THE OHIO STATE UNIVERSITY

COLLEGE OF ARTS AND SCIENCES

SYLLABUS: STAT 4301
ADVANCED STATISTICAL INFERENCE
AUTUMN 2025

Course overview

Instructor

Instructor: Sebastian Kurtek
Office: Cockins Hall 440B
Email address: kurtek.1@stat.osu.edu
Office hours: Tuesdays, 2PM-3PM or by appointment

Graduate teaching assistant and tutoring

Arkajyoti Bhattacharjee

Tutoring and GTA office hours will be coordinated through the Data Analytics Learning Center (DALC) (https://data-analytics.osu.edu/dalc) and the Mathematics and Statistics Learning Center (MSLC) (https://mslc.osu.edu/). More details on hours for this course will be coming soon.

Course description

This course will introduce advanced theory and methods for statistical inference at the undergraduate level. This course is primarily intended for seniors in the Statistics major. The course will cover probability theory, statistical models and distributions, and methods for estimation and hypothesis testing. We will discuss mathematical theory behind these approaches and provide examples showing applications of these methods.

Course topics:

1. Introduction to Probability
    a. Introduction to probability and counting methods

   b. Conditional probability, independence, Bayes' Theorem
   c. Discrete random variables and probability distributions
   d. Continuous random variables and probability distributions
   e. Conditional and marginal distributions
2. Functions of random variables
3. Expectation and moments
4. Law of large numbers and central limit theorem
5. Estimation methods
6. Sufficient statistics, Bayes estimators, Fisher information
7. Sampling distribution of estimators, confidence intervals
8. Hypothesis testing

Prerequisite or corequisite

Prerequisites: STAT 3201 and STAT 3202

Course learning outcomes

Upon successful completion of the course, students will be able to

1. Quantify uncertainty about events using mathematical descriptions of probability;
2. Understand important concepts in mathematical statistics;
3. Learn statistical methods for estimation and inference and understand the mathematical theory behind them.

Course materials

Required

Probability and Statistics **by Morris H. DeGroot and Mark H. Schervish**
(Pearson, ISBN: 978-0321500465)

I will also post incomplete lecture notes on Carmen before each class, which will be interactively completed in class through annotation. You are strongly encouraged to regularly attend class to understand the material and be prepared for homework assignments.

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 this course

- Basic computer and web-browsing skills
- Navigating 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

Necessary software

- While this class is primarily theoretical, occasionally we may use the statistical software package called R to illustrate certain methods or theories through simulation (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 the 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 three times per week on Mondays, Wednesdays and Fridays, 10:20AM-11:15AM in Pomerene Hall 250. All assignments will be posted on the Carmen class website. You will be given ample time to complete the assignments. Assignment due dates will be announced in class and on the Carmen course webpage. I will hold weekly in person office hours in my office in Cockins Hall 440B.

Grading and faculty response

Grades

Assignment or category	Percentage
Homework	**45**
Midterm exam	**25**
Final Exam	**30**
Total	**100**

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

Assignment information

Homework: Homework will be assigned regularly (approximately 5-6 assignments over the course of the semester). It will consist of written problems. Homework assignments need to be turned in in-class on the assigned due date. You are encouraged to work together on the problems, but each student must submit their own work, written in their own words. Do not copy any part of another student's homework. 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. Please make sure your solutions are clearly written, complete and legible. I encourage you to talk to me during office hours if you have questions after serious attempts have been made to work on an assignment.

Exams: There will be one in-class midterm exam and a final exam. Coverage includes lecture material, assigned reading, and homework. All exams are in-person and closed book/closed notes. The in-class midterm exam will take place in the usual lecture room during regular class hours. The final exam location and time are set by the university and will be communicated as the information becomes available. Further details will be given in advance of each exam. Statistical tables will be provided as needed. Calculators may be used, but no communication devices are allowed (e.g., mobile phones). You may use one 8.5x11 inch handwritten sheet of paper (both sides) with formulas. I will collect your formula sheets after the exams.

Generally, late assignments will not be accepted, and no make-up exams will be provided. However, if there are extenuating circumstances beyond your control, please contact the course instructor immediately.

Tentative dates for exams.
Tentative date for midterm exam: Wednesday, Oct 29, 2025, during class time.
Final exam (university scheduled): Tuesday, Dec 16, 2025, between 10:00am-11:45am.

