Syllabus: STAT 6730
Introduction to Computational Statistics
Autumn 2024

Course Information

- **Course times and location:** MW 1:50pm – 2:45pm in
  - M – lecture – Dreese Lab 264
  - W – computer lab (bring a laptop) – Eighteenth Avenue Building 295
- **Credit hours:** 2
- **Mode of delivery:** In-Person (P)
- **Office hours:** in person: Mondays 3pm-4pm
  Zoom : by appointment

Instructor

- **Name:** Sally Paganin
- **Email:** paganin.1@osu.edu
- **Office location:** 229 Cockins Hall

Communications:

- My preferred method for questions is **email.**
- My class-wide communications will be sent through the Announcements tool in CarmenCanvas. Please check your notification preferences (go.osu.edu/canvas-notifications) to be sure you receive these messages.

Teaching Assistant

- **Name:** Kiljae Lee
- **Email:** Lee.10428@buckeyemail.osu.edu

Course Prerequisites

This course is intended to be taken during the second year of the MAS program. Students are expected to have exposure at a mathematical level to foundational concepts in probability and statistics including random variables, estimation, hypothesis testing, and linear regression. The formal prerequisites for this course are: Stat 6301 and 6302 or equivalent; Stat 6410 and 6450, or Stat 6910 and 6950, or permission of the instruction. Previous programming experience is not required, but familiarity with computer systems is expected.

Course Description

Computational statistics is an area within statistics that encompasses computational and graphical approaches to solving statistical problems. Students will learn how to manipulate data, design, and perform simple Monte Carlo experiments, and be able to use resampling methods such as Bootstrap. They will be introduced to technologies that are useful for statistical computing. By creating customized graphical and numerical summaries, students can discuss the results obtained from their analyses. The topics of the course include:

1. Introduction to R
2. Dynamic and reproducible reports with Quarto
3. Data manipulation in R
4. Visualization of data
5. Smoothing and density estimation
6. Generating random variables
7. Monte Carlo simulation
8. The Bootstrap
9. Permutation methods
10. Cross-validation

Learning Outcomes

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

- Produce dynamic and reproducible reports with Quarto
- Visualize various types of data in R using the ggplot2 package
- Import, manipulate and summarize data in R
- Write and execute R functions that involve iterations or conditional statements
- Apply computational methods including Monte Carlo, smoothing and density estimation, the bootstrap and permutation methods

Course Materials, Fees, and Technologies

The primary resource for reading will be slides and additional references assigned for reading by the instructor. There is one required book for the course that will be used for the parts of the course dealing with data manipulation and visualization in R. The web version of the books can be accessed freely from any web browser.

Note that there are two editions of the book. A second edition of the book has been released in June 2023. However, some important chapters for the course have been discarded in the second edition, so few readings will refer to the first edition of the book.

Required Materials

- [**R4DS_1**] Hadley Wickham, and Garrett Grolemund (2017): *R for Data Science*
  Electronic version: https://r4ds.had.co.nz/index.html
- [**R4DS_2**] Hadley Wickham, Mine Çetinkaya-Rundel, and Garrett Grolemund (2023): *R for Data Science (2e)*.
  Electronic version: https://r4ds.hadley.nz.

I will highlight other useful references as the course progresses.

Required Equipment

- **Computer:** current Mac (macOS) or PC (Windows or Linux) with a high-speed internet connection, capable of running R and RStudio (described below).
  Note: A computer will be also needed for the in-person labs on Wednesdays.

Required Software

- This class requires you to use the statistical software called R (The R Project for Statistical Computing; http://www.r-project.org/ . This software 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
- An easy-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 https://posit.co/downloads/. **Note that RStudio requires R to be installed.**

Grading and Faculty Response

How Your Grade is Calculated

Assignment Category	Percentage
Homework	15%
Labs	15%
Exam 1 (October 2)	25%
Exam 2 (November 13)	25%
Final project	20%

See Course schedule for due dates.

Assignment Information

Homework

- Homeworks will generally be assigned on a biweekly basis
- Students are required to use **Quarto** for their homeworks. The homeworks should be written in a style that smoothly integrates prose, code, tables, and graphics. It should be **human-readable**, and it should not simply contain computer output with no explanation.
- Submit both the **Quarto** source (.qmd) and **HTML** output to CarmenCanvas.
- Homework will be graded on a 3-point scale: 1 point for good-faith effort, 1 point for technically correct working solutions, 1 point for well-formatted and easily-readable code.

