SYLLABUS for Math 407 Fall 2020 lecture 39625, labs 39626–27 (Aug 13, 5pm revision)

Professor Richard Arratia, rarratia@usc.edu. Please put 407 in the subject line of any email that you send me!

This is my first experience teaching fully online, since last spring I met my students in person for the first 9 or so weeks of the semester. So many details, of how to give quizzes, midterms, and the final, have still to be worked out.

TIMES are reported in Pacific; note that there is a shift, from PDT to PST (Pacific Daylight (savings) Time, to Pacific Standard time, on November 1, 2020.

9–10 MWF lecture; labs 8–9, or 9–10 T Th with Apoorva Shah, apoorvps@usc.edu .

Online "office" hours M 10am (the hour directly after lecture), W 8am (the hour directly before lecture), and W 9pm (11 hours after the start of lecture), but adjustments may be made after the semester begins, and I learn what students' preferences are!

Text: We have *no text*. If you want an inexpensive backup reference, around $20 for Schaum Outline Series – Probability, Random Variables, and Random Processes, 3rd edition, Hwei Hsu is a good value. If you want a standard course, not too exciting, Ross, A First course in Probability Theory, any edition, is good. If I had been forced to choose a text, it would have been Introduction to Probability, by Anderson, Seppalainen, Valko. The *best* book, and reference, is WIlliam Feller, Volume I, An Introduction to Probability Theory and Its Applications, and if I could only own one book, this would be it; Volume II is also excellent, but not as accessible. A lovely, succinct book, handling measure theory efficiently, and only $40, is David Williams, Probability with Martingales, written 'for 3rd year undergraduates at Cambridge'.

We emphasize *indicators* and *expectations*, all semester long. We avoid measure theory, pretending that *all* subsets of the sample space are events. We will cover the basic discrete distributions (Bernoulli, Binomial, Geometric, Poisson), with additional material including Stirling's formula, entropy (exponential growth/decay rates), and, at the end of the semester, generating functions, and some Huffman coding. We cover second moments, variance, the Cauchy-Schwarz inequality, Bayes's Theorem. We cover basic continuous distributions (Uniform, Exponential, Normal) and the change of variables relation arising when a smooth function is applied to a random variable having a density. We study the basic Poisson process. We learn how to apply the Central Limit Theorem, without proof.

Course philosophy: Probability theory is a very lively subject. Blaise Pascal (1623–1662) said "Probability is common sense made precise." Probability theory is both a branch of science, making falsifiable predictions about real world experiments, and a branch of mathematics, so that starting from a few simple assumptions, logical consequences can be proved. Elementary probability is mostly algebra, combinatorics, and calculus, featuring exact formulas. But approximations, and limits, are also very important.

I am a probabilist; starting from my doctoral degree in 1979,

see https://en.wikipedia.org/wiki/Brownian_web.
You can retrace my PhD ancestry via the Mathematics Geneology Project
https://www.genealogy.math.ndsu.nodak.edu/id.php?id=9633
and clicking on successive ancestors. One path through the tree is: David Griffeath (Cornell 1976,) Frank Spitzer (U. Michigan 1953,) Don Darling (Caltech 1947,) Morgan Ward (Caltech 1928,) Eric Temple Bell (Columbia 1912,) Frank Cole (Harvard 1886,) Felix Klein (Bonn 1868,) Rudolf Lipschitz (Berlin 1853,) Gustav Dirichlet (Bonn 1827,) Simeon Poisson (Paris 1800,) Joseph Lagrange (advisor Euler, 1750s, no degree,) Leonhard Euler (Basel 1726,) Johann Bernoulli (1694,) Jacob Bernoulli (1690 or 1694,) Gottfried Leibnitz (1666). Another path uses Poisson's second advisor, Pierre-Simon Laplace (1769, lived 1749–1827). I had no idea, when studying for my PhD, what a distinguished family tree I was on the verge of lucking in to!

You can enjoy browsing my recent papers at
https://arxiv.org/search/?query=arratia_r&searchtype=author&abstracts=show;
see especially a fun paper about lotteries, 'Some people have all the luck',
https://arxiv.org/pdf/1503.02902.pdf .
You may also enjoy clicking on https://en.wikipedia.org/wiki/Richard_Arratia and
https://scholar.google.com/citations?user=l7ubIk8AAAAJ&hl=en.

Grading policy:

10 percent Homework

10 percent Quizzes

40 percent projects, which are (all, or mostly) Matlab assignments; 10 percent per class day late penalty.

20 percent = 10 percent each, Midterm 1 and Midterm 2.

20 percent Final exam

Some details.
'Homework' will be one assignment per lecture, and always the same easy question: write a 4 sentence summary of the lecture. The purpose of this is to encourage students to keep current, and view lectures within 24 hours of broadcast; the HW is due at the end of 24 hours, and cannot be made up. I *hope* to figure out how to use blackboard to collect these assignments. They will be graded generously; any four reasonable sentences, that indicate that you watched the lecture, will get full credit. You are always encouraged to study together, but you are NOT allowed to copy work! We won't grade these assignments every day, but late in the semester, we will grade a sample. And evidence of copying will have accumulated, and academic integrity violations will be pursued; both the person who copies, and the person who is copied from, would be guilty.

'Quizzes' are weekly, give or take a day or so. The purpose is to focus your attention on a few tasks; you will see in advance a sample copy, and then the actual quiz will mostly repeat the same questions, though with different constants, and with a small amount of new types of questions.

The midterms will be similar to the quizzes; again, you will see a sample in advance. I delay

scheduling midterms, for now, till I learn more about giving online exams. But, roughly, they will occur after 6 weeks and after 12 weeks. As per `https://classes.usc.edu/term-20203/finals/` , our final will be Monday Novemeber 23, 11am to 1pm.

My quizzes used to be 10 minutes, at the end of lecture, usually Fridays. Perhaps I will be able to convert the questions to multiple choice, and I believe that then there is an automated blackboard tool for grading them. Perhaps not; then collecting and grading would be an excess burden — and in this case, I invite you to take the quiz under timed conditions, not hand it in, then a day or so later I will post the answers, suggest that you grade yourself, but I will enter a perfect 10 as your score on blackboard, so that you will feel free to grade your own work strictly! In the latter case, everyone will have perfect quiz scores, and since the overall course is curved, the net effect will be to reduce, in my grading policy, the contribution from quizzes, from 10 percent to zero, and to scale up the other 90 percent to, in effect, 100 percent. There might be a mixture of the two modes (strictly graded multiple choice, versus super-generously graded while not handed in), to evolve as I struggle to work with blackboard.

I am aware that there are internet sites that collect old exams, and that some enterprising students will be able to find my old midterms and quizzes. So the policy, above, of providing official samples in advance, should make it unnecessary, and minimally productive, to search the internet!

Bonus points will be awarded, at my discretion. The primary bonus activity is typo-spotting; the first person to chime up in lecture with a query, that is answered by saying "Oh, I wrote it incorrectly, or left out something important", should be rewarded with a bonus point. The idea is: if something going by in lecture confuses you — it might be my fault, so it helps everyone if you speak up quickly. I also care about typos in my handouts. Another bonus activity might be internet-mining; I would like to have a comprehensive collection of exam materials from my previous teachings of 407, and I will reward people who forward me copies, of anything not already in my collection. The total extent of bonus points is meant to be moderate; the most diligent student might get the equivalent of raising a final exam score by 10 or 20 points.