announcements will be sent via email and Canvas Announcements. Please check your email regularly to ensure you have the latest announcements for the course.

Email

If you have questions about assignment extensions, accommodations, or any other matter, please email me directly at sib2@duke.edu. **If you email me, please include "BIOSTAT 725" in the subject line.** Barring extenuating circumstances, I will respond to BIOSTAT 725 emails within 48 hours Monday - Friday. Response time may be slower for emails sent Friday evening - Sunday.

Five tips for success

Your success in this course depends very much on you and the effort you put into it. Your TA(s) and I will help you be providing you with materials and answering questions and setting a pace, but for this to work you must do the following:

1. Complete all the preparation work before class.
2. Ask questions. As often as you can. In class, out of class. Ask me, ask the TA, ask your friends, ask the person sitting next to you. This will help you more than anything else. If you get a question wrong on an assessment, ask us why. If you're not sure about the homework, ask. If you hear something on the news that sounds related to what we discussed, ask. If the reading is confusing, ask.
3. Do the readings and other preparation work.
4. Do the homeworks. The earlier you start, the better. It's not enough to just mechanically plow through the exercises. You should ask yourself how these exercises relate to earlier material, and imagine how they might be changed (to make questions for an exam, for example).
5. Don't procrastinate. The content builds upon what was taught in previous weeks, so if something is confusing to you in Week 2, Week 3 will become more confusing, Week 4 even worse, etc. Don't let the week end with unanswered questions. But if you find yourself falling behind and not knowing where to begin asking, come to office hours and work with a member of the teaching team to help you identify a good (re)starting point.

Getting help in the course

- If you have a question during lecture, feel free to ask it! There are likely other students with the same question, so by asking you will create a learning opportunity for everyone.
- The teaching team is here to help you be successful in the course. You are encouraged to attend *office hours*[1] to ask questions about the course content and assignments. Many

[1] Office hours are times the teaching team set aside each week to meet with students. Click here to learn more about how to effectively use office hours.

questions are most effectively answered as you discuss them with others, so office hours are a valuable resource. You are encouraged to use them!

Check out the Support page for more resources.

What to expect in the course

Lectures

Lectures are designed to be interactive, so you gain experience applying new concepts and learning from each other. My role as instructor is to introduce you to new methods, tools, and techniques, but it is up to you to take them and make use of them. A lot of what you do in this course will involve writing code, and coding is a skill that is best learned by doing. Therefore, as much as possible, you will be working on a variety of tasks and activities during the lectures. You are expected to prepare for class by completing assigned readings, attend all lecture sessions, and meaningfully contribute to in-class exercises and discussion. Additionally, some lectures will feature application exercises that will be graded based on completing what we do in class.

You are expected to bring a laptop, tablet, or any device with internet and a keyboard to each class so that you can participate in the in-class exercises. Please make sure your device is fully charged before you come to class, as the number of outlets in the classroom will not be sufficient to accommodate everyone.

Activities & Assessment

You will be assessed based on four components: homework, exams, live coding, and application exercises.

Homework

In homework, you will apply what you've learned during lecture to complete data analysis tasks and explain the underlying mathematics, with a focus on the computation and communication. Homework assignments will be completed using Quarto, correspond to an appropriate GitHub repository, and submitted as a PDF for grading in Gradescope. You may discuss homework assignments with other students; however, homework should be completed and submitted individually. HW0 will not be graded for credit.

The lowest homework grade will be dropped at the end of the semester.

Exams

There will be two exams in this course. Each exam will be an open-note take-home assessment. Through these exams you have the opportunity to demonstrate what you've learned in the course thus far. The exams will focus on both conceptual understanding of the applied and mathematical content and application through analysis and computational tasks. The exams will be based on content in reading assignments, lectures, application exercises, and homework assignments. More detail about the exams will be given during the semester.

