USC Viterbi
School of Engineering

EE364: Introduction to Probability and Statistics for EE/CS (Spring 2018)

Course Description: Probability and statistics form the foundation for a large number of 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. For example, given a good model, we can determine how probable it is that Seeds will have more than 4 people in line tomorrow at noon. Statistics is concerned with empirical data and informs the design of experiments and the validity of conclusions that can be drawn from experiments. For example, if you are taking a political poll, statistics tells us the relationship between the number of people polled and the accuracy of the poll (e.g., notice how political polls usually have a $\pm 3\%$ footnote). Statistics and probability are closely connected and rely on one another. In this class we will begin with probably and develop the basic concepts including set probability, conditional probability, random variables, estimation, and decision making. We will then connect to an introduction to statistics through limit theorems. My approach to teaching this class is to introduce general concepts through problems to foster student self-discovery.

Units:	3
Instructor:	Keith M. Chugg EEB 500A (5th floor main office) 213-740-7294 (Voice) Skype: kmchugg chugg@usc.edu – Include 364 in subject
Office Hours:	Monday, Wednesday, 5:30 – 7:00
TA:	Filipe Vital
Office:	EEB 322
Phone:	none
	fvital@usc.edu – Include 364 in subject
Office Hours:	Tuesday, Thursday: 3:30-5:00
Grader:	Siddharth Gupta
	gupt232@usc.edu – Include 364 in subject
Office:	No office hours, email only for questions on grading. Grader is not a TA.
Lecture:	Monday, Wednesday, 4:00 - 5:20 pm in THH 119
Discussion:	Friday, 4:00-4:50 am in THH 106
Webpages:	Piazza Class Page for everything except grades and USC Blackboard Class Page for grades – All HWs, handouts, solutions will be posted in PDF format with some Matlab, Excel, Python resources – *Student has the responsibility to stay current with webpage material*
Prereq:	MATH 225 or MATH 245
Other Requirements:	Basic computer skills (e.g., plotting, Matlab, Excel, Python, etc.).
Grading:	16% Homework 24% Midterm Exam 1 (1 hour, 20 minutes) 24% Midterm Exam 2 (1 hour, 20 minutes) 36% Final Exam (2 hours)

Note on e-mail vs. Piazza: If you have a question about the material or logistics of the class and wish to ask it electronically, please post it on the piazza page (not e-mail). You may post it anonymously if you wish. Often times, if one student has a question/comment, other also have a similar question/comment. Use e-mail with the professor, TA, graders only for issues that are specific to your individually (e.g., a scheduling issue or grade issue).

Catalogue 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.

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.

Exam Dates:

- **Midterm Exam 1:** Wednesday, February 21, 4:00 - 5:20 PM (TBR, finalized Lecture 1)
- **Midterm Exam 2:** Wednesday, April 4, 4:00 - 5:20 PM (TBR, finalized Lecture 1)
- **Final Exam:** Wednesday, May 2, 4:30 - 6:30 PM as set by the university

Grading Policies:

- **Final grades** will be assigned by a combination of student score distribution (curve) and the discretion of the instructor. Final grades are nonnegotiable.
  - Final grades are non-negotiable and are assigned at the discretion of the instructor. If you cannot accept this condition, you should not enroll in this course.
- **Homework Policy**
  - **Late HW** will not be accepted. A late assignment results in a zero grade. 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.

- **Exam Policy**

  - **Make-up Exams:** No make-up exams will be given. If you cannot make the above 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 (possibly with a crib sheet allowed).
  - The weight of each exam in the course grade is proportional to the duration of the exam.
  - All exams are cumulative, but with an emphasis on material presented since the last exam.

- **Attendance:** Lecture attendance is encouraged but not mandatory. However, students are responsible for all material presented in lecture.

Statement for Students with Disabilities: Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.

Statement on Academic Integrity: USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect ones own academic work from misuse by others as well as to avoid using anothers work as ones own. All students are expected to understand and abide by these principles. Scampus, the Student Guidebook, contains the Student Conduct Code in Section 11.00, while the recommended sanctions are located in Appendix A. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at http://www.usc.edu/student-affairs/SJACS/.

Emergency Preparedness/Course Continuity in a Crisis In case of a declared emergency if travel to campus is not feasible, USC executive leadership will announce an electronic way for instructors to teach students in their residence halls or homes using a combination of Blackboard, teleconferencing, and other technologies.

Textbooks:

- **Required Textbooks:**

  1. Charles Boncelet, Probability, Statistics, and Random Variables, Oxford University Press, 2016.

- **Optional Textbook:**

  1. A. Leon-Garcia, Probability, Statistics, and Random Processes for Electrical Engineering, 3rd Edition, Addison Wesley, 2008. (early editions are acceptable, just verify any problems assigned)
  2. Robert V. Hogg and Elliot A. Tanis, Probability and Statistical Inference, 8th Ed., Prentice-Hall.

Course Outline

1. Introduction and Motivation
   (a) Modeling, mathematics, measurements, and engineering pragmatism
   (b) Probability, statistics, and superstition
   (c) How EE/CS people use probability and statistics
2. Probability basics [**Ch. 1-3, 6.1-6.2**]
   (a) Mathematical formalisms
   (b) Set probability
   (c) Statistical Independence
   (d) Combinatorics (counting)
   (e) Introduction to Binomial Probability Distribution
   (f) Conditional Probability and Bayes' Law
   (g) Maximum Likelihood and Maximum A-Priori Decisions
3. Single, Discrete Random Variables [**Ch. 4**]
   (a) Complete Statistical Description (probability mass functions)
   (b) Common Discrete Random Variables
   (c) Incomplete Statistical Description (mean, variance, moments, tail bounds).

   MIDTERM 1
4. Multiple Discrete Random Variables [**Ch. 5**]
   (a) Joint, marginal, and conditional distributions
   (b) Independent random variables
   (c) Incomplete statistical descriptions (mean, variance, moments, covariance)
   (d) Example dsitrubtions
   (e) MMSE Estimation and Conditional Expectation
5. Continuous Random Variables [**Ch. 7-9**]
   (a) Cumulative Distribution Function
   (b) Probability Density Function
   (c) Joint, marginal, and conditional distributions
   (d) Independent random variables
   (e) Incomplete statistical descriptions (mean, variance, moments, covariance)
   (f) Example dsitrubtions
   (g) MMSE Estimation and Conditional Expectation
6. Introduction to Statistics [**Ch. 10-12**]
   (a) Random sampling

(b) Sample mean

(c) The Central Limit theorem and Law of Large Numbers
MIDTERM 2 approximately here

(d) Sample variance

(e) t-ditribution and F-distribution

(f) Confidence intervals on the mean

(g) Estimation of proportions and probability

(h) Linear Regression

(i) Hypothesis Testing as application of the sample mean confidence interval

Notes:

- My practice is to post lecture summaries after each lecture.
- We will not cover every section of every listed chapter. I will provide details as we progress through the book.
- I will extensively utilize spreadsheets and simple computer scripts (Matlab and/or Python) to build intuition. Some assignments will have problems that require using a computer. Students are encouraged to become proficient in these methods during the course.
- The discussion material is determined by the students. Please provide suggestions and questions to the TA beforehand. If you show up to discussion and ask no questions, the TA will present summaries of the material and work example problems. The TA will not work the HW problems for you in discussion, although the TA will provide hints/help.