USC Viterbi
School of Engineering

EE364: Introduction to Probability and Statistics for Electrical Engineering and Computer Science (4 Units), Fall 2018 - Silvester

Catalog Description: Introduction to concepts of randomness and uncertainty: probability, random variables, statistics. Applications to digital communications, signal processing, automatic control, computer engineering and computer science. **Prerequisite(s):** MATH 225 or MATH 245 **Co-Requisite(s):** none, **Concurrent Enrollment:** none **Recommended Preparation:** Some programming experience (Matlab, Python). Basic use of Microsoft Excel for data analysis and presentation.

Lecture (30491): Tuesday, Thursday 12:00 – 1:50 pm, KAP 156
Discussion (30779): Wednesday 3:00 – 3:50 pm, LVL 16

Instructor: Professor John Silvester
Office: EEB 240
Office Hours: Tuesday, Thursday
Contact Info: silvester@usc.edu

Teaching Assistant: TBD

Grader: TBD

Course Webpage: Assignments, handouts, solutions, grades, etc. will be posted on Blackboard (https://blackboard.usc.edu)

Exam Dates:
Midterm: TBD
Final Exam: 11:00 – 1:00 pm. Tuesday, December 11 (as per university-wide exam schedule)

Recommended Text(s)

- Charles Boncelet, *Probability, Statistics, and Random Signals*, Oxford University Press, 2016. ISBN 9780190200510.
- Henk Tijms, *Understanding Probability*, Cambridge University Press, 3rd Edition 2012 (or 5th Printing 2016), ISBN 9781107658561.

Other Useful Resources

- Leon-Garcia, Probability, Statistics, and Random Processes for Electrical Engineering, 3rd Edition, Addison Wesley, 2008.
- Robert V. Hogg and Elliot A. Tanis, Probability and Statistical Inference, 8th Ed., Prentice-Hall.

Course Description

Probability and statistics form a foundation for many fields and techniques in electrical engineering and computer science – e.g., adaptive signal processing and machine learning, information theory and communications, decision theory, classification, noise modeling and mitigation, etc.

Probability uses models to inform us about the outcome of an experiment to be conducted; or to calculate the odds of various possible outcomes. *Random Processes* allow us to study probabilistic models of systems that evolve over time. *Statistics* is concerned with empirical data and informs the design of experiments and the validity of conclusions that can be drawn from experiments. Probability, statistics and random processes are closely connected and rely on one another. In this class, we will begin looking at probability to develop the basic concepts, including set probability, conditional probability, random variables, estimation, decision making, and a brief introduction to simple random processes. We will then introduce statistics for data analysis utilizing limit theorems.

Learning Objectives

Upon successful completion of this course a student will

- Understand probability as a model for uncertainty
- Be able to perform basic set probability relations including conditional probabilities and Bayes' Law
- Understand random variables as models for numerical measurements with uncertainty
- Use the complete statistical characterization of random variables (e.g. distribution and density functions) to compute probabilities
- Develop novel probability distributions given a description of a random experiment.
- Interpret the incomplete statistical characterization of random variables, such as mean and variance, to draw qualitative and quantitative conclusions.
- Be able to apply common distributions such as Gaussian, Poisson, Binomial, Exponential and uniform to solve problems as appropriate.
- Utilize joint distributions and joint moments to compute probabilities and make estimates of random variables.
- Understand the Law of Large Numbers and Central Limit Theorem and their relation to statistical analysis.
- Apply basic confidence interval formulas to characterize the accuracy of estimates from experimental data
- Make decisions between a finite set of hypotheses from experimental data
- Perform linear regression to estimate one variable from another using experimental data.

Description and Assessment of Assignments

Homework

- Late HW will not be accepted. Please have your homework turned in by the beginning of lecture on the date that it is due.
- Homework will be assigned and collected weekly
- Show your work in your homework solution; the correct answer alone is worth only partial credit.
- Homework collaboration is encouraged. This is discussing problems and solution strategies with your classmates, the TA, and/or the instructor and is to be distinguished from copying solutions of others which is prohibited.