Live Coding

There will be an in-class live coding evaluation in this course. The exercise will take place on Thursday, April 9, during the regularly scheduled class period, and will account for 10% of the final course grade. Students will work independently in a real-time setting to implement and analyze a Bayesian model using Stan, drawing on concepts from lectures and course assignments. This will be an open-book exercise: students may use course materials and external online resources, but may not use AI tools to generate written explanations or narrative interpretations (AI may be used for coding and technical assistance only). The goal of the exercise is to assess students' ability to apply Bayesian modeling concepts and work effectively in Stan under realistic analytical conditions. Materials will be distributed at the start of the session via a Github repo. Students who cannot attend on this date must contact the instructor in advance to arrange an alternative. More information about the project will be provided during the semester.

Application exercises

You will get the most out of the course if you actively participate in class. Parts of some lectures will be dedicated to working on Application Exercises (AEs). AEs are submitted by pushing your work to the relevant GitHub repo. AEs from Tuesday lectures should be submitted by Friday by 11:59p ET, and AEs from Thursday lectures should be submitted by Sunday at 11:59p ET. Because AEs are intended for in-class activities, there are no extensions given on AEs.

AEs will be graded based on making a good-faith effort to attempt all questions covered in class. You are welcome to, but not required, to work on AEs beyond lecture.

Successful on-time effort on at least 80% of AEs will result in full credit for AEs in the final course grade.

Grading

The final course grade will be calculated as follows:

Category	Percentage
Homework	40%
Exam 01	20%
Exam 02	20%
Live Coding	10%
Application exercises	10%

The final letter grade will be determined based on the following thresholds:

Letter Grade	Final Course Grade
A	>= 93
A-	90 - 92.99
B+	87 - 89.99
B	83 - 86.99
B-	80 - 82.99
C+	77 - 79.99
C	73 - 76.99
C-	70 - 72.99
D+	67 - 69.99
D	63 - 66.99
D-	60 - 62.99
F	< 60

Course policies

Duke Community Standard

All students must adhere to the Duke Community Standard (DCS): Duke University is a community dedicated to scholarship, leadership, and service and to the principles of honesty, fairness, and accountability. Citizens of this community commit to reflect upon these principles in all academic and non-academic endeavors, and to protect and promote a culture of integrity.

To uphold the Duke Community Standard, students agree:

- I will not lie, cheat, or steal in my academic endeavors;

- I will conduct myself honorably in all my endeavors;and
- I will act if the Standard is compromised.

Academic honesty

TL;DR: Don't cheat!

- The homework assignments must be completed individually and you are welcomed to discuss the assignment with classmates at a high level (e.g., discuss what's the best way for approaching a problem, what functions are useful for accomplishing a particular task, etc.). However you may not directly share answers to homework questions (including any code) with anyone other than myself and the teaching assistants.
- You may not discuss or otherwise work with others on the exams. Unauthorized collaboration or using unauthorized materials will be considered a violation for all students involved. More details will be given closer to the exam date.
- **Reusing code**: Unless explicitly stated otherwise, you may make use of online resources (e.g. StackOverflow) for coding examples on assignments. If you directly use code from an outside source (or use it as inspiration), you must explicitly cite where you obtained the code. Any recycled code that is discovered and is not explicitly cited will be treated as plagiarism.
- **Use of artificial intelligence (AI)**: You should treat AI tools, such as ChatGPT, the same as other online resources. There are two guiding principles that govern how you can use AI in this course:[2] (1) *Cognitive dimension:* Working with AI should not reduce your ability to think clearly. We will practice using AI to facilitate—rather than hinder—learning. (2) *Ethical dimension*: Students using AI should be transparent about their use and make sure it aligns with academic integrity.
  - **AI tools for code:** You may make use of the technology for coding examples on assignments; if you do so, you must explicitly cite where you obtained the code. Any recycled code that is discovered and is not explicitly cited will be treated as plagiarism. You may use these guidelines for citing AI-generated content.
  - **No AI tools for narrative:** Unless instructed otherwise, AI is **not** permitted for writing narrative on assignments. In general, you may use AI as a resource as you complete assignments but not to answer the exercises for you. You are ultimately responsible for the work you turn in; it should reflect your understanding of the course content.

