ECO S394D: Probability and Statistics

Instructor: James Scott (james.scott@mccombs.utexas.edu)
Office: GDC 7.516
Office hours: M W 3:20 – 4:20 PM (GDC 7.516)

Lectures: M T W Th, 1:30 – 3:15 p.m., BRB 1.118
TA session: Friday 1:00 – 2:00 p.m., BRB 1.118

TA: Molin Li (lixx2812@utexas.edu)
TA office hours: TBA

Background and objectives. This course is an intermediate level introduction to probability theory and statistics. The main goal is to prepare students for econometrics. Students taking the course should have a working knowledge of calculus and basic descriptive statistics. The emphasis will be on conveying the basic principles of statistical theory. This is fast-paced course with a condensed schedule, so it is essential to attend lectures regularly and keep up with the material.

Course materials. Your main point of reference will be the lecture notes from class. As a reference on many probability topics we will also use: "Introduction to Probability Lecture Notes," by Dimitri P. Bertsekas and John N. Tsitsiklis. This is posted as a PDF file on the course web page. As a reference for some of the material on data analysis, I have posted a set of course notes entitled "Data Science: A Gentle Introduction."

I will also draw on "All of Statistics: A Concise Course in Statistical Inference" by Larry Wasserman. You should not feel obligated to buy this. It is entirely optional. Since the material we're covering is pretty standard, basically any intermediate probability/statistics textbook can be used as a supplement.

Communication. I will post all assignments, announcements, etc., on the class website: https://github.com/jgscott/ECO394D

Software. While this course is geared more towards the basic mathematics of probability and statistics, the homework will sometimes include some simulation or data-analysis exercises. We will R and RStudio for this purpose.

Assignments, exams and grading. There are three components to your grade: homework (30%), midterm (30%), and the final exam (40%).

There will be an in-class mid-term exam on Monday, July 29th, worth 30%.

There will be four weekly problem sets, together worth 30% (no homework the week of the midterm):

- HW1: Due Friday, July 19th at the beginning of the TA session
- HW2: Due Friday, July 26th at the beginning of the TA session
- HW3: Due Friday, August 9th at the beginning of the TA session

- HW4: Due Friday, August 16th at the beginning of the TA session

These will be posted to the class website.

You are allowed to work on the homework in groups of up to 4 people. If you work in a group, please turn in one copy with all your names on it.

The homework sets are graded primarily on an effort basis. We are not looking at whether your solutions are 100% correct (although that is certainly sufficient to do well). The primary goal of the homework sets is to prepare you for the exams, for econometrics next semester, and for living your lives in a world full of data. We learn the most from our mistakes – so if you make mistakes on the homework, that is OK, as long as you treat them as an opportunity to learn. In grading the homework, we will be looking at the following:

- Did you make an honest, concerted attempt at each problem?
- For a math problem: did you show all your steps? If you were stuck, did you show evidence of attempting to get yourself unstuck, e.g. by writing down results you know that you think might be relevant?
- For a data-analysis problem: did you attempt to address all parts of the question? Did you include figures/tables where appropriate? Did you write up your solution with some semblance of narrative flow and professionalism (good), or did you just copy and paste a bunch of R code without much in the way of explanation (bad)?

The solutions will be discussed at each Friday's TA session. Note: turn in a hard copy of your homework each Friday at the beginning of the TA session. No electronic submissions will be accepted. If you cannot attend the TA session, you can turn in your homework in class on the Thursday before.

The final exam will take place in class on the day announced by the registrar, and it is worth 40%. It is comprehensive, with material drawn from the entire course. I will announce the date when it becomes available.

Course outline

I. Basics of probability

Introduction: Random experiment. Set operations, Kolmogorov's rules of probability. Interpretations of probability. Basic rules.

Joint, conditional, and marginal probability. Rule of total probability. Independence, compounding, and confounding. Bayes' rule.

Random variables and their distributions. Discrete random variables and their PMFs: binomial, Poisson. Continuous random variables and the CDF/PDF: normal distribution. Transformations of random variables.

Properties of distributions: expectation (mean), variance, conditional expectation, conditional variance, covariance and correlation.

The bivariate normal distribution. Regression to the mean.

II. Introduction to data analysis

Basic data visualization

Least squares: fitting equations to data.

Nonlinear equations: polynomials, exponential growth/decay, power laws

If time: Model for groups: dummy variables, interactions.

III. Statistical theory

Random sampling, i.i.d. random variables. Population parameters and sample statistics (estimators). The concept of a sampling distribution. Bootstrapping estimators. Confidence intervals.

Hypothesis testing: basic concepts. Null and alternative hypotheses, confusion matrix, Type 1 and 2 errors. Alpha level vs. p-values. Permutation tests.

General methods for constructing estimators: maximum likelihood, method of moments.

Large-sample properties of estimators: Convergence in probability. The Law of Large Numbers. Convergence in distribution. The Central Limit Theorem. Inference based on asymptotic normality. Consistency.

University policies:

Honor code: "The core values of the University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the University is expected to uphold these values through integrity, honesty, trust, fairness, and respect towards peers and community."

Any student with a documented disability (physical or cognitive) who requires academic accommodations should contact the Services for Students with Disabilities area of the Office of the Dean of Students at 471-6259 (voice) or 471- 4641 (TTY for users who are deaf or hard of hearing) as soon as possible to request an official letter outlining authorized accommodations.

Students who violate University rules on scholastic honesty are subject to disciplinary penalties, including the possibility of failure in the course and dismissal from the University. Since dishonesty harms the individual, fellow students, and the integrity of the University, policies on scholastic dishonesty will be strictly enforced.

Occupants of buildings on The University of Texas at Austin campus are required to evacuate buildings when a fire alarm is activated. Alarm activation or announcement requires exiting and assembling outside. Familiarize yourself with all exit doors of each classroom and building you may occupy. Remember that the nearest exit door may not be the one you used when entering the building. In the event of an evacuation, follow the instruction of faculty or class instructors. Do not re-enter a building unless given instructions by the following: Austin Fire Department, The University of Texas at Austin Police Department, or Fire Prevention Services office.

Students requiring assistance in evacuation shall inform their instructor in writing during the first week of class.

Behavior Concerns Advice (BCAL): 512-232-5050.