# COMPSCI 177: Applications of Probability in Computer Science

University of California, Irvine, Fall 2017

Probability and statistics play a key role in real-world applications of computer science. Examples include the modeling of text and web data, speech recognition, robotics, network traffic and system reliability modeling, probabilistic analysis of algorithms and graphs, machine learning and data mining, cryptography, and more. In this course, students will expand their knowledge of probabilistic models and methods, and apply them to diverse computational problems. The mathematical topics we will study include conditioning and Bayes' rule, joint distributions of discrete and continuous random variables, independence and conditional independence, covariance and bivariate normal distributions, rare events, limit theorems, and discrete-time Markov processes.

**Prerequisites:** An introductory course in probability and statistics (STATS 67). Courses in calculus (MATH 2B), linear algebra (MATH 3A or I&C SCI 6N), and discrete mathematics (I&C SCI 6B, I&C SCI 6D). Basic programming experience required for homework assignments.

## Administrative Information

**Textbook:** *Introduction to Probability*, second edition. Dimitri P. Bertsekas & John N. Tsitsiklis, Athena Scientific, 2008. Supplemental readings may be distributed for some topics.

**Lectures:** Tuesdays and Thursdays from 2:00-3:20pm, Rowland Hall 104.

**Instructor:** Prof. Erik Sudderth (sudderth@uci.edu; 949-824-8169; DBH room 4028)

**Teaching Assistant:** John (Gabriel) Hope (hopej@uci.edu)

**Reader:** Geng Ji (gji1@uci.edu)

**Office Hours:** See the course website for a detailed schedule.

## Syllabus: Summary of Course Topics

*Please see the course website for a more detailed weekly schedule and reading list.*

**Review of Basic Probability** axioms of probability, events and random variables, combinatorics, conditioning and Bayes' rule, independence

**Discrete & Continuous Random Variables** joint distributions of multiple random variables, conditional independence, functions and derived distributions, expectation and moments

**Limit Theorems** Markov and Chebyshev inequalities, law of large numbers, central limit theorem

**Normal Distributions** covariance and correlation, bivariate distributions, linear regression

**Monte Carlo Methods** pseudo-random number generation, Monte Carlo integration

**Discrete-time Markov Chains** classification of states, steady-state behavior and equilibrium distributions, absorption probabilities, queueing theory

**Statistics** classification and hypothesis tests, maximum likelihood parameter estimation

**Applications** data visualization, machine learning, computer simulation, algorithms and graphs

## Exams and Course Grades

Overall course grades will be assigned as follows: 40% homeworks, 25% midterm exam, 35% final exam. The midterm exam will be given during the normal lecture time on Tuesday, November 7. The final exam will be given on Thursday, December 14 from 1:30pm-3:30pm. *Exams **must** be taken at these times. Exceptions are granted only for medical or family emergencies.*

Exams will include questions similar to the non-programming portions of the homework assignments. Electronic devices are not allowed. You are not allowed to bring notes or other reference materials, but we will provide a reference page with useful mathematical formulas.

## Homework Assignments

There will be seven homework assignments, each due at least one week after it is handed out. Homework problems will emphasize probabilistic derivations, calculations, and reasoning. Each homework will also have a problem requiring software implementation and analysis of some probabilistic method. We will drop your lowest homework score, and average the scores of the other six homeworks equally, to determine an overall homework score. Homeworks must be submitted electronically via the EEE+ Canvas website.

**Formatting Homework Solutions** Your answers to all questions, with the exception of source code, must be included in a single pdf document. Number your answers by question and part using the same order as in the handout. Result plots must be submitted as figures in the same pdf as your other answers, *not* as separate files. We recommend that you use the LaTeX template we provide to typeset your solutions, but if you prefer, you may use another program that generates easy-to-read pdf files. Any English text in your answers must be typed, *not* handwritten. We allow an exception for mathematical derivations, which if you prefer may be scanned and included in your single solution pdf. However it is your responsibility to make sure that any scanned math is legible, and graders have the discretion to deduct points for illegibility. *Remember to show your work clearly, and make it easy for the graders to check your work!*

**Late Submission Policy** Homework assignments are due by 11:59pm on Thursday evenings. Your answers may be submitted up to 4 days late (by 11:59pm Monday evening); after this point, solutions will be distributed and handins will no longer be accepted. To encourage you to keep up with the material presented in lecture, for each homework that is submitted on time, you will receive *1 bonus point* (out of a maximum of 100) on the next exam. *Exceptions to this policy are only given in very unusual circumstances, such as documented family or medical emergencies, and any extensions must be requested in advance by e-mail to the instructor.*

**Collaboration Policy** Students are encouraged to discuss and work on homework problems in groups. However, each student must write up their solutions independently, and do any required programming independently. You may *not* directly copy solutions or code from other students, or from materials distributed in previous versions of this or other courses. You may *not* make your solutions available to other students: files in your home directory may not be world-readable, and you may not post your solutions to public websites or repositories. *It is each student's responsibility to know and follow these guidelines, as well as the UCI ICS School Policy on Academic Honesty.*