Stat 3202: Statistical Inference for Data Analytics
Pomerene 250, Autumn 2021 (23470)

Course Overview

Instructor Information

Instructor: Thomas Metzger, PhD
Email: metzger.181@osu.edu; please do not use my Buckeyemail address.
Office hours: Virtual or in-person meetings by appointment, time/date TBD
Grader: TBD
Teaching Assistant: TBD

Course Delivery

This course meets Tuesdays and Thursdays in Pomerene 250 from 9:35 am - 10:55 am. As of August 2, 2021, masks are required in class for all students. If it is safe and reasonable for you to do so, lecture attendance is mandatory. If you cannot attend due to illness, contact tracing, or another reasonable health-related reason, please let me know in advance and follow all of Ohio State's guidelines on health and safety. Autumn 2021 lasts 16 weeks, but due to holidays and break days not every week will have both lectures. Each lecture will be labeled with a week number and a letter, "A" (Tuesday lecture) or "B" (Thursday lecture). For example, the Thursday lecture of week 3 will be Lecture 3B.

Lab tutorials and supplemental problems will be provided during your corresponding recitation time. Lab assignments will be due at the end of each week. These meetings will take place in Pomerene 155. Each lab will be labeled with a week number, but not every week will have a lab. For example, the week 7 lab will be Lab 7.

Course Description

Foundational inferential methods for learning about populations from samples, including point and interval estimation, and the formulation and testing of hypotheses. Statistical theory is introduced to justify the approaches. The course emphasizes challenges that arise when applying classical ideas to big data, partially through the use of computational and simulation techniques. Prereq: C- or better in 3201, or permission of instructor. Not open to students with credit for 4202.

Course learning outcomes

By the end of this course, students should successfully be able to:
- Compare the performance of estimators via bias, mean squared error, consistency, and sufficiency
- Use Monte Carlo simulation to model the performance of estimators and testing procedures
- Propose estimators via the method of moments and maximum likelihood estimation
- Use the Central Limit Theorem to model the sample distribution of a sample mean
- Conduct hypothesis tests on mean and variance parameters, including t-tests, chi-square tests, and F tests
- Determine and interpret the power and type-II error of a test
- Use bootstrapping to conduct inference
- Perform nonparametric hypothesis tests on mean parameters

Materials

Text

- Required text: Stat 3202 Course Notes (electronic, on Carmen)
- Recommended text: Mathematical Statistics with Applications, 7th edition, by Wackerly, Mendenhall, and Scheaffer, Brooks/Cole, Cengage Learning, 2008. eBook PDFs are much cheaper and are highly encouraged.

Software

- Required software: we will extensively use the statistical software package called R (The R Project for Statistical Computing; http://www.r-project.org/). This software package is available for free. 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. Tutorials are available in the Swirl system, which you can learn about at http://swirlstats.com/. "R Programming: The basics of programming in R" is an appropriate first tutorial for students who have never used R.
- Required software: we will also use the R interface 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.
- Required software: 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.

Grades and Assignments

Homework

Homework assignments will comprise 20% of your grade for the course. Assignments will only be accepted through Carmen as a .pdf file submission, with clear and organized work and relevant code and output provided. Every assigned problem should be completed, but only a subset of problems may be graded. You are encouraged to collaborate remotely on homework assignments, but ultimately the work you submit must be your own.

Labs

Lab assignments will comprise 20% of your grade for the course. Most weeks a lab assignment will be introduced during recitation, incorporating recent lecture topics with coding. Labs will be due Fridays before 11:59 pm. You are encouraged to collaborate remotely on lab assignments, but ultimately the work you submit must be your own. Labs will be completed in R Markdown and must be compiled into organized, professional PDF documents. Relevant plots should be included and labeled, code should be organized and clear, and supporting answers and text should be properly formatted and professionally written.

Lecture Assignments

Lecture assignments will comprise 15% of your grade for the course. These short, graded assignments will frequently be given during lectures, or, as Carmen quizzes posted shortly after lecture. The purpose of these assignments is to give you practice, ensure you are staying up to date with course content, incentivize attendance and participation, and to give me a chance to quickly find and address any misconceptions. Missed

lecture assignments can only be made up if the absence is excused, and, if the student reviews the material on their own time and attends office hours to make up the assignment.

The requirement for social distancing has been relaxed this semester, so students will be highly encouraged to collaborate on these assignments during class. I will also work to engage with students during these assignments. However, if you are not yet comfortable resuming undistanced interactions, you may choose to remain distanced from myself and from other students without penalty or judgment.

