



THE OHIO STATE UNIVERSITY

COLLEGE OF ARTS AND SCIENCES

SYLLABUS: STAT 4301

ADVANCED STATISTICAL INFERENCE

AUTUMN 2024

Course overview

Instructor

Instructor: Subhadeep Paul

Email address: paul.963@osu.edu

Lectures: Mondays, Wednesdays and Fridays, 10:20AM – 11:15 AM at cockins Hall 218.

Office hours: Cockins Hall 231, Thursdays 2:00 – 3:00 PM.

Teaching Assistant and Tutoring

Zhizhen Zhao (zhao.3053@osu.edu)

Tutoring and office hours will be coordinated through Data Analytics Learning Center (DALC) (<https://data-analytics.osu.edu/dalc>) and

Mathematics and Statistics Learning Center (MSLC) (<https://mslc.osu.edu/>). More details on hours for this course coming soon.

Course description

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

Topics we will cover:

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 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 – maximum likelihood estimators
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 those

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 in Carmen before each class, which will be interactively completed in class through annotation. You are not required to study the incomplete lecture notes beforehand. After the lecture is over, I will upload the annotated lecture notes to Carmen.

However, typically the posting of annotated lecture notes will be done with a lag (e.g., all lecture notes for the week posted at the end of the week). Therefore, you are strongly encouraged to come to class regularly to understand the material and be prepared for the 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

Technology skills necessary for this specific course

- Zoom
- Scanning a written solution and submitting a PDF file through 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, occasional 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 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

The course will be **primarily delivered in-person. Occasionally some lectures will be presented online either live over zoom during the lecture time or recorded lectures will be posted on the class website in carmen. In accordance to the university’s policy for in-person modes, we aim to keep approximately 90% of the total lectures in-person.** Please visit the following link for more information on OSU’s in-person teaching modality.

<https://teaching.resources.osu.edu/glossary/term/modality-mode>

Each week we will cover approximately 165 minutes of content in total. You will be responsible for attending in-person and any live online/recorded videos as well as studying the material that is assigned. All incomplete and annotated lecture slides will be posted on the class website in Carmen. In addition to the lectures, assignments will also be posted on the class website. You will be given ample time to complete the assignments.

The instructor will hold weekly office hours in his office at Cockins Hall 231. The times are given above.

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 (about 5-6 assignments over the semester). It will consist of written problems. The homework assignments need to be turned in in-class on the 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 including computer output. 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 and legible.**

Please note late submission of assignments will be penalized at a rate of 5% of points received in the assignment per day they are late. The late penalty may be waived if prior exception has been sought. if you are unable to complete an assignment on time and need extra time, please get in touch with me as soon as possible so we can discuss your situation.

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 at the usual lecture room during regular class hours. The final exam location and time are university scheduled and will be communicated as the information become 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. Makeup exams require a valid excuse and official proof if I am notified in advance or as soon as possible.

Tentative Dates for exams:

Tentative Date for midterm exam: Friday, October 25, 2024, during class time.

Final Exam (University scheduled): Tuesday, Dec 10, 2024, between 10:00am-11:45am.

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 **72 hours on school days**. However, if you have questions on understanding the course materials or regarding the homework assignments please visit my office hours, the shared tutoring hours at MSLC or DALC.

Attendance, participation, and discussions

Students are expected to regularly participate, discuss, and answer questions in in-person lectures. Students may miss class, for a variety of reasons including those related to COVID-19. As much as possible, please stay in contact with the instructor so that we can discuss accommodations should they be needed.

Student participation requirements

- **Logging in: AT LEAST ONCE PER WEEK**
Be sure you are logging in to the course in Carmen each week, including weeks with holidays or weeks with minimal online course activity. (During most weeks you will

probably log in many times.) If you have a situation that might cause you to miss an entire week of class, discuss it with me *as soon as possible*.

- **In-person lectures: REGULAR ATTENDANCE EXPECTED** Students will be expected to participate, discuss, and answer questions during in-person lectures.
- **Office hours: OPTIONAL OR FLEXIBLE**
All office hours are optional.

Other course policies

Health and safety

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. 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.
- 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 exams 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 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.

Course schedule (tentative)

Week	Dates	Topics
1	Aug 21, 23	Review of probability, combinatorial methods
2	Aug 26, 28, 30	Discrete probability distributions, conditional probability and Bayes theorem
3	Sep 4, 6	Continuous probability distributions, conditional and marginal distributions
4	Sep 9, 11, 13	Bivariate distributions, functions of random variables
5	Sep 16, 18, 20	Functions of random variables
6	Sep 23, 25, 27	Expectation and moments
7	Sept 30, Oct 2, 4	Special distributions – Binomial, Poisson, Hypergeometric Normal, Gamma, Beta etc.
8	Oct 7, 9	Law of large numbers and Central limit theorem
9	Oct 14, 16, 18	Estimation – Method of moments and Maximum likelihood estimators
10	Oct 21, 23, 25	Sufficient Statistics, Midterm review, Midterm Exam (Oct 25)
11	Oct 28, 30, Nov 1	Sufficient Statistics, Bayes estimators
12	Nov 4, 6, 8	Sampling distribution of estimators, confidence intervals
13	Nov 13, 15	Unbiased estimators and Fisher information
14	Nov 18, 20, 22	Hypothesis testing
15	Nov 25	Hypothesis testing
16	Dec 2, 4	Hypothesis testing, Final exam review