Econometrics I*

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Course Description: This course (September 5th-October 17th) will provide a graduate-level introduction to probability and statistics for economists.

Prerequisite(s): My main assumption is that you have been exposed to at least one proof-based course in economics or mathematics. Previous undergraduate work in probability and statistics is neither assumed nor required.

Background: Familiarity with the following concepts would be helpful: sequences of real numbers, convergence of a sequence of real numbers, euclidean spaces, continuity of $\mathbb{R}^m$-valued functions, integration.

Text(s): The lectures will be based on a set of notes and slides posted online. Ocassionally, the following references will be cited:

a) "*Probability: Theory and Examples*" by Rick Durret [2010]. Cambridge University Press. Fourth Edition

b) "*Testing Statistical Hypothesis*" by Lehmann, E.L. and Romano, J.P. [2005]. Springer Verlag

c) "*Probability Theory with Economic Applications*" by Efe Ok. Available online.

d) "*Introduction to Mathematical Statistics*" by Hogg, Robert V. and Mckean, Joseph W. and Allen, Craig D. [2006] Pearson Education India.

e) "*Real analysis and Probability*" by Dudley, Richard [2002]. Cambridge University Press.

f) "*Probability and Measure*" by Billingsley, Patrick [1995]. John Wiley & Sons.

*First version: August 26th, 2013. This version: September 9, 2018

g) "*Introduction to Mathematical Statistics: a Decision Theoretic Approach*" by Ferguson, Thomas [1967]. Academic Press New York

These are optional references that you can find helpful during the course.

Evaluation: There will be 5 problem sets. Each of them will have a weight of 12% in the final grade. The remaining 40% will be based on a final exam. This means that the problem sets are important.

Lecture Notes and Slides: The lecture notes and slides were prepared with two different styles in mind. The slides were prepared to provide an overview of the lectures; thus, you should not expect to learn specific details from them. The lecture notes were intended to provide a thorough explanation of the materials covered in class. I expect you to look at the notes carefully, using the slides to get a sense of what the goal of the lecture is.

Course Outline (Tentative)

1. Probability Theory (4 lectures/2 weeks)

   - *Lecture 1-2*: Probability Spaces, Real-valued Random Variables, Cumulative Distribution Functions (c.d.f.), Probability Density Functions (p.d.f.), Moments of Random Variables, Mean and Variance, Moment Generating Function.

     Appendix: If I have time, I will give have a very quick discussion concerning *distance between probability measures*.

   - *Lecture 3-4* Multivariate Distributions, Moments of Random Vectors, Independence of Random Variables and some useful characterizations, Conditional Probability and Conditional Expectation.

     Appendix: Kolmogorov's definition of Independence.

2. Mathematical Statistics (8 lectures/4 weeks) (This is my favorite part!)

   - *Lecture 5-6:* Statistical Models and Statistical Decision Problems. Elements of a finite-sample statistical decision problem.

   - *Lecture 7-8:* Point estimation. Maximum-Likelihood Estimators. Bayesian Estimators. Method-of-Moments Estimators. Finite-sample properties of point estimators (bias, variance, and mean-squared error).

   - *Lecture 9-10:* Testing. Null hypothesis and alternative hypothesis. Score Test, Likelihood Ratio Test, Wald tests, and Bayes Tests. Finite-sample properties of statistical tests (rate of Type I/Type II error). Neyman-Pearson Lemma and the optimality of the Likelihood Ratio Test. Testing Problems with a nuisance parameter.

   - *Lecture 11-12:* Confidence sets and credible sets. (Parametric) Bootstrap confidence intervals and Bayesian equal-tailed credible intervals. Finite-sample properties of confidence/credible sets. Constructing confidence sets via test-inversion. Confidence bands.