



THE OHIO STATE UNIVERSITY

COLLEGE OF ARTS AND SCIENCES

# **SYLLABUS: STAT 4301**

## **ADVANCED STATISTICAL INFERENCE (30326)**

### **AUTUMN 2023**

## **Course overview**

### **Instructor**

Instructor: Mario Peruggia

Email address: [peruggia@stat.osu.edu](mailto:peruggia@stat.osu.edu)

Office hours: Virtual Hours via CarmenZoom: Tuesday 1:30-2:30 pm and Thursday 10:00-11:00 am (beginning the second week of class). The instructor will also be available to answer any questions via CarmenZoom by appointment.

Office Location: 205A Cockins Hall

### **Graders**

Jiahao Ping ([ping.24@osu.edu](mailto:ping.24@osu.edu))

Emerson Webb ([webb.944@osu.edu](mailto:webb.944@osu.edu))

Tutoring schedule and mode of delivery to be announced.

### **Course description**

STAT 4301 is a course on advanced statistical theory and is intended for statistics majors in their senior year. Students will learn about advanced probability and statistical methods. They will work with univariate and multivariate distributions, will formulate statistical models, construct confidence intervals, and perform hypothesis tests. Statistical procedures will be motivated by examples and backed by formal theoretical arguments.

## Course learning outcomes

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

- Work with and derive univariate and multivariate distributions.
- Derive distributions of transformed random variables.
- Formulate, construct, and interpret confidence intervals about parameters in a statistical model.
- Formulate statistical hypotheses, construct appropriate hypotheses tests, and interpret results.
- Construct distribution-free hypotheses testing procedures.
- Construct formal mathematical proofs for certain claims.

## Course materials

### Required textbook:

*Probability and statistics*, 4th Edition, by Morris H. DeGroot and Mark H. Schervish (Pearson, ISBN: 978-0321500465)

## Course technology

The course is scheduled to be offered in person. However, office hours will be offered via CarmenZoom. Because of this, certain technical skills for online courses will be relevant.

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>, and support for urgent issues is available 24x7.

- **Self-Service and Chat support:** <http://ocio.osu.edu/selfservice>
- **Phone:** 614-688-HELP (4357)
- **Email:** [ServiceDesk@osu.edu](mailto:ServiceDesk@osu.edu)
- **TDD:** 614-688-8743

### Baseline technical skills necessary for online courses

- Basic computer and web-browsing skills
- Navigating Carmen

### Technology skills necessary for this specific course

- CarmenZoom
- Ability to upload documents to Carmen (Word or PDF format)

## 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

- Although this class is mostly theoretical, on occasion, I may use the statistical software package called R (The R Project for Statistical Computing; <http://www.r-project.org/>) to illustrate certain aspects. However, this software is not a requirement for this class. If you wish to download it, here is the information.
  - 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 <https://posit.co/download/rstudio-desktop/>. **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 is scheduled to be offered in person. We will meet MWF 10:20-11:15 in Pomerene Hall 150.

# Grading and faculty response

## Grades

| Assignment or category | Percentage |
|------------------------|------------|
| Quizzes                | 50         |
| Midterm                | 20         |
| Final Exam             | 30         |
| Total                  | 100        |

## Assignment information

**Homework:** There will be regular recommended homework assignments (approximately 11) that will help you to consolidate your understanding of the topics covered in class. The assignments will consist of selected textbook problems.

The assignments should not be turned in and will not be graded. Rather, on their due date, I will provide homework solutions detailed enough to allow you to understand how the question could be approached. These solutions will be available on the class web site. Feel free to ask me for help and clarification after you have attempted the questions, even before the solutions are posted.

The main reason why I do not intend to count the homework performance toward the final grade is that I view doing the homework as a learning opportunity where students should not be penalized for making mistakes. In addition, pirated copies of the solution manual are available online and I know from experience that some students might be tempted to copy their answers from such sources. Rewarding this type of behavior with credit toward the final grade would put the students who answer the questions honestly at a disadvantage.

**Quizzes:** Short 15-minute quizzes will be given in class on the days listed below at the end of lecture. Each quiz will assess your understanding of problems from the previous homework assignment and related examples covered in class. Doing the homework problems, reviewing their solutions, and attending lecture on a regular basis will enable you to do well on the quizzes. Make-up quizzes will only be given under special, documented circumstances. The lowest quiz score will be dropped.

|         |            |
|---------|------------|
| Quiz 1  | Wed Sep 6  |
| Quiz 2  | Wed Sep 13 |
| Quiz 3  | Wed Sep 20 |
| Quiz 4  | Wed Sep 27 |
| Quiz 5  | Wed Oct 4  |
| Quiz 6  | Wed Oct 25 |
| Quiz 7  | Wed Nov 1  |
| Quiz 8  | Wed Nov 8  |
| Quiz 9  | Mon Nov 20 |
| Quiz 10 | Wed Dec 6  |

**Exams:** There will be one midterm exam and one final exam. All exams will be administered in the classroom. The final exam will take place at the time and date established by the University. Information about the exams will be posted well in advance through the course website.

|         |            |                |                  |
|---------|------------|----------------|------------------|
| Midterm | Wed Oct 11 | 10:20–11:15 am | in the classroom |
| Final   | Tue Dec 12 | 10:00–11:45 am | in the classroom |

All quizzes, midterm, and the final exam are **closed book/closed notes**. There are no make-up exams. A basic calculator is allowed. Tablets, laptops, and cellphones cannot be used during the exams. Statistical tables will be provided as needed.

