MATH 562: Statistical Inference – Fall 2025

Institute of Mathematics

École Polytechnique Fédérale de Lausanne

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1 Introduction

Inference from the particular to the general based on probability models is central to the statistical method. This course gives a graduate-level introduction of the main ideas of statistical inference.

2 Useful Information

Instructor:	Rajita Chandak (rajita.chandak@epfl.ch).
Lectures:	Thursdays 13:00 – 15:00 (CE 1 100).
Moodle :	https://go.epfl.ch/MATH-562
TA:	Almond Stöcker (almond.stoecker@epfl.ch)
Lecture Notes:	Slides will be shared on Moodle each week.
Discussion Forum:	See Moodle for link.
Exercises:	Thursdays 15:00 – 17:00 (CE 1 100).

3 Grading

Students will be required to complete one comprehensive final exam. Periodic submission of exercises solutions will be required. The final grade will be determined by a weighted average of the exercises (15%) and the final exam (85%).

4 Lecture contents

1. Introduction, Probability revision
   - Introduction, statistical tasks and models.
   - Probability: basic ideas, Bayes' theorem, random variables, conditional and marginal distributions, exchangeability.
   - Order statistics; moments and conditional moments; multivariate normal distribution; MGFs and KGFs.
   - Exponential tilting and exponential families.
   - Convergence and delta method.

2. Statistics revision
    - Model formulation, point estimation: some types of estimators (MLE, moments, score-matching).
    - Properties of point estimators: consistency, MSE, bias, variance, Bartlett identities.
    - CRLB and Fisher information, efficient estimation.
    - Interval estimation, pivots, confidence and prediction intervals.
    - Hypothesis testing, sampling theory.
    - Bases for inference: Bayes' theorem; randomisation.
3. Basic notions
    - Likelihood and basic properties, selection.
    - Complications: censoring, dependent data, missing data.
    - Sufficiency, minimal sufficiency, factorisation theorem.
    - Rao–Blackwell theorem and completeness.
4. Likelihood
    - Eliminating nuisance parameters, conditioning and ancillary statistics.
    - Inference, likelihood: generalities, consistency.
    - Asymptotic normality of MLE, classical regularity conditions, related statistics, exponential example.
    - Non-regular models, vector case, profile log likelihood.
    - Model selection, nuisance parameters: modified profile likelihood, higher-order asymptotics.
    - Orthogonal parameters, composite likelihood.
5. Significance tests
    - Pure significance tests, uniformity of p-value, exact and inexact tests.
    - Neyman–Pearson approach, critical regions, size, power and the ROC curve, Neyman-Pearson lemma.
6. Multiple testing
    - Optimal test in exponential family, local power and score tests.
    - Multiple testing, graphical methods, error control, Bonferroni procedures, false discovery rate, Benjamini–Hochberg procedure.
7. Testing, Selection and Bootstrap
    - Proof of BH procedure, selection generalities.
    - Sample splitting, randomisation. Introduction to Bootstrap.
8. Bootstrap inference
    - Bootstrap simulation.
    - Bootstrap confidence intervals, nonparametric delta method.