Advanced Statistical Inference I

Instructor: Dr. Zongming Ma (Email: zongming@wharton.upenn.edu).
Class meeting time: Mon/Wed, 10:30–11:50. The first lecture is on August 29.
Location: SHDH 213.
Office hours: Mon 1–3 @ JMHH 468.

General Information

STAT 515 is a first theoretical course on statistical inference for PhD students outside the Statistics Department. It would provide excellent preparation for advanced econometrics courses as well as other graduate level statistics, machine learning and data analytics courses. The target audience is Wharton PhD students but students from around the campus are also welcome. Enrollment in the course is subject to instructor's approval.

Course Prerequisite

Familiarity with multivariate calculus and some basic linear algebra will be assumed as well as some prior knowledge of undergraduate probability and statistics. At Penn this prior knowledge could be attained by taking STAT 430, STAT 431 and MATH 114, MATH 240. The knowledge of various standard results concerning probability and statistics is assumed. A handout with the title "What you should know" will be handed out in class. If you are not familiar with these standard results, please contact the instructor as soon as possible.

Homework, Exam and Assessment

Homework problems will be handed out every other week on Wednesdays in class, and are due in a week later, in class. There are seven problem sets in total. A random half of the problems in each set will be graded. Solutions to all problems will be handed out in class.

There is no exam. *Final grades are given based on homework performance.*

Textbook

The course will be based on "Statistical Inference (2nd edition)" by George Casella and Roger Berger. The book is aimed at first-year graduate students and builds a good foundation in statistical inference from the first principles of probability. References to the textbook are given below against each topic covered in the course.

Syllabus

The main topics covered in the course include the random sample paradigm for statistical inference, non-asymptotic estimation theory and hypothesis testing theory, together with some of their important applications such as those in linear models. Throughout the course, the main focuses are (1) principled ways to design inference procedures under modeling assumptions, and (2) performance evaluation and comparison of inference procedures, with the goal of finding optimal ways of carrying out inference.

The following table provides a more detailed list of topics together with references to the textbook. *The actual topics covered may vary.*

Topic	**Textbook section**
Probability	
Review of background results	Chapter 1
Functions of random variables	2.1, 4.1–4.6
Moments and moment generating functions	2.3
Exponential families	3.1–3.4
Some useful inequalities	3.6, 4.7
Random samples	5.1–5.3
Order statistics	5.4
Estimation	
Basic statistical decision theory	7.3
Sufficiency	6.2
The likelihood principle	6.3, 7.2
Method of moments	7.2
Bayes estimators	7.2
Estimation in linear regression	11.3
Hypothesis testing	
Concepts of hypothesis testing	8.1
p-values	8.3
Likelihood ratio tests and Neyman–Pearson lemma	8.2–8.3
Union-intersection tests	8.2
Testing multiple hypotheses	
Hypothesis testing in linear regression	11.3