STAT 415-500 – Mathematical Statistics II

Spring 2024

Logistics

- **Instructor:** Samiran Sinha (sinha@stat.tamu.edu)

- **Lecture:** Monday, Wednesday, Friday 10:20am - 11:10am, Blocker 457

- **Office hours:** Monday 11:30am - 1pm, Wednesday 11:30 am- 1 pm, Blocker 415F or via Zoom (link is in Canvas)

Teaching Assistants and Recitations

- **Main TA:** Carrie Lei (jlei@tamu.edu), office hours: Blocker 414B, Zoom link for office hours is in Canvas

- **Alternative TA (Section 501):** Yimin Dai (yimindai1999@tamu.edu), office hours: Friday: 3-5 pm BLOC 452A

- **Shared TA:** Niladri Kal (niladrik@tamu.edu), office hours: Monday: 2-3 pm BLOC 461A, Wednesday: 4-5 pm BLOC 452A

- **Recitation and OH schedule:** All recitations will be held in Blocker 162.

	Monday	Tuesday	Wednesday	Thursday	Friday
8:00		415-501 (L)		415-501 (L)	
8:30		415-501 (L)		415-501 (L)	
9:00		415-501 (L)		415-501 (L)	
9:30					
10:00	415-500 (L)		415-500 (L)		415-500 (L)
10:30	415-500 (L)		415-500 (L)		415-500 (L)
11:00	415-500 (L)		415-500 (L)		415-500 (L)
11:30	Dr. Sinha (OH)	Niladri (R)	Dr. Sinha (OH)		
12:00	Dr. Sinha (OH)	Niladri (R)	Dr. Sinha (OH)		
12:30	Dr. Sinha (OH)		Dr. Sinha (OH)		
1:00					
1:30		Carrie (OH)			
2:00	Niladri (OH)	Carrie (OH)		Carrie (R)	
2:30	Niladri (OH)			Carrie (R)	
3:00	Niladri (R)			Carrie (OH)	Yimin (OH)
3:30	Niladri (R)			Carrie (OH)	Yimin (OH)
4:00		Dr. Arroyo (OH)	Niladri (OH)		Yimin (OH)
4:30		Dr. Arroyo (OH)	Niladri (OH)		Yimin (OH)
5:00		Dr. Arroyo (OH)	Niladri (R)		Yimin (R)
5:30		Dr. Arroyo (OH)	Niladri (R)		Yimin (R)
6:00					
6:30					
7:00					

L: Lecture, OH: Office hours, R: Recitation

Course description
Continuation of the mathematical theory of statistics, including principles for statistical inference, formulation of statistical models, point estimation, confidence intervals, hypothesis testing, and Bayesian inference.

Prerequisites
STAT 414 or MATH 411.

Course learning outcomes
STAT 415 is the second course of an introduction to the concepts of mathematical statistics. At the end of the semester, students will be able to (1) understand how to formulate statistical models, the likelihood function, and the concept of sufficiency and its use in the reduction of data, (2) derive point estimators for specific distributions using the method of moments, least squares, and maximum likelihood, (3) evaluate (asymptotic) properties of estimators based upon bias, variance, and mean squared error, (4) formulate hypothesis tests and derive properties of tests such as level and power.

Course outline

1. *Distributions*:

   - Introduction.
   - Review of probability distributions (Ch. 1 - 5 from the textbook)
   - Exponential family (Ch. 8.8.1)
   - Distributions derived from the normal distribution (Chapter 6)
   - Sampling distributions (Ch. 7.3)

2. *Point estimation*: (Ch. 8)

   - Introduction to statistical inference
   - Methods of finding estimators (method of moments and maximum likelihood)
   - Efficiency and the Cramér-Rao lower bound
   - Sufficiency

3. *Hypothesis testing and interval estimation*: (Ch. 9)

   - Introduction to formulating hypothesis
   - The Neyman-Pearson paradigm
   - Generalized likelihood ratio tests
   - Confidence intervals
   - p-values
   - The duality of confidence intervals and hypothesis tests

4. *Comparing two populations* (Ch. 11)

5. *Analysis of variance* (Ch. 12)

6. *Regression* (Ch. 14)

7. *Bayesian statistical inference* (Ch. 8.6)

Textbook

- Main reference: J. A. Rice, "Mathematical Statistics and Data Analysis, 3rd ed.", Duxbury.

- Optional reference: A. M. Mood et al., "Introduction to the theory of statistics, 3rd ed.", McGraw-Hill.

Course links and communication

- All class materials, notes and homework assignments will be posted at *Canvas* https://canvas.tamu.edu/.

- Homework submission will be done through Canvas.

- We will use Piazza to handle questions and discussions about class materials, assignments and exams. Please sign up with your TAMU email to the class site https://piazza.com/tamu/spring2024/stat415.

- You are encouraged to use these forums to ask questions about the class, as well as answer other classmates' questions. The TAs and the instructor will be monitoring the forums at least once a day and aim to respond within 24 hours during weekdays.

- You are also encouraged to attend office hours to talk questions directly with the instructor and TAs.

Email

- Please use email communication only for personal matters that cannot be solved through the discussion board.

- When communicating via email, please include "STAT 415" in the subject line.

Grading Policy

- Homework assignments: 20% of the total grade.

- Midterm exams: 50% (the best of the two exams) of the total grade

- Final exam: 30% of the total grade.

- Each homework assignment will be graded out of 100.

- Students' grade will be based on the percentage performance score. For example, if a student obtains 620 out of seven homeworks, 88 and 65 in the two midterm exams and 82 in the final exam, then his/her overall score (percentage performance) will be $620 \times 20/700 + \max(88, 65) \times 50/100 + 82 \times 30/100 = 86.31$.