Computer Based Projects (or labs)

- Computer-based project/lab assignments will run concurrent to homework.
- Lab collaboration is encouraged. This is discussing problems and solution strategies with your classmates, the TA, and/or the instructor and is to be distinguished from copying solutions of others which is prohibited.
- No code can be shared or copied from the internet. The only exception is code provided to the entire class by the instructor or TA.
- Lab instruction and discussion will occur in lecture, in discussion, and outside of class. Labs will be introduced, motivated, and started in lecture.

Exams and Quizzes

- No make-up exams will be given. If you cannot make the given dates due to a class schedule conflict, you must notify me by the last day to add/drop. If I cannot accommodate your schedule, you must drop the class. In the case of a medical emergency, a signed letter from your doctor is required. This letter must include the telephone number of your doctor.
- Exams will be closed book (with a 1-page crib sheet allowed).
- There will be a short in-class quiz after each major topic section.

Grading Breakdown

10% Homework
10% Computer-based Projects
20% Review Quizzes (5)
30% Midterm Exam (1 hour, 50 minutes)
30% Final Exam (1 hour, 50 minutes)

Grading Scale

Final grades will be assigned by a combination of student score distribution (curve) and the discretion of the instructor. Final grades are nonnegotiable.

Lecture Attendance

Lecture attendance is strongly encouraged but not mandatory. However, students are responsible for all material presented in lecture.

Course Outline

Introduction and Motivation

Probability basics

- Mathematical formalisms
- Set probability
- Statistical Independence
- Combinatorics (counting)
- Introduction to Binomial Probability Distribution
- Conditional Probability and Bayes' Law
- Maximum Likelihood and Maximum A-Priori Decisions

Single, Discrete Random Variables

- Complete Statistical Description (probability mass functions)
- Common Discrete Random Variables
- Incomplete Statistical Description (mean, variance, moments, tail bounds).
- Example distributions

Multiple Discrete Random Variables

- Joint, marginal, and conditional distributions
- Independent random variables
- MMSE Estimation and Conditional Expectation

Simple Stochastic Process Concepts

- General Definition, Restrict to Discrete State, Discrete Time
- Markov Chains
- Solution Techniques
- A Simple Discrete Time Queue

Continuous Random Variables

- Single CRV's
- Cumulative Distribution Function
- Probability Density Function
- Example distributions
- Multiple CRV's
- Joint, marginal, and conditional distributions
- Independent random variables
- Incomplete statistical descriptions (mean, variance, moments, covariance)
- MMSE Estimation and Conditional Expectation

Introduction to Statistics

- Random sampling
- Sample mean
- The Central Limit theorem and Law of Large Numbers
- Sample variance
- t-distribution and F-distribution
- Confidence intervals on the mean
- Estimation of proportions and probability
- Linear Regression
- Hypothesis Testing as application of the sample mean confidence interval

Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, "Behavior Violating University Standards" https://policy.usc.edu/scampus-part-b/. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct.

Support Systems:

Student Counseling Services (SCS) - (213) 740-7711 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. https://engemannshc.usc.edu/counseling/

National Suicide Prevention Lifeline - 1-800-273-8255
Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. http://www.suicidepreventionlifeline.org

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-4900 - 24/7 on call.
Free and confidential therapy services, workshops, and training for situations related to gender-based harm. https://engemannshc.usc.edu/rsvp/

Sexual Assault Resource Center
For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: http://sarc.usc.edu/

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086
Works with faculty, staff, visitors, applicants, and students around issues of protected class. https://equity.usc.edu/

Bias Assessment Response and Support
Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. https://studentaffairs.usc.edu/bias-assessment-response-support/

The Office of Disability Services and Programs
Provides certification for students with disabilities and helps arrange relevant accommodations. http://dsp.usc.edu

Student Support and Advocacy – (213) 821-4710
Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. https://studentaffairs.usc.edu/ssa/

Diversity at USC

Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. https://diversity.usc.edu/

USC Emergency Information
Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible, http://emergency.usc.edu

USC Department of Public Safety – 213-740-4321 (UPC) and 323-442-1000 (HSC) for 24-hour emergency assistance or to report a crime.
Provides overall safety to USC community. http://dps.usc.edu