

# INTRODUCTION TO Statistical Inference



## TEACHING TEAM & HOURS

**Class Hours:** 14-15:30 Saturday & Monday  
**Office Hours:** **TBA**

**Instructor:** Dr. Aboalghasemi Dahaqani

**Head Teaching Assistants:**

AmirAli Soltani  
AmirReza Salamat

**Teaching Assistants:**  
**TBA**



## COURSE DESCRIPTION

Statistical Inference is a fundamental and a very important subject in the field of mathematics and statistics , so essential that it significantly informs and enhances disciplines such as Machine Learning. The course provides students with the necessary tools and techniques for analyzing collected data and utilizing statistics in real and practical decision-making. This course enables students to to evaluate hypotheses and conduct hypothesis testing. It emphasizes generating valid estimates, understanding significance, effect sizes, and the power of tests to derive insightful conclusions from data, enhancing data-driven inference. Additionally, it also touches upon concepts of experimental design and Bayesian Inference. The course is designed to reduce the stress of grades, paving the way for a deep exploration of statistical inference. It encourages students to delve into its diverse aspects with the passion and curiosity of a data scientist, applicable in in various components of social sciences, natural sciences, finance, engineering and many many other fields.



## OVERVIEW OF THE TOPICS

### 1 Foundations of Engineering Statistics & Probability

Basic principles, Law of Large Numbers, Central Limit Theorem

### 2 Data Concepts and Sampling

Neyman-Pearson Paradigm, t-tests, Chi-square tests, One-sample Sign Test, Paired Sign Test, Wilcoxon Signed Rank Test, Wilcoxon Rank-Sum Test, Kolmogorov-Smirnov test, QQ plots, contingency table analysis, Likelihood Ratio Test, Bonferroni correction

### 3 Statistical Testing

Neyman-Pearson Paradigm, mean-related tests (t-tests), variance tests, non-parametric tests (One-sample Sign Test, Paired Sign Test, Wilcoxon Signed Rank Test, Mann-Whitney test), Kolmogorov-Smirnov test, multiple hypothesis testing

### 4 Analysis of Variance

ANOVA, MANOVA, Kruskal-Wallis test

### 5 Regression Analysis and Estimation

Linear regression, non-linear regression, parameter estimation, Cramer-Rao Lower Bound, Generalized Likelihood Ratio Tests

### ★ Bayesian Inference

If time permits, a short itnro to Bayesian data analysis



## PREREQUISITE

No prerequisite courses, but needs:

- Familiarity with Engineering Probability
- Basic Statistical Understanding
- Basic Programming Skills ([R](#) or [Pyhton](#) Preferred)



## MODES OF ASSESMENT\*\*

### Analytical and Computer Assignments



About 5 Assignments before the end of each chapter so students can start working as they learn.

### Midterm Exam



Conceptual questions and or short problem solving. No need for memorization. 2 A4 Cheatsheets are allowed.

### Final Exam



Conceptual questions and or short problem solving. No need for memorization. 2 A4 Cheatsheets are allowed.

### Final Project



A simple Data Science project on a real dataset (15% of total grade) with a bonus part (5% of total grade), guiding the students on how they would use their new inference skills in the real world and then report and present their findings.

### Bonus Quizes + Brainstorm Sessions



Bi-weekly short-answer quizzes to help students keep up with the course and improve their weaknesses followed by a problem solving session or a hands-on demo related to the current chapter.

**\*\*Note 1:** In the spirit of reducing the stress of grades, the sum of grades is **23** instead of **20**.

**\*\*Note 2:** The structure of the course grading is subject to change. But it will always be in favour of the students.



## RESOURCES

- [Class Slides](#)
- John A. Rice, [Mathematical Statistics and Data Analysis](#), 3rd edition
- Larry Wasserman, [All of Statistics: A concise course in statistical inference](#)
- David Diez, Mine Åtëetinkaya-Rundel, Christopher D Barr - [OpenIntro Statistics](#)
- Some class videos might be available gradually



Coordinated by  
The Brain Computation Lab, IIT