STAT 430: Probability
Sections 003 and 004
Fall 2021 syllabus (version 5, Oct. 25)

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Classes:	Section 003: TR 3:30–5:00 pm, JMHH G55 Section 004: TR 5:15–6:45 pm, JMHH G55
Office hours / problem sessions:	
Junbin and Keshav:	Sun. 4–5:30 pm, by Zoom
Mauricio:	Wed. 5:15–6:45 pm, JMHH 355
Winston:	Wed. 7–8:30 pm, JMHH G92 or by appointment
Mauricio:	Thurs. 1:45–3:15 pm, SHDH 1206
Andrea and Caroline:	Thurs. 8–9:30 pm, by Zoom
Alexandru:	Fri. 12 noon–1:30 pm, SHDH 110

Prerequisite

Multivariable calculus at the level of MATH 114.

Required textbook

Joseph K. Blitzstein and Jessica Hwang, *Introduction to Probability*, Second Edition (2019)

- You can buy or rent the book from Penn Bookstore, Amazon, or other sellers, or you can view a free online version at `http://probabilitybook.net`.
- Regardless of whether you use a hardcopy or online version, I recommend always having a pen(cil) and paper handy. Mathematical books at this level often leave out steps, assuming you can fill in the steps on your own. When I read books on probability or statistics, I usually need to scribble notes in the margins or on scratch paper (figuring out missing steps, trying out simple examples or diagrams, etc.). You don't need to fill in

every missing step on your own (I'll help with some of them in class), but you're likely to learn more if you nudge yourself to *try* to fill in some steps. (You may be pleasantly surprised to find that you can fill in more than you expected.)

- You don't need to follow every line and example in the book (my lectures and slides will cover the concepts required for our course), but I strongly recommend at least attempting to study it. My slides are mostly based on the book and are meant to help you understand the main ideas, but they're not a substitute for it.
- Joe Blitzstein's website `http://stat110.net` has links to many helpful resources, including lecture videos and animations. These are optional, but some of you may find them helpful (and the animations are very cute!).

Canvas website

Lecture slides, problem sets, solutions, and announcements will be posted on Canvas. I'll also post a file called "news.pdf" explaining which portions of the textbook you should be reading, which slides were covered in class, and so on. I'll add a new entry after each lecture (either that evening or the next morning). Following the "news" file is a good way to keep up to date with the course.

Recordings of all classes will also be posted on Canvas.

Requirements and grading

First midterm exam (Thurs., Sept. 30, in class) : 25%

Second midterm exam (Thurs., Nov. 4, in class): 30%

Final exam (Wed., Dec. 15, 6–8 pm): 35%

Problem sets (dropping the two lowest scores): 10%

- Problem sets will be due almost every week (with exceptions such as the first two weeks and the weeks of exams) and should be submitted electronically on Gradescope. We'll post information about how to submit your work.
- You're encouraged to discuss problem sets with classmates (this can be a good way to learn), but you must write your solutions independently and in your own words. If you discuss a problem set with other students, please write an acknowledgment listing their names.
- Late problem sets won't be accepted unless there are extenuating circumstances (e.g., an illness or family emergency). As mentioned above, we'll drop your two lowest scores. So, although you'll receive a score of zero for any late homework that we don't accept, that score will be dropped unless you already have two or more zeros.

Electronic devices

It's okay to use tablets (iPads, etc.) to take notes in class. Please keep them flat on the table and use them only for note-taking.

In general, I prefer that students not use phones or laptops in class, because these can be distracting for all of us.[1] Exceptions will be made if you need to use a laptop because of a disability or other reason (feel free to let me know).

(My phone will be in airplane mode during class. If it looks like I'm using my phone, I'm just turning off an alarm that I set to keep myself from running overtime.)

Email

Emails are fine for some administrative questions and very straightforward conceptual questions (e.g., when you think there's a typo in a homework problem). When you have conceptual questions that require more explanation, it's better to talk (during class, at office hours or problem sessions, or by appointment) in person or by Zoom.

Also, we won't always be able to answer emails immediately, so please anticipate that it may take us a day or so to reply.

Outline

This is just an outline of our main topics. (We won't cover every section of these chapters. In the "news.pdf" file on Canvas, I'll give more specific advice on what to read.)

- Probability and counting (Ch. 1): Review of set theory and combinatorics. Sample spaces and events. "Naive" definition of probability (equally likely outcomes). "Non-naive" (axiomatic) definition of probability. Inclusion–exclusion principle.
- Conditional probability (Ch. 2): Definition. Bayes' rule. Law of total probability. Independence of events.
- Random variables and their distributions, with a focus on the discrete case (Ch. 3): Definition. Probability mass functions. Binomial and hypergeometric distributions. Cumulative distribution functions. Functions of random variables. Independence of random variables.
- Expectation (Ch. 4): Definition. Linearity. Geometric, negative binomial, and Poisson distributions. Variance and standard deviation.

[1] Susan Dynarski gives a thoughtful discussion of research on how students' use of laptops in class may affect their own and their classmates' learning:
`www.brookings.edu/research/for-better-learning-in-college-lectures-lay-down-the-laptop-and-pick-up-a-pen`

- Continuous random variables (Ch. 5): Probability density functions. Continuous uniform, normal, and exponential distributions. “Universality of the uniform” (probability integral transform and its inverse). Poisson processes.
- Moment generating functions (Ch. 6).
- Joint distributions (Ch. 7): Joint, marginal, and conditional distributions. Covariance and correlation. Multivariate normal distribution.
- Transformations (Ch. 8): Change of variables. Convolutions.
- Conditional expectation (Ch. 9): Conditional expectation given an event. Conditional expectation given a random variable. Law of iterated expectations (“Adam’s law”). Conditional variance and law of total variance (“Eve’s law”).
- Inequalities and limit theorems (Ch. 10): Markov’s and Chebyshev’s inequalities. Laws of large numbers. Central limit theorem.