The use of generative artificial intelligence (GenAI) tools is not permitted in this course. Any use of GenAI tools for work in this class may therefore be considered a violation of Ohio State's Academic Integrity policy and Code of Student Conduct because the work is not your own. If I suspect that you have used GenAI on an assignment for this course, I will ask you to explain your process for completing the assignment in question. The unauthorized use of GenAI tools will result in referral to the Committee on Academic Misconduct.

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 weekly assignments, you can generally expect graded homeworks back within **14 days**.

E-mail

I will reply to e-mails related to course logistics within **24 hours on school days**. However, if you have questions about course material or regarding homework assignments please visit my office hours or the shared tutoring hours at MSLC or DALC.

Attendance, participation, and discussions

Student participation requirements

The following is a summary of everyone's expected participation:

- **In person class meetings: REQUIRED**
  While formal attendance will not be taken during class, all students are required to attend all in-person lectures and are responsible for all material presented during these lectures. Students will be expected to participate, discuss, and answer questions in lectures.
- **Logging in**: **AT LEAST THREE TIMES PER WEEK**
  Be sure you are logging in to the course in Carmen each week, including weeks with holidays. 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**
  All office hours will be held in person in my office in Cockins Hall 440B. Office hours are optional. If you are required to discuss an assignment with me, please contact me at the beginning of the week if you need a time outside of my scheduled office hours.

Religious accommodations

It is Ohio State's policy to reasonably accommodate the sincerely held religious beliefs and practices of all students. The policy permits a student to be absent for up to three days each academic semester for reasons of faith or religious or spiritual belief.

Students planning to use religious beliefs or practices accommodations for course requirements must inform the instructor in writing no later than 14 days after the course begins. The instructor is then responsible for scheduling an alternative time and date for the course requirement, which may be before or after the original time and date of the course requirement. These alternative accommodations will remain confidential. It is the student's responsibility to ensure that all course assignments are completed.

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.

- **Tone and civility**: Let us maintain a supportive learning community where everyone feels safe and where people can disagree amicably.

- **Citing your sources**: When we have academic discussions, please cite your sources to back up what you say.

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. Guidelines and requirements for campus safety from the University's COVID-19 Transition Task Force were published on July 1 on the Safe and Healthy website (https://safeandhealthy.osu.edu).

Potential disruptions to instruction

- As much as is possible, students will have access to material online if they are unable to attend class because of positive diagnosis, symptoms, or quarantine required following contact tracing. However, please note that lectures will not be recorded.
- If the instructor is unable to be present in person because of positive diagnosis, symptoms, or quarantine following contact tracing, alternative arrangement of instruction will be made. Details will be given on the course website.

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 course

- **Exams**: You must complete the exam by yourself, without any external help or communication.
- **Written assignments**: Your written assignments should be your own original work. You are allowed to discuss with your peers and work together on the assignments. However, the submission must be written in your own words.

- **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.

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 at titleix@osu.edu

Accessibility accommodations for students with disabilities

The university strives to make all learning experiences as accessible as possible. 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. 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; http://slds.osu.edu; 098 Baker Hall, 113 W. 12th Avenue.

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 I 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	Dates	Topics
1	Aug 27, 29	Review of probability, Combinatorial methods
2	Sep 3, 5	Discrete probability distributions, Conditional probability, Bayes' theorem
3	Sep 8, 10, 12	Continuous probability distributions, Conditional and marginal distributions
4	Sep 15, 17, 19	Bivariate distributions, Functions of random variables
5	Sep 22, 24, 26	Functions of random variables
6	Sep 29, Oct 1, 3	Expectation and moments
7	Oct 6, 8, 10	Special distributions – Binomial, Poisson, Hypergeometric Normal, Gamma, Beta, etc.
8	Oct 13, 15	Law of large numbers, Central limit theorem
9	Oct 20, 22, 24	Estimation: method of moments and maximum likelihood estimators
10	Oct 27, 29, 31	Midterm exam review, Midterm Exam (Oct 29), Sufficient statistics
11	Nov 3, 5, 7	Sufficient statistics, Bayes estimators
12	Nov 10, 12, 14	Sampling distribution of estimators, confidence intervals
13	Nov 17, 19, 21	Unbiased estimators, Fisher information, Hypothesis testing
14	Nov 24	Hypothesis testing
15	Dec 1, 3, 5	Hypothesis testing
16	Dec 8, 10	Hypothesis testing, Final exam review