# Stat 24400: Statistical Theory and Methods 1 (Autumn 2024)

Tuesday-Thursday 2:00 - 3:20 pm, Eckhart 133 (5734 S University Ave)

**Course description** This course is the first quarter of a two-quarter systematic introduction to the principles and techniques of statistics, as well as to practical considerations in the analysis of data, with emphasis on the analysis of experimental data. This course covers tools from probability and the elements of statistical theory. Topics include the definitions of probability and random variables, binomial and other discrete probability distributions, normal and other continuous probability distributions, joint probability distributions and the transformation of random variables, principles of inference (including Bayesian inference), maximum likelihood estimation, hypothesis testing and confidence intervals, likelihood ratio tests, multinomial distributions, and chi-square tests. Examples are drawn from the social, physical, and biological sciences.

See `https://www.stat.uchicago.edu/~yibi/IntroStat` for help deciding between Stat 200, 220, 234, 244, and 24410.

**Course info**

- Instructor: Mei Wang `(meiwang at uchicago dot edu)`

  Office hours: TTh 3:20 - 4 pm (Jones 219; after answering brief post-class questions); and by appointments.

- TAs: Aabesh Bhattacharyya `(aabesh at uchicago dot edu)`
  David Chen `(davchen at uchicago dot edu)`

  Office hours:
  - Fridays 3:30 - 4:30 pm in Eckhart 133 (tentative; room reservation pending)
  - Mondays 4:30 - 5:30 pm in Eckhart 133 (tentative; room reservation pending)

- The main course page is on Canvas, where registered students can find all lecture slides, assignments, etc. Homework assignments will be handed in and graded on *Gradescope*. We will use *Ed Discussion* for Q&A.

- The course will be in-person, no recording.
  Lectures will be posted shortly before each class under *Modules* (link in sidebar in Canvas).

**Contacting us** We will try to reply to all questions within 24 hours.

- For any questions about the material or assignments or exams (aside from regrade requests), please contact us through the discussion boards on Ed Discussion.
  - You can write a public post if appropriate (e.g., questions about material, clarification on homework, questions to help understand a midterm problem after the exam has been graded, etc). Note that you can choose to post anonymously but your name will still be visible to the instructor and TAs.
  - Alternatively, you can write a private post, visible only to the instructor and TAs (e.g., if you help on a homework problem but posting your question would reveal too much of your work).

- For any questions about your graded HW or exams, please submit a regrade request on Gradescope.
  Please limit your regrading requests to less than 10 during the whole quarter.

- For other questions such as enrollment, prerequisites, accommodations, makeup times for exams, etc, please contact the instructor by brief email.

**Textbook & resources** The textbook for this course is:

- *Mathematical Statistics and Data Analysis*, Rice, 3rd edition.

Several printed copies of the textbook are reserved in Eckhart Library.
The textbook can be purchased from the bookstore or rented from the publisher:
`https://www.cengage.com/c/mathematical-statistics-and-data-analysis-3e-rice/9780534399429PF/`
In homework assignments we will restate any problems from the textbook, however the book is a very useful reference for the material, and we may also be posting suggested practice problems from the textbook.

**Handing in assignments**

- Assignments are due on Tuesdays at 9 am.
- At the end of the quarter, the lowest grade of homework 1-8 (or one missing grade) will be dropped.
  We cannot excuse any missed HWs beyond the one that is dropped.
- To give additional flexibility, late HWs will be accepted with a penalty of 4% per hour (late time is rounded up, i.e., one minute late counts as one hour late).
- Assignments are submitted and graded via Gradescope, which can be accessed from the Canvas course page.
  - For each problem, Gradescope will prompt you to tag the pages containing your answer to that problem. Be sure to tag all the pages that contain any part of your answer — For example if for problem 1, your written explanation is on page 1 and on half of page 2, you will need to tag both of these pages for problem 1.
  - It's fine to have multiple problems on the same page (be sure to tag that page for all problems it contains).
  - Assignment 0 is designed to practice Gradescope submission and should be submitted asap (due Thursday 11 pm of week 1).
- To submit via Gradescope, you will need to upload a single PDF file.