Labs

- Labs will consist of exercises to be completed during Wednesday meetings.
- As with homework, students are required to use Quarto and the lab report should be written in a style that smoothly integrates prose, code, tables, and graphics.
- Labs are due within 24 hours of the end of the class meeting and should be submitted as **Quarto** source (.qmd) and **HTML** to CarmenCanvas.
- Labs will be graded on the same 3-point scale as the homework.

Homework and lab assignments in the wrong format (e.g., .pdf, plain text, .doc) will receive 0 points automatically, no exceptions.

Exams

There will be two exams. Both exams are open book/internet access, but absolutely **no use of GenAI tools or communication with other humans**. Each exam is cumulative.

Final Project

Students will work in small groups on a final data analysis project. The instructor will provide a list of topics. Each group will cooperate on the data analysis, report writing, and making a presentation on the project in class. Details will be announced on CarmenCanvas and during one of the lectures.

Academic integrity and collaboration: Your written assignments, including discussion posts and code, should be your own original work.

Use of GenAI tools in assignments

In a hands-on class like this one, the internet plays a significant role in learning, especially when dealing with coding and debugging. It is acceptable to use online resources, including generative artificial intelligence (GenAI), for tasks such as clarifying lecture material, seeking examples, and brainstorming ideas. Just as you would consult with a classmate for these purposes without violating academic integrity, you may also turn to GenAI. Students are permitted to use GenAI tools with this declination for most course assignments, **except for exams**.

If you use GenAI in any of your assignments, please include a statement in your assignment specifying the name of the tool you used (e.g. ChatGPT, Copilot, etc..) and how you used it. You are responsible for ensuring that the information you submit based on a GenAI query does not contain misinformation, unethical content, or violate intellectual property laws. Submission of GenAI-generated content as your own work is considered a violation of Ohio State's Academic Integrity policy and Code of Student Conduct because the work is not your own. The use of unauthorized GenAI tools will result in referral to the Committee on Academic Misconduct.

If I suspect that you have used GenAI inappropriately on an assignment for this course, I will ask you to communicate with me to explain your process for completing the assignment in question.

Late Assignments

Generally, late homework and labs will not be accepted. However, if there are extenuating circumstances beyond your control, please contact the course instructor immediately.

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

Instructor 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 614-688-4357 (HELP) at any time if you have a technical problem.

- **Preferred contact method:** If you have a question, please contact me first through my Ohio State email address. I will reply to emails within **48 hours on days when class is in session at the university**.
- **Class announcements:** I will send all important class-wide messages through the Announcements tool in CarmenCanvas. Please check your notification preferences (go.osu.edu/canvas-notifications) to ensure you receive these messages.
- **Grading and feedback:** For homework and lab assignments, you can generally expect feedback and grades within **7 days**.

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. A more conversational tone 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. I will provide specific guidance for discussions on controversial or personal topics.

- **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.

Academic Integrity Policy

See Descriptions of Major Course Assignments for specific guidelines about collaboration and academic integrity in the context of this class.

Ohio State's Academic Integrity Policy

Academic integrity is essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. Thus, The Ohio State University and the Committee on Academic Misconduct (COAM) expect that all students have read and understand the university's Code of Student Conduct (studentconduct.osu.edu), and that all students will complete all academic and scholarly assignments with fairness and honesty. Students must recognize that failure to follow the rules and guidelines established in the university's *Code of Student Conduct* and this syllabus may constitute "Academic Misconduct."

The Ohio State University's *Code of Student Conduct* (Section 3335-23-04) defines academic misconduct as: "Any activity that tends to compromise the academic integrity of the university or subvert the educational process." Examples of academic misconduct include (but are not limited to) plagiarism, collusion (unauthorized collaboration), copying the work of another student, and possession of unauthorized materials during an examination. Ignorance of the university's *Code of Student Conduct* is never considered an excuse for academic misconduct, so I recommend that you review the *Code of Student Conduct* and, specifically, the sections dealing with academic misconduct.

If I suspect that a student has committed academic misconduct in this course, I am obligated by university rules to report my suspicions to the Committee on Academic Misconduct

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/**.

