Statistics - Inferential Statistics

Course Description

Statistical analysis and understanding are the foundations of data-driven methods and machine learning approaches. This course gives a thorough introduction to point estimators and discusses various techniques to estimate and optimize parameters. Special focus is given to a detailed discussion of both statistical and systematic uncertainties as well as the propagation of uncertainties. Bayesian statistics is fundamental to data-driven approaches, and this course takes a close look at Bayesian techniques such as Bayesian parameter estimation and prior probability functions. Furthermore, the course gives an in-depth overview of statistical testing and decision theory, focusing on aspects such as A/B testing, hypothesis testing, p-values, and multiple testing, which are fundamental to statistical analysis approaches in a broad range of practical applications.

Contents

1. Point Estimation
   1. Method of Moments
   2. Sufficient Statistics
   3. Maximum Likelihood
   4. Ordinary Least Squares
   5. Resampling Techniques
2. Uncertainties
   1. Statistical and Systematic Uncertainties
   2. Propagation of Uncertainties
3. Bayesian Inference and Non-Parametric Techniques
   1. Bayesian Parameter Estimation
   2. Prior Probability Functions
   3. Parzen Windows
   4. K-Nearest Neighbors
4. Statistical Testing
   1. A/B testing
   2. Hypothesis Tests and Test Statistics
   3. P-Values and Confidence Intervals
   4. Multiple Testing
5. Statistical Decision Theory
   1. The Risk Function
   2. Maximum Likelihood, Minimax, and Bayes
6. Admissibility and Stein’s Paradox