Grading scale
Guaranteed grades according to the percentage performance (PP) are as follows:

$$\text{PP} \geq 85\% \quad \Rightarrow \quad \text{A} \qquad\qquad 85\% > \text{PP} \geq 70\% \quad \Rightarrow \quad \text{B}$$
$$50\% > \text{PP} \geq 70\% \quad \Rightarrow \quad \text{C} \qquad\qquad 50\% > \text{PP} \quad \Rightarrow \quad \text{F}$$

Important Dates

Event	Date
First day of the semester	Jan 16, Tuesday
Midterm 1	Feb 26, Monday, in-class
Spring break	March 11-15
Good Friday (reading day)	March 29
Midterm 2	April 08, Monday, in-class
Q-drop date	April 16, Tuesday
The last day of our class (redefined day for MWF classes)	April 30, Tuesday
Final exam	May 6, Monday, 8-10 am

Homework

- There will be homework assignments approximately every other week, and these will typically be due by 11:59 pm on the assigned date. Below is the <u>tentative calendar</u>.

    1. Homework 1: due on January 26
    2. Homework 2: due on February 09
    3. Homework 3: due on February 23
    4. Homework 4: due on March 8
    5. Homework 5: due on March 28
    6. Homework 6: due on April 12
    7. Homework 7: due on April 26

- The assignments should be submitted electronically as a single PDF on Canvas. Late assignments will not be graded unless there is a university excused absence.

- Each homework carries equal weight in the final grade. The lowest homework score will be dropped, and the final grade will be calculated based on the remaining homeworks.

- The assignments are intended to help you put in practice the concepts learned in class. The problems involve derivations and calculations, and the difficulty level might vary. It is advised to start with the homework early, and to attend office hours and recitations if you have any questions.

- You may discuss homework problems with your colleagues, but the solutions are expected to be your individual work, consistent with the academic integrity policies of the university. You may use class notes, slides and the textbook to complete your work, and you should refrain from using other materials, such as online resources, manuals or solutions from previous years.

Software

We will use R in class and homework assignments occasionally. Some basic knowledge of R is assumed for this course. You are welcome to discuss your coding questions during recitations and office hours. Below are some resources to get you started.

- James Long and Paul Teetor, "R Cookbook, 2nd edition". Available at https://rc2e.com/.

- RStudio, an open source IDE for R https://www.rstudio.com/.

Recitations and office hours

- Attending recitations is an important part of the course. The TAs will discuss examples and problems related to the topics covered in class.

- You are also encouraged to attend office hours to ask questions to the instructor and the TAs directly. Solving class problems and discussing your solutions with others is perhaps the best way to learn the class materials.

- The instructor will hold office hours in person, and via Zoom.

Exams

- Exams will be in-class on the assigned dates. No exams may be taken early or made up, unless a university excused absence with appropriate documentation is provided.

- You must adhere to the academic integrity policies. All answers to the exams should be your own work, only using materials that are explicitly allowed.

- You can bring a one page (letter sized paper) of cheat sheet where you may write (handwritten or printed) anything. You may write on the both sides of the page.

- Midterm exams will focus on the materials covered during the specified periods. The final exam will be cumulative and comprehensive.

- Based on university policy: if you must miss an exam due to illness or other excused absence, please notify the instructor or the Statistics Department as soon as possible (or within two business days after your return) to schedule an alternative solution. An incomplete will be given only in the event you have completed most of the work, but circumstances beyond your control cause prolonged absence from class and the work cannot be made up.

Grading disputes
Your scores will be entered and stored on the Canvas page for the course. You are responsible for keeping track of your scores and to notify the course instructor should there be any missing grades or discrepancies. Your assignments and exams will be returned to you after they had been graded. Please keep all returned assignments and exams. A grading dispute might entail a regrading of the whole submission.

University Policies

COVID Syllabus Statement
To help protect Aggieland and stop the spread of COVID-19, Texas A&M University urges students to be vaccinated and to wear masks in classrooms and all other academic facilities on campus, including labs. Doing so exemplifies the Aggie Core Values of respect, leadership, integrity, and selfless service by putting community concerns above individual preferences. COVID-19 vaccines and masking – regardless of vaccination status – have been shown to be safe and effective at reducing spread to others, infection, hospitalization, and death.

Attendance Policy
The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments. Please refer to Student Rule 7 in its entirety for information about excused absences, including definitions, and related documentation and timelines.

Makeup Work Policy
Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student's grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor. Please refer to Student Rule 7 in its entirety for information about makeup work, including definitions, and related documentation and timelines.

"Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor" (Student Rule 7, Section 7.4.1).

"The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence" (Student Rule 7, Section 7.4.2).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See Student Rule 24.)

Academic Integrity Statement
"An Aggie does not lie, cheat or steal, or tolerate those who do."

"Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one's work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case" (Section 20.1.2.3, Student Rule 20).

You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at `aggiehonor.tamu.edu`.

Americans with Disabilities Act (ADA) Policy
Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit `disability.tamu.edu`. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Title IX and Statement on Limits to Confidentiality
Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking. With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

- The incident is reasonably believed to be discrimination or harassment.

- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention —- including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, a person who is subjected to the alleged conduct will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University's goal is to make sure you are aware of the range of

options available to you and to ensure access to the resources you need. Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS). Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University's Title IX webpage.

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors that influence a student's academic success and overall wellbeing. Students are encouraged to engage in healthy self-care by utilizing available resources and services on your campus Students who need someone to talk to can contact Counseling and Psychological Services (CAPS) or call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at `suicidepreventionlifeline.org`.

Copyright notice

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