Syllabus: STA 732 – Statistical Inference

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Duke University

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Course Description

This course provides a comprehensive introduction to the theory of statistical inference, covering classical, likelihood, and Bayesian approaches. Topics include foundations of statistical decision theory, point estimation; properties of estimators (bias, consistency, efficiency, sufficiency, shrinkage, robustness); hypothesis testing (Type I and II errors, power, likelihood ratios); Bayesian inference (Bayesian decision theory, complete class theorem, minimax theorem, Bayes factors). Applications include estimation and testing in (asymptotically) normal models, as well as model choice and criticism.

The course covers both finite-sample statistical decision theory and elementary large-sample (asymptotic) theory.

Instructor

Lasse Vuursteen (lasse.vuursteen@duke.edu)

Teaching Assistant

Han Chen (han.chen2@duke.edu)

Prerequisites

- Linear algebra and real analysis.
- A background in measure theoretic probability theory (at the level of STA 711 or equivalent).
- A background in statistical modeling (STA 702, 721 or equivalent)

Course Information

Dates	January 7 – April 30, 2026
Lectures	Tuesdays/Thursdays 10:05–11:20am
Location	Biological Sciences 155

Important Dates

Jan 8	First day of class
Mar 3	**Midterm Exam** (in class)
Mar 10, 12	Spring Break (no class)
Apr 14	Last day of class
Apr 30	**Final Exam** (9:00am–12:00pm)

Homework deadlines are listed on the course schedule.

Lecture notes

The course is based around the lecture notes. The lecture notes are in some sense a convex combination of notes by predecessor instructors; Peter Hoff, Surya Tokdar, Yuansi Chen, and Li Ma. It is the first draft of the notes, so I expect there to be many typos and mistakes (made by me), so please report them.

The notes are based on various classical books, listed below. They are not required reading, but they are a good source of additional information.

These are work in progress, please check back on the course website frequently for updates.

References

The lecture notes draw from several sources:

- Keener, *Theoretical Statistics: Topics for a Core Course* (2010).
- Lehmann & Casella, *Theory of Point Estimation* (1998).
- Lehmann & Romano, *Testing Statistical Hypotheses* (2005).
- van der Vaart, *Asymptotic Statistics* (1998).

Office Hours

Office hours can be found on the course website.

TA office hours are intended for homework questions—both the assignment that's due and the one coming up. Instructor office hours are intended for general questions / discussion about the material. For other questions or if you cannot make the scheduled times, email to arrange an appointment.

Grading

The grade is made up out of combination of these four components:

- final exam
- midterm
- handwritten homework
- popquizes

Your final grade is the maximum of:

1. *Exams only: Midterm (30%) + Final (70%)*
2. *Exams + Homework: Midterm (24%) + Final (56%) + Homework (15%) + Pop Quizzes (5%)*

This means homework and pop quizzes can only improve your grade, never lower it.

There will be 11 random (5-minute) pop quizzes throughout the semester, designed to encourage regular reading. Homework assignments are due at the beginning of the lecture on Thursdays. Only your best 10 homeworks/popquizes count.

Homework

There will be 11 homework assignments. Homework is due at the **beginning of Thursday's lecture**. Submit a *handwritten copy* in class, or place it in the instructor's mailbox before the deadline if you cannot attend.

- Non-handwritten homework is not accepted.
- Late homework is not accepted; however, only your best 10 scores count, so no need to worry about one missed assignment.

Presentation: Write legibly and show your reasoning. A correct answer with no justification will receive little credit; a clear argument with a minor error may receive most of the points.

Use of AI: You are permitted and encouraged to use AI tools (such as an LLM) to help with homework. However, make sure you understand everything you write down. The exams will reflect the homework heavily, and you will not have access to AI during exams.

Collaboration: You are encouraged to discuss problems with classmates; talking through ideas is a valuable part of learning. However, you must write up your solutions independently and in your own words. If your write-up resembles another student's too closely, both may receive a zero.

Getting stuck: Start early. If you're stuck, come to office hours or email me. A good question is often the first step toward a solution.

Late Policy: Late homework is generally not accepted. If you have an emergency, contact the TA as soon as possible: han.chen2@duke.edu.

Regrade requests: The TA's grading decisions are final except in cases of clear error (e.g., arithmetic mistakes or a correct solution marked wrong). If you believe such an error occurred, submit a written request within one week. The entire problem may be regraded—up or down. Please reserve regrade requests for genuine errors; the homework is meant to help you learn, not to optimize points.

Pop Quizzes

There will be 11 short (5-minute) unannounced quizzes throughout the semester. The purpose is simple: to encourage you to engage with the material actively and consistently, rather than cramming before exams.

What to expect: Quizzes will test basic comprehension—definitions, theorem statements, and simple examples. If you've read the notes before class, you'll do fine.

Grading: Only your best 10 scores count, so one missed quiz will not affect your grade.

First quiz: The first quiz (Lecture 1) will ask: "What do you expect to learn in this course?".

Examination

Students who did the exercises will be well-prepared for the exam and midterm. Mock versions of the exam and midterm will be available on the course website.

Tips for Success

1. **Read before class.** The reading is about 10 lecture notes pages per lecture—this might not seem like much, but the material is dense. Come to lecture having read the relevant section of the notes. You don't need to understand everything (that's what lecture is for), but familiarity with the notation and main ideas will help you engage more deeply.
2. **Ask questions early.** If something is unclear, ask in class, in office hours, or by email. A small confusion in Week 2 can become a major obstacle by Week 5.
3. **Start homework early.** Proofs take time to digest. Starting early gives your subconscious time to work and leaves room to ask questions before the deadline.
4. **Don't let gaps accumulate.** Statistical theory builds on itself—sufficiency leads to completeness, completeness leads to UMVUE, and so on. If something doesn't click, address it before moving on.

Academic Integrity

All students are expected to follow the Duke Community Standard. On homework, you may discuss problems with classmates but solutions must be written and submitted independently. On exams, all work must be entirely your own.

Accessibility

If you need accommodations for this course, please register with the Student Disability Access Office (SDAO), who will work with you to determine appropriate accommodations. Note that accommodations are not retroactive and cannot be provided until I receive a Faculty Accommodation Letter. Once you have your letter, please share it with me.

Contact SDAO: sdao@duke.edu or `access.duke.edu`.

Religious Accommodations

Students are permitted by university policy to be absent from class to observe a religious holiday. If you need to miss class for a religious observance, please let me know at the beginning of the semester so we can make suitable arrangements ahead of time.

For the official policy and notification form, see: `trinity.duke.edu/undergraduate/academic-policies/religious-holidays`