STAT 850/442 Statistical Inference (University of Saskatchewan)

Description

This course provides a rigorous theoretical foundation for statistical inference—the process of drawing conclusions about populations or scientific truths from data. The course offers a comparative study of the three dominant inferential paradigms: **Bayesian**, **Likelihood**, and **Frequentist** frameworks. Through the lens of **Decision Theory**, students will learn to evaluate estimators and tests based on optimality criteria. Key topics include the geometry of **Exponential Families**, the roles of **Sufficiency and Completeness** in data reduction, the **Neyman-Pearson** theory of hypothesis testing, and the asymptotic properties of Maximum Likelihood Estimators. The ultimate goal is to equip students with the theoretical depth required to derive, analyze, and justify statistical methods in research contexts.

Prerequisite(s): STAT 342.

Important Note: Students are expected to have a strong background in probability theory. Although not strictly required, it would also be useful for students to have had some exposure to applied statistical methods to provide context and intuition for the models that will be discussed.

Instructor

Longhai Li, Professor, Department of Mathematics and Statistics, University of Saskatchewan
Email: longhai.li@usask.ca.

Times and Places

- **Lectures:** TTH 11:30-12:20, MCLN 242.1
- **Office Hours:** TBA
- **No lab**

Textbook and Course Materials

- **Lecture Notes**
- This one-drive folder releases the assignments, tests, and their solutions if available.
- **Recommended Text:** Young G. A. & R. L. Smith, *Essentials of Statistical Inference*, Cambridge University Press, 2005.

    – We will aim to cover Chapters 1-6, and 8.

Learning Outcomes

After completing this course, students are expected to:

1. **Understand Paradigms:** Be able to understand the Bayesian and frequentist paradigms for statistical inferences, and therefore develop a high-level understanding of various applied statistical methods.
2. **Apply Theory:** Be able to apply the theoretical results in statistical inference to practical statistical problems.
3. **Evaluate Methods:** Be able to evaluate different statistical methods with appropriate criteria.
4. **Compare Approaches:** Gain a comparative appreciation of different inferential paradigms.

Tentative Schedule

Week	Cal Week	Date (Mon)	Lecture Topic	Tests & Notes
1	2	Jan 05	1. Decision Theory	Jan 06: First Lecture
2	3	Jan 12	1. Decision Theory (Cont'd)	
3	4	Jan 19	2. Bayesian Inference	
4	5	Jan 26	2. Bayesian Inference	**Feb 01: Assignment 1 due**
5	6	Feb 02	2. Bayesian Inference	
6	7	Feb 09	3. Hypothesis Testing	
N/A	**8**	**Feb 16**	**—**	**Reading Week – No classes**
7	9	Feb 23	3. Hypothesis Testing (Cont'd)	**Mar 01: Assignment 2 due**
8	10	Mar 02	4. Likelihood Ratio Test and AIC	**Mar 05: Midterm (during class)**
9	11	Mar 09	5. Exponential Family	
10	12	Mar 16	6. Sufficient and Complete Statistics	
11	13	Mar 23	7. Likelihood Theory	
12	14	Mar 30	7. Likelihood Theory	**Apr 05: Assignment 3 due**
13	15	Apr 06	Review	Apr 07: Last lecture

> ❗ Important
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> The schedule may change depending on the course pace. The exact assignment and test dates are given on Canvas.

Evaluation

Grading Scheme

3 Assignments: $3 \times 10\%$, **1 Term Test: 20%, 1 Final Exam: 50%.**

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Assignments and Tests

Assignment questions are released in the one-drive folder. You will submit your solutions via Canvas. **If you miss an assignment without proper excuse, the weight will NOT be shifted to the final.** Undergraduate students will be assigned with different assignments and tests.

Assignments

- I will accept late assignments only for three (3) days beyond the due date. The penalty for your delay is 10 percentage points per day of lateness from the value of the assignment (including weekends). **Extensions are only granted in rare instances (notably as a result of family or medical emergencies) and upon receipt of adequate documentation/proof.**
- Answer the questions in the order they appear in the assignment. Neatness is important.
- Solutions to problems are to be included. Hence, simple answers without work will receive few (or no!) marks.
- Most problems in statistics have a "real-life" basis. Hence, solutions should include not only numerical solutions but also a statement as to what the numbers say about the problem.
- The work handed in must not be an exact duplicate of others.
- Submitting Assignments: The assignment can be typed and/or handwritten. Save your assignment as **one PDF file** (for handwritten assignments, feel free to take a picture/scan of your work and save it as one PDF file). Upload the **PDF file** as an assignment submission in Canvas.
- More details will be provided ahead of each assignment.
- Due Date: See Course Schedule.

Midterm

- The midterm is given in class period.
- Midterms must be written on the dates scheduled. Students must do midterms completely on their own. More details (including syllabus) will be provided ahead of each midterm.
- Type: Short-answer questions, problem-solving, open-book.
- Calculator: A scientific calculator is allowed.
- Make-up exam will not be given. If you miss an exam for a legitimate reason (e.g., illness, emergency) and notify me within 48 hours of the scheduled exam, the weight of the missed exam will be transferred to the final exam.

Final Exam

- Scheduling: Final examinations may be scheduled at any time during the examination period; students should therefore avoid making prior travel, employment, or other commitments for this period. If a student is unable to write an exam through no fault of their own for medical or other valid reasons, documentation must be provided and an opportunity to write the missed exam may be given. Students are encouraged to review all examination policies and procedures: http://students.usask.ca/academics/exams.php.
- The final exam will cover material of the entire course. More details will be provided ahead of the exam.
- Length: 3-hour in-person exam.
- Type: Short-answer questions, problem-solving, open-book.

Criteria That Must Be Met to Pass

The **final exam is a required component of the course**. Students must complete the final exam in order to be eligible to receive a passing grade in this class.

Attendance Expectation

Attendance is highly correlated with student performance. While a syllabus and suggested readings are provided, it is not an adequate substitute for attending class. Your **attendance is highly recommended** but not required, and you will not be graded on your attendance.

Recording of the Course

Recording of the lectures will only be allowed in certain circumstances. Please see the instructor for information on how to receive approval. In general, there will be no videos available for in-person lectures. Therefore, **attendance is strongly recommended**.

Use of Generative AI and Electronic Devices

1. AI for Learning vs. Assessment. Students are free (and encouraged) to use Generative AI tools as a study aid to understand course concepts, debug code, or explain complex theorems. However, **all submitted work for assignments must be your own.** You must write your own solutions. Directly copying text, derivations, or code from an AI tool and submitting it as your own may receive a **severe penalty** (up to receiving a 0% on the assignment.

2. Electronic Devices During Tests. All term tests and the final exam are **Open Book**, meaning you may bring printed notes, textbooks, and lecture slides.

- **No Electronic Devices:** You are **NOT allowed** to use laptops, tablets, smartwatches, or any other electronic devices during the exam.

- **Phone Exception:** You are permitted to bring a smartphone, but it must remain stowed away during the writing period. It may **only** be used at the very end of the exam for the specific purpose of taking photos of your answer sheets for submission (if required). Using the phone for any other reason during the exam will be treated as academic misconduct.