Stats Camp for Economists and Econometricians

Rice University

Summer 2016

Logistics

Instructor:	Mehreen Gul, mehreen.gul@rice.edu
TA:	Amir Kazempour, akp@rice.edu
Schedule:	July 1 - July 29, MTWTF, 20 Lectures
Time:	2-hour online lecture every weekday
Office Hours:	8am-9am and 8pm-9pm (Central Daylight Time), every week-day.
Location:	Canvas Platform, https://canvas.rice.edu

Course Outline

In this intensive summer course, we will equip students with the essential tools and knowledge in statistics that are essential to modern econometric theory. As probability theory lies in the very foundation of statistics, we will build up the probability tools we need along the way. The students are expected to not only understand the tools but also be able to have a firm understanding of the mathematics behind them, in order to prepare for future econometrics training and research.

We will have 2 hours of lecture every weekday, and there will be in total 10 problem sets that are due three days after distributed. I will ask questions to be answered during the online lectures to measure your attendance. You should expect to study three hours on average for reviewing the material and doing the homeworks. In addition, there will be daily office hours twice a day. The attendance to the office hours is not mandatory but highly encouraged. I will be available to answer your questions and you will have opportunity to interact with your classmates. There will be an exam at the end of the course. The weights of the attendance to the lectures, homeworks and the exam are 10%, 40% and 50%.

I. Probability Theory (lecture 1-4)

Introduction:

- Why study statistics?
- Statistics and econometrics.

Axiomatic Probability Theory:

- Basic set theory (intersection, union, complement, DeMorgan's law)
- Sigma algebra
- Sample space and events
- Axioms of probability measures
- Probability and its properties
- Conditional Probability
- Independence
- Bayes rule

Readings:

Casella and Berger, 2002. *Statistical Inferences*, Duxbury. Chapter 1, 1.1-1.3.

Bierens, 2005. *Introduction to the Mathematical and Statistical Foundations of Econometrics*, Cambridge University Press. Chapter 1.

II. Random Variables (lecture 5-10)

Random Variables and Distributions:

- Random variables (RV) and induced probability.
- Cumulative distribution function (CDF).
- Probability mass function (PMF) and probability density function (PDF)
- Transformations.
- Probability integral transformations.
- Moments of distribution (mean, variance among others)
- Moment Generating Functions (MGF)

- Transformations of random variables: MGF approach
- Convergence in Distribution

Readings:

Casella and Berger, 2002. *Statistical Inferences*, Duxbury. Chapter 2, 2.1-2.4.

Common Families of RVs:

- Bernoulli.
- Binomial.
- Poisson.
- Relationship between binomial and Poisson.
- Uniform.
- Normal.
- Cauchy
- Gamma function and gamma distribution.
- Chi-squared.
- Exponential.
- Log-normal.

Readings:

Casella and Berger, 2002. *Statistical Inferences*, Duxbury. Chapter 3.

III. Multivariate Random Variables (lecture 11-15)

Multivariate Random Variables:

- Joint and marginal PMF.
- Conditional PMF.
- Independence of RVs.
- Example: sum of independent Poisson RVs.
- Continuous multiple RVs

- Conditional PDF.
- Conditional expectations.
- Independence of RVs revisit.
- Sum of independent normal RVs
- Jacobian transformations of multivariate random variables
- Law of iterated expectation.
- Law of total variance.
- Covariance.
- Bivariate normal and its properties

Probability Inequalities:

- Markov (proof).
- Chebyshev (proof).
- Jensen (proof).

Readings:

Casella and Berger, 2002. *Statistical Inferences*, Duxbury. Chapter 4.

Bierens, 2005. *Introduction to the Mathematical and Statistical Foundations of Econometrics*, Cambridge University Press. Chapter 2, 2.6.

IV. Large Sample Theory (lecture 16-20)

Random Sampling:

- Sample mean.
- Sample variance.
- Sample covariance.
- Distributions derived from normal: chi-squared, t and F.

Limit Theorems in Probability:

- Modes of convergence

- Examples (convergence in prob doesn't imply a.s.)
- Weak Law of large numbers (WLLN)
- a proof of WLLN with Chebyshev's inequality
- Central Limit theorem (CLT)
- a proof of CLT using MGF when second moment exists.

Readings:

Casella and Berger, 2002. *Statistical Inferences*, Duxbury. Chapter 5.

Bierens, 2005. *Introduction to the Mathematical and Statistical Foundations of Econometrics*, Cambridge University Press. Chapter 6.

Stats Camp for Economists and Econometricians - Part II

Rice University

Summer 2016

Logistics

Instructor:	Mehreen Gul, mehreen.gul@rice.edu
Schedule:	August 1 - 14, MTWTF, 10 Lectures
Time & Location:	TBA

Course Outline

In this second half of the summer course, we will continue to develop the statistical theory that are essential to modern econometric theory, based on the fundamental probability theory introduced in the first half. The students are expected to not only understand the tools but also be able to have a firm understanding of the mathematical mechanisms behind them, in order to prepare for future econometrics training and research.

We will have 2 hours of lecture every weekday, and there will be in total 4 problem sets that are due three days after distributed. You should expect to study three hours on average for reviewing the material and doing the homework. In addition, there will be daily office hours. There will be an exam at the end of the course. The weights of problem sets and the exam are 50% and 50%.

V. Useful Asymptotic Tools (lecture 1-2)

- Slutskys lemma
- Continuous mapping theorem
- Delta method.
- Cramer-Wold device.

- Stochastic o and O symbols

Readings:

Bierens, 2005. *Introduction to the Mathematical and Statistical Foundations of Econometrics*, Cambridge University Press. Chapter 6, 6.2 and 6.7.

VI. Estimation (lecture 3-5)

- Asymptotic Evaluations: Consistency, Unbiasedness and Efficiency.
- Method of Moments.
- Maximum Likelihood.
- Bayesian Estimation.
- Mean Square Errors (MSE)
- Relations between MSE, bias and variance.
- Cramer-Rao lower bound (CRLB) and Fishers information.

Readings:

Casella and Berger, 2002. *Statistical Inferences*, Duxbury. Chapter 7 and 10.1.

VII. Hypotheses Testing (lecture 6-8)

- Notions of statistical testing
- Likelihood ration tests
- Example: normal with known variance.
- P-value
- Examples

Readings:

Casella and Berger, 2002. *Statistical Inferences*, Duxbury. Chapter 8.

VIII. Asymptotic properties for MLE (lecture 9-10)

- Consistency
- Asymptotic normality

Readings:

Bierens, 2005. *Introduction to the Mathematical and Statistical Foundations of Econometrics*, Cambridge University Press. Chapter 8.