Introduction to Computational Statistics Syllabus

STAT 6730 Autumn 2021

Course Information

- **Course times and location:** MW 1:50pm – 2:45pm in Enarson 209 (Mondays) and EA 295 (Wednesdays)
- **Credit hours:** 2
- **Mode of delivery:** In-Person (P)

Instructor

- **Name:** Vincent Q. Vu
- **Email:** vu.104@osu.edu
- **Office location:** 428B Cockins Hall
- **Office hours:** Tuesdays 2:00pm – 3:00pm via CarmenZoom (link in CarmenCanvas)
- **Preferred means of communication:**
    - My preferred method of communication 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:** Rui Zhang
- **Email:** zhang.9473@osu.edu

Course Prerequisites

This course is intended to be taking during the second year of the MAS program. It is expected that students will 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 the Bootstrap. They will be introduced to technologies that are useful for statistical computing. Through creating customized graphical and numerical summaries students will be able to discuss the results obtained from their analyses. The topics of the course include:

1. Introduction to R
2. Dynamic and reproducible reports with R Markdown
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 R Markdown
- 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 course dealing with data manipulation and visualization in R:

Required Materials

- [**R4DS**] Grolemund and Wickham (2016): *R for Data Science*. Electronic version: http://r4ds.had.co.nz. This web version of the book can be accessed freely from any web browser.

Required Equipment

- **Computer:** current Mac (macOS) or PC (Windows or Linux) with high-speed internet connection, capable of running R and RStudio (described below)

Required Software

R and **RStudio:** Students will be required to use R and RStudio software. RStudio can be downloaded for free at https://www.rstudio.com/. **Before installing RStudio, you must also download and install the base R software at** https://cloud.r-project.org/**.** You are expected to install R and RStudio on your personal computer by downloading the software from the links above.

Grading and Faculty Response

How Your Grade is Calculated

Assignment Category	Percentage
Homework	15%
Labs	15%
Exam 1 (October 6)	20%
Exam 2 (November 10)	20%
Final project	30%

See Course Schedule for due dates.

Assignment Information

Homework

Homeworks will generally be assigned on a biweekly basis. Students are required to use **R Markdown** 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 **R Markdown** source 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-formated and easily-readable code.

Labs

Labs will consist of exercises to be completed during Wednesday meetings. As with homework, students are required to use R Markdown and the lab report should be written in a stytle 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 R Markdown source to CarmenCanvas.

Exams

There will be two in-class exams. Both exams are open book/internet access, but absolutely no communicating 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.

Late Assignments

If you absolutely need turn in an assignment late and have a valid excuse, please see me for the necessary arrangements. However, you must notify me in advance in such a situation. Exceptions to this policy will be permitted only in extreme situations such as serious injury immediately prior to an assignment being due or severe illness requiring hospitalization.

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 **24 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.
- **Discussion board:** I will check and reply to messages in the discussion boards within **48 hours on days when class is in session at the university**.

- **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 online 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. If COAM determines that you have violated the university's Code of Student Conduct (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in this course and suspension or dismissal from the university.
If you have any questions about the above policy or what constitutes academic misconduct in this course, please contact me.

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)

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.

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

The Ohio State University is committed to building and maintaining a community to reflect diversity and to improve opportunities for all. All Buckeyes have the right to be free from harassment, discrimination, and sexual misconduct. Ohio State does not discriminate on the basis of age, ancestry, color, disability, ethnicity, gender, gender identity or expression, genetic information, HIV/AIDS status, military status, national origin, pregnancy (childbirth, false pregnancy, termination of pregnancy, or recovery therefrom), race, religion, sex, sexual orientation, or protected veteran status, or any other bases under the law, in its activities, academic programs, admission, and employment. Members of the university community also have the right to be free from all forms of sexual misconduct: sexual harassment, sexual assault, relationship violence, stalking, and sexual exploitation.

To report harassment, discrimination, sexual misconduct, or retaliation and/or seek confidential and non-confidential resources and supportive measures, contact the Office of Institutional Equity:

1. Online reporting form at equity.osu.edu,
2. Call 614-247-5838 or TTY 614-688-8605,
3. Or email equity@osu.edu

The university is committed to stopping sexual misconduct, preventing its recurrence, eliminating any hostile environment, and remedying its discriminatory effects. All university employees have reporting responsibilities to the Office of Institutional Equity to ensure the university can take appropriate action:

- All university employees, except those exempted by legal privilege of confidentiality or expressly identified as a confidential reporter, have an obligation to report incidents of sexual assault immediately.
- The following employees have an obligation to report all other forms of sexual misconduct as soon as practicable but at most within five workdays of becoming aware of such information: 1. Any human resource professional (HRP); 2. Anyone who supervises faculty, staff, students, or volunteers; 3. Chair/director; and 4. Faculty member.

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. No matter where you are engaged in distance learning, The Ohio State University's Student Life Counseling and Consultation Service (CCS) is here to support you. If you find yourself feeling isolated, anxious or overwhelmed, on-demand mental health resources (go.osu.edu/ccsondemand) are available. You can reach an on-call counselor when CCS is closed at 614- 292-5766**. 24-hour emergency help** is available through the National Suicide Prevention Lifeline website (suicidepreventionlifeline.org) or by calling 1-800-273-8255(TALK). The Ohio State Wellness app (go.osu.edu/wellnessapp) is also a great resource.

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

Accessibility Accommodations for Students with Disabilities

Requesting Accommodations

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 (SLDS). After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. In light of the current pandemic, students seeking to request COVID-related accommodations may do so through the university's request process, managed by Student Life Disability Services.

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 online 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.

Date	Day	Topic	Reading	Due
8/25	W	Overview, Introduction to R	R4DS 4	
8/30	M	Data types in R	R4DS 6	
9/1	W	Lists and data frames in R	R4DS 10	
9/6	M	**No class**		
9/8	W	Data manipulation and summarization in R	R4DS 5	
9/13	M	Grammar of graphics	R4DS 3	
9/15	W	Lab 1: ggplot2		HW1
9/20	M	Smoothing		
9/22	W	Lab 2: Smoothing		
9/27	M	Functions	R4DS 19	
9/29	W	Lab 3: Functions		HW2
10/4	M	Density estimation		
10/6	W	**Exam 1**		
10/11	M	Generating random variables		
10/13	W	Lab 4: Conditionals and iteration	R4DS 21-21.4	
10/18	M	Monte Carlo integration		
10/20	W	Lab 5: Monte Carlo		HW3
10/25	M	The Bootstrap		
10/27	W	Lab 6: The Bootstrap		
11/1	M	Functional programming with purrr	R4DS 21.4-21.9	
11/3	W	Lab 7: Functional programming with purrr		HW4

Date	Day	Topic	Reading	Due
11/8	M	pipes and dplyr	R4DS 18	
11/10	W	**Exam 2**		
11/15	M	Permutation tests		
11/17	W	Lab 8: Permutation tests		
11/22	M	rsample		
11/24	W	**No Class**		
11/29	M	Cross-validation		
12/1	W	Lab 9: Cross-validation		HW5
12/6	M	TBD		
12/8	W	**Final project presentations**		