[2]These guiding principles are based on *Course Policies related to ChatGPT and other AI Tools* developed by Joel Gladd, Ph.D.

If you are unsure if the use of a particular resource complies with the academic honesty policy, please ask a member of the teaching team.

Regardless of course delivery format, it is the responsibility of all students to understand and follow all Duke policies, including academic integrity (e.g., completing one's own work, following proper citation of sources, adhering to guidance around group work projects,and more). Ignoring these requirements is a violation of the Duke Community Standard. Any questions and/or concerns regarding academic integrity can be directed to the Office of Student Conduct and Community Standards at conduct@duke.edu.

Late work policy

The due dates for assignments are there to help you keep up with the course material and to ensure the teaching team can provide feedback in a timely manner. We understand that things come up periodically that could make it difficult to submit an assignment by the deadline. *Note that the lowest homework assignment will be dropped to accommodate such circumstances.*

- Homework may be submitted up to 2 days late. There will be a 5% deduction for each 24-hour period the assignment is late.
- The late work policy for exams will be provided with the exam instructions.

Waiver for extenuating circumstances

If there are circumstances that prevent you from completing a homework assignment by the stated due date, you may email me at sib2@duke.edu before the deadline to waive the late penalty. In your email, you only need to request the waiver; you do not need to provide explanation. *This waiver may only be used once in the semester, so only use it for a truly extenuating circumstance.*

If there are circumstances that are having a longer-term impact on your academic performance, please let your director of graduate studies (DGS) know, as they can be a resource. Please let me know if you need help contacting your DGS.

Regrade Requests

Regrade requests must be submitted on Gradescope within a week of when an assignment is returned. Regrade requests will be considered if there was an error in the grade calculation or if you feel a correct answer was mistakenly marked as incorrect. Requests to dispute the number of points deducted for an incorrect response will not be considered. Note that by submitting a regrade request, the entire question will be graded which could potentially result in losing points.

No grades will be changed after the last day of classes.

Attendance policy

Every student is expected to attend and participate in lecture. There may be times, however, when you cannot attend class. Lecture recordings will be made available upon request for students who have an excused absence. If you miss a lecture, make sure to review the material and complete the application exercise, if applicable, before the next lecture.

Accommodations

Academic accommodations

If you need accommodations for this class, you will need to register with the Student Disability Access Office (SDAO) and provide them with documentation related to your needs. SDAO will work with you to determine what accommodations are appropriate for your situation. Please note that accommodations are not retroactive and disability accommodations cannot be provided until a Faculty Accommodation Letter has been given to me. Please contact SDAO for more information: sdao@duke.edu or access.duke.edu.

Academic and wellness support

CAPS

Duke Counseling & Psychological Services (CAPS) helps Duke Students enhance strengths and develop abilities to successfully live, grow and learn in their personal and academic lives. CAPS recognizes that we are living in unprecedented times and that the changes, challenges and stressors brought on by the COVID-19 pandemic have impacted everyone, often in ways that are tax our well-being. CAPS offers many services to Duke undergraduate students, including brief individual and group counseling, couples counseling and more. CAPS staff also provides outreach to student groups, particularly programs supportive of at-risk populations, on a wide range of issues impacting them in various aspects of campus life. CAPS provides services to students via Telehealth. To initiate services, you can contact their front desk at 919-660-1000.

Important dates

- **January 7**: Classes begin
- **January 19**: MLK Jr Day. No classes
- **January 21**: Drop/Add ends
- **March 7 - 15**: Spring Break. No classes
- **April 15**: Graduate classes end.
- **April 16**: Reading period begins (no classes or projects are due during the reading period).
- **April 26**: Reading period ends.
- **April 27 - May 2**: Final exam period

Click here for the full Duke academic calendar.