  If photographing/scanning handwritten work via smartphone is needed, you may use the free CamScanner or Dropbox apps to produce a single PDF file containing all pages.
  The pdf you submit should be multiple paged, each page should be of standard letter size.
- You should take uploading time into consideration when submitting homework.

  On rare occasions, if you are having trouble uploading to the website and run out of time due to unforeseeable situations, please email your work to the instructors or TAs before the time HW is due as proof of completion, then complete your submission to Gradescope. The time of your email will count as the time of your HW submission. We do not accept the time stamp of the file on your computer as proof of completion.

**Exams**

- The midterm exam should be taken during class time on Thursday of the 5th week (Oct. 31st).
- The final exam will be given during the registrar-assigned day&time (TBA).

Please contact your instructor immediately if you may need an alternative exam time due to grave reasons such as a health emergency.

**Grading** Tentatively the final grade will be determined by the following:

- Problem sets: 25% (including occasional in-class multiple-choice exercise/activity with little credits)

  The lowest grade among HW 1-8 (or one missing HW) will be dropped.
- Midterm exam: 30%.
- Final exam: 40%.
- Better exam: 5% (e.g., if the final exam score is higher than the midterm score, then 30% midterm, 45% final).

**Collaboration guidelines & plagiarism policy**

For problem sets, students are free to discuss the problems and collaborate on strategies for solving the problems, but all writing, code, etc, should be done completely on your own. For example, working out a solution as a group, then transferring it to your own page, is not acceptable. Referring to material from past quarters of this course is not permitted.

For exams, no collaboration or discussion of any kind is allowed.

Any copied material (from websites, published materials, or another students' work) that is handed in without attribution will be considered to be plagiarism and will be reported to the appropriate university department. Feel free to reach out to the instructor or TAs if you have any questions about what is appropriate for collaboration or online resource use.

Please consult the student manual on university policies and regulations that make it clear that the University will not tolerate cheating and plagiarism: `https://studentmanual.uchicago.edu`

**Recording and Deletion Policies**

The Recording and Deletion Policies for the current academic year can be found in the Student Manual under Petitions, Audio & Video Recording on Campus.

- Do not record, share, or disseminate any videos, transcripts, audio related to the course (including office hours).
- Do not share links for the course to those not currently registered.

By attending course sessions, students acknowledge that:

- They will not: (i) record, share, or disseminate University of Chicago course sessions, transcripts, including any video-audio contents; (ii) retain such materials after the end of the course; or (iii) use such materials for any purpose other than in connection with participation in the course.
- They will not share links to University of Chicago course sessions with any persons not authorized to be in the course session. Sharing course materials with persons authorized to be in the relevant course is permitted. Syllabi, handouts, slides, and other documents may be shared at the discretion of the instructor.
- Course recordings, content, and materials may be covered by copyrights held by the University, the instructor, or third parties. Any unauthorized use of such recordings or course materials may violate such copyrights.
- Any violation of this policy will be referred to the Area Dean of Students.

**Special SDC Accommodations**

The University of Chicago is committed to ensuring equitable access to our academic programs and services. Students with disabilities who have been approved for the use of academic accommodations by Student Disability Services (SDS) and need a reasonable accommodation(s) to participate fully in this course should follow the procedures established by SDS for using accommodations. Timely notifications are required in order to ensure that your accommodations can be implemented. Please contact the instructor to discuss your access needs in this class after you have completed the SDS procedures for requesting accommodations. Phone: (773) 702-6000, Email: `disabilities@uchicago.edu`

**Ackknowledgments**

The construction and preparation of the course benefited greatly from the generous support of several colleagues. Thanks to Professors R. Barber, J. Reinitz, D. Sanz-Alonso, S. Stigler, and Y. Huang for sharing their teaching experiences and course materials, especially to Prof. R. Barber.