Exams

Three exams, each comprising 15% of your grade, will take place during the semester: Exam 1, covering lectures 1A-5A, will take place Wednesday, September 29 from 6:30 pm - 8:00 pm in Pomerene 250. Exam 2, covering lectures 5B-10B, will take place Wednesday, November 3 from 6:30 pm - 8:00 pm in Pomerene 250. Exam 3 (the final exam), which will be comprehensive but focus on lectures 11A-16A, will take place Friday, December 10 from 8:00 am - 9:45 am in Pomerene 250. If you have a conflict with one of these times, please reach out as soon as possible to arrange an alternate time. Missed exams can only be made up if the absence is excused.

Late Assignments

Late homeworks, labs, and lecture assignments will be accepted for 24 hours after the original due date with a 1% deduction per hour. **After this, no late assignments will be accepted.** Do not wait until the last moment to begin working on assignments. Unexpected obstacles will occur in life - it is your responsibility to be prepared for them. If something unexpected comes up 2 hours before an assignment is due that impedes your ability to submit on time, then you should have started the assignment earlier. Submitting the wrong document - such as the blank assignment template, an incomplete version, or a corrupted version of the file - is not a valid excuse. It is your responsibility to ensure you have submitted the proper document in the proper format.

Can I please have an extension on my homework/lab/lecture assignment?

Yes! You may have up to 24 extra hours, with a 1% deduction per hour. Beyond that, no late assignments will be accepted.

Late exams will not be accepted under any circumstances.

Grading Scale

- Homework: 20%
- Labs: 20%
- Lecture assignments: 15%
- Exam 1: 15%
- Exam 2: 15%
- Final Exam: 15%

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

Attendance, Participation, and Discussion

Students are expected to attend every lecture and every recitation. Because Ohio State does not have a universal student absence policy, absences will be considered on a case by case basis. Your case may be strengthened with documentation such as doctor's notes, OSU athletics schedules, advance notice, and strong prior attendance. In the event of an excused and missed in-class assignment, recitation assignment, or exam, it is the student's responsibility to schedule a mutually agreeable time with their TA or professor to complete the assignment. Just because a student is absent does not guarantee they will be given an opportunity to make up an assignment.

Professionalism and Civility

Above all, please remember to be professional, respectful, and thoughtful.
• Writing style: Please remember to use appropriate grammar, spelling, and punctuation. This includes emails, Carmen comments, written work, and code.
• Tone and civility: Please maintain a supportive learning community where everyone feels safe and where people can disagree amicably. Be respectful in class of your classmates, TAs, graders, and myself.
• 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 pasting into the Carmen discussion.

Academic Integrity

I take academic integrity very seriously. There is no place at The Ohio State University for academic misconduct, and I have submitted many students in the past for violations including copying other students' work and receiving unauthorized assistance on exams.

• Lecture assignments: during class, you are encouraged to collaborate with other students in small groups if you are comfortable doing so, but ultimately the work you submit must be your own. Directly copying another student's work is not permitted.
• Labs: You are encouraged to collaborate on lab assignments, but ultimately the work you submit must be your own. Directly copying another student's code, work, or file is not permitted.
• 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 and peer-review of major written projects is encouraged, remember that comparing answers on an exam is not permitted. If you're unsure about a particular situation, please feel free just to ask ahead of time.

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/.

Health, Safety, and Accommodations

COVID Information

The Ohio State University Wexner Medical Center's Coronavirus Outbreak site (https://wexnermedical.osu.edu/features/coronavirus) includes the latest information about COVID-19 as well as guidance for students, faculty and staff. Be sure to review policies for students that can be found here: https://safeandhealthy.osu.edu/current-students.

As of August 2, all students, faculty and staff are required to wear masks in classrooms and other shared indoor spaces. These include common areas, conference rooms, shared office spaces, hallways, buses and shared vehicles on all Ohio State campuses. Physical distancing is no longer required in classrooms. The university has limited the capacity of some of the largest classes, but there are no longer requirements for a certain physical distance between individuals. Individuals should not eat in classrooms. Individuals can take an occasional drink, but should take masks off only as necessary.

You have voluntarily elected to take the in-person section of this course, so your physical attendance and participation in class is expected every day that it is safe for you to do so. In the event you are unable to attend class for an extended period of time, please reach out to me as soon as possible. If it is reasonable for you to continue participating remotely, all materials will remain accessible for you. In the event I am unable to participate for an extended period of time, I will let students know as soon as possible. A replacement instructor will be available through the Department of Statistics.

Title IX Policy

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.

Student Services and 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.

If you have accommodations, it is your responsibility to communicate these with me in a timely and efficient manner.

Student academic services: http://advising.osu.edu/welcome.shtml

Student support services: http://ssc.osu.edu

Diversity and Inclusion

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.

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

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.

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.