The topics covered on the quizzes and on the midterm will be announced in class and posted on Carmen.

The final will cover all the material for the course.

## Grading scale

Final grades will be assigned based on performance in the course. The grades will not be lower than those in the “straight scale” of 90% for an A, 80% for a B, 70% for a C and so on. Appropriate adjustments to these cutoffs will be made to account for the difficulty of the quiz and exam questions.

## 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 quizzes and the midterm, you can generally expect feedback within **7 days**.

## E-mail

I will reply to e-mails within **24 hours on school days**.

# Attendance, participation, and discussions

## Student participation requirements

The class is designed around the lectures. Attendance is strongly encouraged as is class participation. If you have questions, ask in class, or see me during office hours.

If you are unable to attend due to COVID-19 or for other reasons, let me know. If you test positive for the virus or believe that you have symptoms, it is best that you take care of health concerns before worrying about this class. Let me know of the situation promptly and we will make special arrangements.

## 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. Informality (including an occasional emoticon) 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.
- **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.

# 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 Reactivation Task Force are published on the Safe and Healthy website (<https://safeandhealthy.osu.edu>).

## Weather or other short-term closing

Should in-person classes be canceled, I will notify you as to which alternative methods of teaching will be offered to ensure continuity of instruction for this class. Communication will be via [CarmenCanvas, email or other mode of communication].

## 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.

## 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:  
<https://artsandsciences.osu.edu/current-students/undergraduate-students/student-resources>.

## Academic integrity policy

### Policies for this course

- **Quizzes and exams:** You must complete the quizzes and exams yourself, without any external help or communication.
- **Written assignments:** In preparation for the quizzes, you are encouraged to work with fellow students on the homework, but please make sure that you acquire your own individual understanding of all the topics.
- **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 have 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 a quiz or assignment is not permitted. If you are unsure about a particular situation, please feel free just to ask ahead of time.

### 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 <https://trustees.osu.edu/bylaws-and-rules/code>.

### 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, Kellie Brennan, at [titleix@osu.edu](mailto:titleix@osu.edu)

### 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](https://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.

## **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](mailto:slds@osu.edu); 614-292-3307; [slds.osu.edu](https://slds.osu.edu); 098 Baker Hall, 113 W. 12th Avenue.

If you are isolating while waiting for a COVID-19 test result, please let me know immediately. Those testing positive for COVID-19 should refer to the Safe and Healthy Buckeyes site for resources. Beyond five days of the required COVID-19 isolation period, I may rely on Student Life Disability Services to establish further reasonable accommodations. You can connect with them at [slds@osu.edu](mailto:slds@osu.edu); 614-292-3307; or [slds.osu.edu](https://slds.osu.edu).

### **Accessibility of course technology**

This course requires use of Carmen (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 with your instructor.

- [Carmen \(Canvas\) accessibility](#)
- Streaming audio and video
- Synchronous course tools

## **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, Readings, Assignments, Deadlines   |
|------|----------------|--|
| 1    | Aug 23, 25     | Review of probability, Discrete probability distributions  |
| 2    | Aug 28 – Sep 1 | Continuous probability distributions; Conditional probability; Independence; Joint distributions; Marginal distributions |
| 3    | Sep 6, 8       | Independence; Conditional distributions; Bayes' Theorem; Multivariate distributions; Functions of random variables       |
| 4    | Sep 11 – 15    | Functions of random variables  |
| 5    | Sep 18 – 22    | Expected values  |
| 6    | Sep 25 – 29    | Expected values, moments   |
| 7    | Oct 2 – 6      | Conditional Expectations; The Bivariate Normal Distribution; Large sample theory   |
| 8    | Oct 9          | Large sample theory  |
| 9    | Oct 16 – 20    | Statistical Inference; Method of Moments Estimators; Prior and Posterior Distributions                                   |
| 10   | Oct 23 – 27    | Conjugate Priors; Bayes Estimators   |
| 11   | Oct 30 – Nov 3 | Maximum Likelihood Estimators  |
| 12   | Nov 6, 8       | Maximum Likelihood Estimators; Sufficiency   |
| 13   | Nov 13 – 17    | Sufficiency; Hypothesis testing  |
| 14   | Nov 20         | Hypothesis testing   |
| 15   | Nov 27 – Dec 1 | Hypothesis testing   |
| 16   | Dec 4, 6       | Hypothesis testing   |