**Schedule** (subject to updates)

| Week | Dates | Topics (related sections in the textbook) | Due (Tuesday 9am) |
|---|---|---|---|
| 1 | Tue Oct 1<br><br>Thu Oct 3 | Lecture 1a: Intro to probability (1.2-1.4)<br>Lecture 1b: Conditional probability and independence (1.5-1.6)<br>Lecture 2a: Intro to discrete random variables part 1 (2.1)<br>Lecture 2b: Intro to discrete random variables part 2 (2.1) | P-set 0 due (by Th 11pm) |
| 2 | Tue Oct 8<br><br>Thu Oct 10 | Lecture 3a: Intro to continuous random variables (2.2)<br>Lecture 3b: Random variables and distributions part 1 (2.3)<br>Lecture 4a: Random variables and distributions part 2 (2.3)<br>Lecture 4b: Expected value (4.1) | P-set 1 due |
| 3 | Tue Oct 15<br><br>Thu Oct 17 | Lecture 5a: Variance (4.2)<br>Lecture 5b: Joint distributions part 1 (3.2, 3.5)<br>Lecture 6a: Joint distributions part 2 (3.3-3.4)<br>Lecture 6b: Joint distributions part 3 (3.5-3.6) | P-set 2 due |
| 4 | Tue Oct 22<br><br>Thu Oct 24 | Lecture 7a: Joint distributions part 4 (3.7)<br>Lecture 7b: Covariance and correlation (4.3)<br>Lecture 8a: Conditional expectation and variance part 1 (4.4)<br>Lecture 8b: Conditional expectation and variance part 2 (4.4) | P-set 3 due |
| 5 | Tue Oct 29<br><br>Thu Oct 31 | Lecture 9a: Conditional distrib.'s and intro to Bayesian inference I (3.5, 4.4, 8.6)<br>Lecture 9b: Conditional distrib.'s and intro to Bayesian inference II (3.5, 4.4, 8.6)<br>Midterm exam<br>(During class time) | P-set 4 due |
| 6 | Tue Nov 5<br><br>Thu Nov 7 | Lecture 10a: Introduction to frequentist inference (7.3, 9.2)<br>Lecture 10b: Central limit theorem part 1 (5.2-5.3)<br>Lecture 11a: Central limit theorem part 2 (5.3)<br>Lecture 11b: Moment generating function (4.5, 5.3) | P-set 5 due |
| 7 | Tue No 12<br><br>Thu Nov 14 | Lecture 12a: $\chi^2$ distribution and $t$ distribution (6.2)<br>Lecture 12b: Inference for sample means (6.3, 7.3)<br>Lecture 13a: Parameter estimation (8.3-8.4))<br>Lecture 13b: Maximum likelihood estimation part 1 (8.5) | P-set 6 due |
| 8 | Tue Nov 19<br><br>Thu Nov 21 | Lecture 14a: Maximum likelihood estimation part 2 (8.5)<br>Lecture 14b: Bayesian inference (8.6)<br>Lecture 15a: Hypothesis testing part 1 (9.1-9.2)<br>Lecture 15b: Hypothesis testing part 2 (9.2-9.3) | P-set 7 due |
| 9 | Nov 25-29 | Thanksgiving break | |
| 10 | Tue Dec 3<br><br>Thu Dec 5 | Lecture 16a: Generalized likelihood ratio test (9.4)<br>Lecture 16b: $\chi^2$ test for multinomial data part 1 (9.5, 13.4)<br>Lecture 17a: $\chi^2$ test for multinomial data part 2 (9.5, 13.4)<br>Lecture 17b: Estimation and inference: more examples | P-set 8 due |
| 11 | | Final exam: in-class, time TBA | |