Exam 1: Wednesday, September 29; 6:30-8:00 pm, Pomerene 250
Exam 2: Wednesday, November 3; 6:30-8:00 pm, Pomerene 250
Final Exam: Friday, December 10; 8:00-9:45 am, Pomerene 250

Date	Meeting	Topic	Wackerly & Mendenhall Sections
Tuesday, August 24	**Lecture 1A**	**Course intro; statistics vocab; expectation and variance**	**3.2, 3.3, 4.2, 4.3**
Thursday, August 26	**Lecture 1B**	**Common probability distributions; assessing normality**	**3.4, 3.8, 4.4, 4.5, 4.6**
Monday, August 30	*Recitation 2*	*Simple Monte Carlo and sampling distributions lab*	
Tuesday, August 31	**Lecture 2A**	**Frequently used statistics and sampling distributions**	
Thursday, September 2	**Lecture 2B**	**Monte Carlo simulation and custom R functions**	
Monday, September 6	*Recitation 3*	*No meeting - Labor Day; no lab*	
Tuesday, September 7	**Lecture 3A**	**The central limit theorem; estimators and bias**	**8.1, 8.2**
Thursday, September 9	**Lecture 3B**	**Mean squared error**	**8.2, 8.3**
Monday, September 13	*Recitation 4*	*Illustrating the CLT and MSE lab*	
Tuesday, September 14	**Lecture 4A**	**Consistency**	**9.1, 9.3**
Thursday, September 16	**Lecture 4B**	**Likelihood I**	
Monday, September 20	*Recitation 5*	*Consistency lab*	
Tuesday, September 21	**Lecture 5A**	**Sufficiency**	**9.4**
Thursday, September 23	**Lecture 5B**	**Likelihood II**	**9.6**
Monday, September 27	*Recitation 6*	*Exam 1 review; no lab*	
Tuesday, September 28	**Lecture 6A**	**Method of moments estimation**	**9.4, 9.6**
Thursday, September 30	**Lecture 6B**	**Maximum likelihood estimation**	**9.7**
Monday, October 4	*Recitation 7*	*Computational maximum likelihood lab*	
Tuesday, October 5	**Lecture 7A**	**Intro to inference and confidence intervals**	**8.5, 8.6**
Thursday, October 7	**Lecture 7B**	**CLT-based confidence intervals for mean parameters**	**8.5, 8.6**
Monday, October 11	*Recitation 8*	*CLT-based confidence interval lab*	
Tuesday, October 12	**Lecture 8A**	**The t-Distribution**	**8.8**
Thursday, October 14	**Lecture 8B**	**No meeting - Fall Break**	
Monday, October 18	*Recitation 9*	*t-based confidence interval lab*	
Tuesday, October 19	**Lecture 9A**	**CIs for differences in means; paired and two-sample data**	**8.8**
Thursday, October 21	**Lecture 9B**	**Pooled variance and more CIs for differences in means**	**8.8**
Monday, October 25	*Recitation 10*	*Confidence interval function lab*	
Tuesday, October 26	**Lecture 10A**	**One-sided confidence intervals and practice**	
Thursday, October 28	**Lecture 10B**	**CIs for variance and ratios of variances**	**8.9**
Monday, November 1	*Recitation 11*	*Exam 2 review; no lab*	
Tuesday, November 2	**Lecture 11A**	**Bootstrapping**	
Thursday, November 4	**Lecture 11B**	**Introduction to hypothesis testing**	**10.1, 10.2, 10.3**
Monday, November 8	*Recitation 12*	*Bootstrapping theory lab*	
Tuesday, November 9	**Lecture 12A**	**Hypothesis testing with confidence intervals and type-I error**	**10.5, 10.6**
Thursday, November 11	**Lecture 12B**	**No meeting - Veterans Day**	
Monday, November 15	*Recitation 13*	*Type-I error lab*	
Tuesday, November 16	**Lecture 13A**	**Rejection regions and p-values I**	**10.4**
Thursday, November 18	**Lecture 13B**	**Rejection regions and p-values II**	**10.4**
Monday, November 22	*Recitation 14*	*p-value lab*	
Tuesday, November 23	**Lecture 14A**	**Power and type-II error I**	**15.1, 15.3**
Thursday, November 25	**Lecture 14B**	**No meeting - Thanksgiving Day**	
Monday, November 29	*Recitation 15*	*Simulating power and type-II error lab*	
Tuesday, November 30	**Lecture 15A**	**Power and type-II error II**	**15.1, 15.3**
Thursday, December 2	**Lecture 15B**	**Nonparametrics I**	**15.4, 15.5, 15.6**
Monday, December 6	*Recitation 16*	*Final exam review; no lab*	
Tuesday, December 7	**Lecture 16A**	**Nonparametrics II**	**15.4, 15.5, 15.6**