Mathematical Statistics - Spring 2019 - Final - Syllabus

Midterm Syllabus

- Reminders of probability: Law of Large Numbers, Central Limit Theorem, convergence in probability, independence, probability distribution functions, cumulative distribution functions etc. See Chapter 1–5, especially 1.5, 2.2, 2.3, 2.4, 2.7, 3.1–3.4, 4.1, 4.2, 5.2–5.4.
- Notions: statistical model, statistics, parameter. Estimator, consistent estimator, (asymptotically) unbiased estimator, asymptotically normal estimator. Chapter 6, mostly 6.2, 6.3.1.
- Non-parametric estimation: empirical mean, the empirical mean is a "good" estimator, empirical cdf, the empirical cdf is a "good" estimator. Chapter 7.
- Parametric estimation: method of moments, MLE and its properties (asymptotic normality, Fisher information). Chapter 9, especially 9.2–9.7, 9.13.1.
- Be familiar with: difference between quantitative/non-quantitative results, existence of quantitative bounds (Markov, Tchebychev, Hoeffding etc.), what a confidence interval is.
- Homework 1–4. In particular: how to compute expectation, variance – either directly from a pdf or by algebraic manipulations. How to study biasedness and consistency of estimators. How to compute an estimator by the method of moments, a MLE estimator, a Fisher information.

Post-midterm syllabus

- Hypothesis testing: null and alternative hypothesis, test statistic, rejection region, Type I and type II errors, p-value. Some specific tests: Wald's test, χ^2 square test, goodness-of-fit test. No need to know the formulas by heart (e.g. Pearson's statistic), but you should understand the strategies, and be able to define a useful test, to use limit results in order to control type I errors. Chapter 10.1–10.4. and 10.8
- Statistical learning: concepts of risk, of a predictor, of a learning rule. See lecture notes.
- Linear regression: simple, multiple. Chapter 13.1, 13.3, 13.5. No need to know the formulas by heart.
- Correlation, covariance, independence, causality. Chapters 14.1, 14.2, 15.1, 15.2, 16.1–16.4.

- Homeworks 5–9. Being able to execute some classical tests and to take the "right" decision (reject/keep H_0). Being able to design a test given a specific situation, using knowledge on estimators. Computing correlations, covariances, covariance matrices, being aware of the difference between independent and uncorrelated.