Other sources of information on academic misconduct (integrity) to which you can refer include:

- Committee on Academic Misconduct (go.osu.edu/coam)
- Ten Suggestions for Preserving Academic Integrity (go.osu.edu/ten-suggestions)
- Eight Cardinal Rules of Academic Integrity (go.osu.edu/cardinal-rules)

Religious accommodations

Ohio State has had a longstanding practice of making reasonable academic accommodations for students' religious beliefs and practices in accordance with applicable law. In 2023, Ohio State updated its practice to align with new state legislation. Under this new provision, students must be in early communication with their instructors regarding any known accommodation requests for religious beliefs and practices, providing notice of specific dates for which they request alternative accommodations within 14 days after the first instructional day of the course. Instructors in turn shall not question the sincerity of a student's religious or spiritual belief system in reviewing such requests and shall keep requests for accommodations confidential.

With sufficient notice, instructors will provide students with reasonable alternative accommodations with regard to examinations and other academic requirements with respect to students' sincerely held religious beliefs and practices by allowing up to three absences each semester for the student to attend or participate in religious activities. Examples of religious accommodations can include, but are not limited to, rescheduling an exam, altering the time of a student's presentation, allowing make-up assignments to substitute for missed class work, or flexibility in due dates or research responsibilities. If concerns arise about a requested accommodation, instructors are to consult their tenure initiating unit head for assistance.

A student's request for time off shall be provided if the student's sincerely held religious belief or practice severely affects the student's ability to take an exam or meet an academic requirement and the student has notified their instructor, in writing during the first 14 days after the course begins, of the date of each absence. Although students are required to provide notice within the first 14 days after a course begins, instructors are strongly encouraged to work with the student to provide a reasonable accommodation if a request is made outside the notice period. A student may not be penalized for an absence approved under this policy.
If students have questions or disputes related to academic accommodations, they should contact their course instructor, and then their department or college office. For questions or to report discrimination or harassment based on religion, individuals should contact the Office of Institutional Equity. (Policy: Religious Holidays, Holy Days and Observances)

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.**

Creating an Environment Free from Harassment, Discrimination, and Sexual Misconduct

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.

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 ill and need to miss class, including if you are staying home and away from others while experiencing symptoms of a viral infection or fever, please let me know immediately. In cases where illness interacts with an underlying medical condition, please consult with Student Life Disability Services to request reasonable accommodations. You can connect with them at slds@osu.edu; 614-292-3307; or slds.osu.edu.

Disability Services Contact Information

- Phone: 614-292-3307
- Website: slds.osu.edu
- Email: slds@osu.edu
- In person: Baker Hall 098, 113 W. 12th Avenue

Accessibility of Course Technology

This course requires use of CarmenCanvas (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 as early as possible.

- CarmenCanvas accessibility (go.osu.edu/canvas-accessibility)
- Streaming audio and video
- CarmenZoom accessibility (go.osu.edu/zoom-accessibility)

Course Schedule (tentative)

Refer to the CarmenCanvas course site for up-to-date information.

R4DS_1 - 1 edition https://r4ds.had.co.nz/index.html
R4DS_2 - 2 edition https://r4ds.hadley.nz

Date	Day	Topic	Reading	Due
8/21	W	Course overview and introduction	R4DS_2 Intro, 2	
8/26	M	Data types in R	R4DS_2 6	
8/28	W	Lists and data frames in R	R4DS_1 10	
9/02	M	**No class - Labor Day**		
9/04	W	Data manipulation and summarization in R	R4DS_2 3	
9/09	M	Grammar of graphics	R4DS_2 2	
9/11	W	Lab 1: ggplot2		HW1
9/16	M	Smoothing		
9/18	W	Lab 2: Smoothing		
9/23	M	Functions	R4DS_2 25	
9/25	W	Lab 3: Functions		HW2
9/30	M	Density estimation		
10/02	W	**Exam 1**		
10/07	M	Generating random variables		
10/09	W	Lab 4: Conditionals and iteration	R4DS_1 21-21.4	
10/14	M	Monte Carlo integration		

10/16	W	Lab 5: Monte Carlo		
10/21	M	The Bootstrap		HW3
10/23	W	Lab 6: The Bootstrap		
10/28	M	Functional programming with purrr	R4DS_1 21.4-21.9	
10/30	W	Lab 7: Functional programming with purrr		
11/04	M	Permutation tests		HW4
11/06	W	Lab 8: Permutation tests		
11/11	M	**No Class – Veterans day**		
11/13	W	**Exam 2**		
11/18	M	Cross-validation		
11/20	W	Lab 9: Cross-validation		
11/25	M	Efficiency & projects in R (*) (* potentially online)		HW5
11/27	W	**No Class – Thanksgiving break**		
12/02	M	** Project presentations**		
12/04	W	** Project presentations**		
12/11	W	Final project due		