Stats Camp for Economists and Econometricians
Rice University
Summer 2019

Logistics

Instructor: Amir Kazempour, akp@rice.edu
Schedule: June 10 - July 26.
Office Hours: Monday 9am-10am and Wednesday 8pm-9pm CT.
Location: Canvas Platform, https://canvas.rice.edu

Course Outline

In this 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 the probability tools we need along the way. In this sense, this course is designed to be self-contained. 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.

There are four modules covered over twenty lectures of approximately two hours each. There is one problem set for each module and one quiz for each lecture. We 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. There will be an exam at the end of the course. Assignment of course grades will be based on attendance (10%), quizzes (20%), homeworks (20%) and the exam (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


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 and Variance among others)
- Moment Generating Functions (MGF)
- Transformations of Random Variables: an MGF Approach
- Convergence in Distribution


Common Families of RV’s:

- Bernoulli.
- Binomial.
- Poisson.
- Relationship Between Binomial and Poisson.
- Uniform.
- Normal.
- Cauchy
- Gamma Function and Gamma Distribution.
- Chi-squared.
- Exponential.
- Log-normal.


III. Multivariate Random Variables (lecture 11-14)

Multivariate Random Variables:
- Joint and Marginal PMF.
- Conditional PMF.
- Independence of RV’s.
- Example: Sum of Independent Poisson RV’s.
- Continuous Multiple RV’s
- Conditional PDF.
- Conditional Expectations.
- Independence of RV’s revisited.
- Sum of Independent Normal RV’s
- Jacobian Transformations of Multivariate Random Variables
- Law of Iterated Expectations.
- Law of Total Variance.
- Covariance.
- Bivariate Normal and its Properties

Useful Inequalities:
IV. Large Sample Theory (lecture 15-20)

Random Sampling:
- Sample Mean.
- Sample Variance.
- Sample Covariance.
- Distributions Derived from Normal: Chi-squared, t and F.

Limit Theorems in Probability:
- Modes of Convergence (Almost sure, Probability and Distribution).
- Examples (convergence in probability does not imply almost sure convergence).
- Weak Law of Large Numbers (WLLN) for Uncorrelated Random Variables (proof with Chebyshev’s inequality) and i.i.d Random Variables (proof).
- Central Limit theorem (CLT).
- Proof of CLT using MGF when second moment exists.

Delta Method

Stochastic o and O symbols

Stat Camp Summer 2018 Calendar:

Module 1

- Set Theory (Lecture 1) Quiz 1 due Saturday June 2 11:59 pm CST
- Sigma Algebra (Lecture 2) Quiz 2 due Saturday June 2, 11:59 pm CST
- Axioms of Probability Measure and Properties of Probability (Lecture 3) Quiz 3 due Saturday June 9, 11:59 pm CST
- Conditional Probability, Independence and Bayes' Rule (Lecture 4) Quiz 4 due Saturday June 9, 11:59 pm CST
- Module 1 Homework 1 due Saturday June 9, 11:59 pm CST

Module 2

- Random Variables, Induced Probability Measure, Distribution and Density Functions (Lecture 5) Quiz 5 due Sunday June 17, 11:59 pm CST
- Transformations, Probability Integral Transformations, Moments of a Distribution (Lecture 6) Quiz 6 due Sunday June 17, 11:59 pm CST
- Moment Generating Functions and Convergence in Distribution of Random Variables (Lecture 7) Quiz 7 due Sunday June 17, 11:59 pm CST
- Common Families of Random Variables: Discrete Distributions (Lecture 8) Quiz 8 due Monday June 25 11:59 pm CST
- Common Families of Random Variables: Continuous Distributions (Lecture 9) Quiz 9 due Monday June 25 11:59 pm CST
- Exponential Families and Location and Scale Families (Lecture 10) Quiz 10 due Monday June 25 11:59 pm
- Module 2 Homework 2 due Monday June 25 11:59 pm CST
Module 3

- Joint and Marginal Distributions, Conditional Distributions, Independence and Bivariate Transformations (Lecture 11) Quiz 11 due Monday July 2 11:59 pm CST
- Conditional Expectations (Lecture 12) Quiz 12 due Monday July 2 11:59 pm CST
- Covariance, Correlation and Multivariate Distributions (Lecture 13) Quiz 13 due Monday July 9 11:59 pm CST
- Inequalities (Lecture 14) Quiz 14 due Monday July 9 11:59 pm CST
- Module 3 Homework 3 due Monday July 9 11:59 pm CST

Module 4

- Properties of a Random Sample (Lecture 15) Quiz 15 due Tuesday July 17 11:59 pm CST
- Properties of a Random Sample contd. (Lecture 16) Quiz 16 due Tuesday July 17 11:59 pm CST
- Modes of Convergence and Related Theoretical Results (Lecture 17) Quiz 17 due Tuesday July 17 11:59 pm CST
- Modes of Convergence contd. and the Central Limit Theorem (Lecture 18) Quiz 18 due Tuesday July 23 11:59 pm CST
- Delta Method (Lecture 19) Quiz 19 due Tuesday July 23 11:59 pm CST
- O and o Symbols (Lecture 20) Quiz 20 due Tuesday July 23 11:59 pm CST
- Module 4 Homework 4 due Tuesday July 23 11:59 pm CST