Statistical Inference (Econ-180.636)
Fall 2017

Professor: Jonathan Wright
Office: Wyman Hall 584
Phone: 410-516-5728
e-mail: wrightj@jhu.edu
Office Hours: 2pm-3pm Thursdays and by appointment

Teaching Assistant: Tongli Zhang
Office Hours: Mondays, 2:30-4:30, Wyman Student Lounge (6th Floor)
Email: tzhang31@jhu.edu

This course is a semester long introduction to probability theory and statistical inference for graduate students in economics. It is a required course for all Ph.D. students in economics. This is because probability theory and statistical inference are key foundations to later courses in econometrics, and are also important in macro and micro.

There will be an emphasis on programming, particularly in the homeworks but also in class demonstrations. For example, we will simulate artificial random data and see how estimators and test statistics behave. These are known as Monte-Carlo experiments. The software package is Matlab, which is available on all computers in the computer lab. There will be a handout that explains the basics of Matlab. You must use Matlab in the homeworks and you should turn in your Matlab programs for the TA to examine.

The slides for projection that I will go through in class are available on the web. You should focus heavily on these. I recommend that you print them out before class and then you can write notes on them. In this way, you are spending the class time thinking and not just copying. You are expected to know and understand everything on these slides. The vast majority—but not all—of the material in the slides is also covered in the references listed below.

The prerequisites for the course are basic statistics, some linear algebra and a solid foundation in calculus.

Textbook: The textbook for the course is “Statistical Inference” by Casella and Berger, Duxbury Press, Second Edition. Copies have been ordered at the University Bookstore.

Other recommended reading: Casella and Berger is the only book that you should buy. For background, the following could be useful:

> “A First Course in Probability” by Sheldon Ross, Prentice Hall.

"Introduction to Mathematical Statistics" by Paul Hoel, Wiley Series in Probability and Mathematical Statistics.

As reference material, the following could be useful:

"Stochastic Processes" by Sheldon Ross, Wiley Series in Probability and Mathematical Statistics.

"Approximation Theorems of Mathematical Statistics" by Robert Serfling, Wiley Series in Probability and Mathematical Statistics.

"Linear Statistical Inference and Its Applications" by C.R. Rao, Wiley Series in Probability and Mathematical Statistics.

"The Bootstrap and the Edgeworth Expansion" by Peter Hall, Springer Series.

Homework: I expect to assign around 6 homeworks during the semester. Late homeworks will not be accepted. The grade on the lowest homework will be dropped. You can collaborate on homeworks but everyone must write up their own solutions. If the TA finds that two people have identical solutions then both will receive a grade of zero.

Exams: There will be a midterm and a final exam. The exams are closed book. Dates and times are to be determined.

Grades:
Homework: 25 percent
Midterm: 25 percent
Final: 50 percent

Course Outline:

1. Basic probability theory. Probability axioms. Joint, marginal and conditional probabilities. Bayes rule. Random variables. Probability density and cumulative distribution functions. (C&B Chapter 1).
2. Expectations and moments. Moment generating functions. Densities of transformations of random variables. (C&B Chapter 2).
3. Specific densities: continuous and discrete. (C&B Chapter 3).
4. Multivariate random variables. Independence of random variables. Covariance and correlation. The distribution of order statistics. Bivariate and multivariate normal densities. Conditional normal densities. Multivariate change-of-variable formula. Law of Iterated Expectations. (C&B Chapter 4).
5. Stochastic Processes. Markov Chains, Poisson Processes, Martingales, Brownian Motion and related processes. Hitting times. (Ross "Stochastic Processes").

6. Large sample theory. Sums of random variables, convergence concepts. Laws of large numbers. Central limit theorems. The Edgeworth expansion. The delta method. (C&B Chapter 5).
7. Parameter estimation by method of moments, maximum likelihood and Bayes methods, including an overview of the Bayesian methodology and Bayesian simulation methods. Properties of Estimators. Sufficiency. Rao-Blackwell Theorem. Cramer-Rao Bound. Asymptotic distribution of maximum likelihood estimators (C&B Chapter 7 and 10.1).
8. Principles of hypothesis testing. Exact and asymptotic tests. Power functions. Neyman-Pearson Lemma. Wald, LR and LM tests. Local asymptotic power and sequences of Pitman alternatives (C&B Chapter 8).
9. Hypothesis tests and the delta method. The Fieller method. (C&B Chapter 8 and 10.3).
10. Interval estimation. Construction of confidence sets from inversion of acceptance regions of tests. Pivotal and asymptotically pivotal test statistics. (C&B Chapter 10.4).
11. The bootstrap. Other percentile, percentile and percentile-t bootstrap confidence intervals. (Hall).