Math/Stat 394 A: Probability I (Summer 2021)

Aaron Osgood-Zimmerman

<2021-06-14 Mon>

Course Personnel

Instructor Aaron Osgood-Zimmerman, azimmer@uw.edu

Logistics

Prereqs Overall, a firm mastery of multivariable calculus and basic combinatorics (counting methods) will serve you well.

- Required: Univariate calculus (MATH 126/136), sums, power series, basic combinations and permutations.
- Recommended: Any course with combinatorics or discrete math in it (e.g. Math 300 or 381)

Synchronous Lectures MWF 8:30 am - 10:40 am (via Lecture Zoom, recorded)

- 1 hour blocks with 10min break

Office Hours Tuesday 8:30-9:30am PST, Thursdays 4-5pm PST on Zoom

Homework submission Gradescope

Anonymous Feedback Submit here (or find via Canvas Page)

Texts

The textbook we will be following and working problems from is *Introduction to Probability*, by Anderson, Seppäläinen, and Valkó. (you can purchase a digital copy for $8)

Other good references (in no particular order) are:

- *A First Course in Probability*, by Sheldon Ross. A classic. Since this would be used for your reference only, the edition does no particularly matter. However, I would suggest avoiding the latest which is very expensive.
- *Grinstead and Snell's Introduction to Probability* . Freely available. Emphasizes building intuition and working problems through coding.
- *Probability and StatisticsThe Science of Uncertainty* by Evans and Rosenthal. Freely available.
- *Introduction to Probability Models*, 11th Edition, Sheldon Ross. Freely Available.

Beyond those reference texts, here are some more pop probability books that you may find enjoyable:

- Chance: A Guide to Gambling, Love, the Stock Market, and Just About Everything Else, by Amir D. Aczel
- How to Lie with Statistics, by Darrell Huff.
- Chances Are: Adventures in Probability, by Michael and Ellen Kaplan.
- The Drunkard's Walk: How Randomness Rules Our Lives, by Leonard Mlodinow.
- The Lady Tasting Tea: How Statistics revolutionized Science in the Twentieth Century, by David Salsburg.
- The Unfinished Game: Pascal, Fermat, and the Invention of Probability, by Keith Devlin.
- Randomness, by Deborah J. Bennett.

- Fooled by Randomness: The Hidden Role of Chance in the Markets and in Life, by Nassim Nicholas Taleb.

These are just suggestions and a couple of the above books are more about statistics than probability. I list these here for the student interested in expanding their understanding and enjoyment of the domain above and beyond what may be covered in this or any other course. There are books about probability and history, probability and logic, probability and philosophy, and many more. We will each have our own preferences for probability pleasure reading, and I suggest you take the time to find a book that may make probability a little more interesting and real for you, in a context very different from your course work.

Homework

There are 5 problem sets. They are due each every Friday at midnight, except for HW5, which is due the final Tuesday of class. Homeworks are submitted on Gradescope. **No late submission will be accepted.** Each problem set consists of *required* problems and a few *(optional) extra credit problems.*

Grading *Clear, detailed, and legible* mathematical explanation is required to receive full credit.

Format You should submit a PDF. You are strongly encouraged to typeset your solutions, e.g., with LaTeX, or Emacs with AucTex or Org-mode (my personal tool of choice), or GNU TeXmacs. This course is "LATEX compliant" – meaning that every homework assignment (written in LATEX) has its LATEX sourcecode posted on the class website. If you would like to write up your homework in LATEX, simply download the sourcecode, plus a couple supplementary files from the website, and write in your solutions to each problem.

Collaboration You are encouraged to work with your classmates. But you should write up the solutions *on your own.* If you collaborated with someone on a problem set, please mark his/her name in your solution.

Learning Goals

Affective goals how is our relationship with math?

- We will come to see success, and grades, in math classes as a product of effort rather than innate ability (there's no such thing as "math people" and "non-math people").
- We will discover that solving math problems is as much an art as it is a procedure.
- We will develop resilience in problem solving by allowing failure of one approach to motivate other approaches that will succeed.

Cognitive goals what will we learn about math as a whole (rather than just probability)?

- We will learn to prove theorems in the abstract ("prove that the following statement holds") in addition to performing calculations ("compute the ___ of ___") and derivations ("show that the ___ of ___ is_____").
- We will learn how to communicate math effectively, as good writing is necessary for good math and good presentation skills are required to share you knowledge with others.

Participation

By request, synchronous time will be used for lectures. I will try to break up the talking by allowing you to work examples on your own and submit your answers to zoom polls.

Every day of class you participate in zoom polls will earn you 10\of the participation points.

For those of you who wish to take the class asynchronously, you may earn participation points by engaging in course related discussion on Piazza. Every material related question you post will be worth 5\worth 10\

A maximum of 110\

Contents

After this class, among others, you should be able to answer the following questions.

1. What is a probability space and a random variable?
2. How to use Bayes theorem?

3. How to calculate expectation and variance from a pdf/pmf?
4. What are iid random variables?
5. What is the binomial distribution and when is it approximated by normal or Poisson?
6. How to calculate a confidence interval for the sample proportion?

You are welcome to continue taking MATH/STAT 395 in the following B term (starts *<2021-07-22 Thu>*).

Calendar

Here is a tentative calendar. See the up-to-date version here.

Week	Date	Chapter	Topic	Due	Note
	<06-21 Mon>	Appendix C, D	Combinatorial analysis		
1	<06-23 Wed>	§1.1-1.2	Sample space, axioms of probability, inclusion-exclusion		
	<06-25 Fri>	§1.3-1.5, 2.1	Random variables, infinitely many trials. Conditional probability.	HW 1	
	<06-28 Mon>	§2.2-2.3	Bayes formula and independence.	HW 2	
2	<06-30 Wed>	§2.4-2.6	Independent trials. Binomial and geometric distributions.		
	<07-02 Fri>	§3.1-3.3	pmf, PDF and CDF. Uniform distribution. Expectation.		
	<07-05 Mon>		No Class		Holiday
3	<07-07 Wed>	§3.4-3.6	Variance. Gaussian distribution.	HW 3	
	<07-09 Fri>	§4.1-4.3	Normal approximation to Binomial. Confidence interval.		Midterm
	<07-12 Mon>	§4.4	Poisson approxmation to Binomial.	HW 4	
4	<07-14 Wed>	§4.5	Exponential and geometric distributions.		
	<07-16 Fri>	§5.2, 6.1	Distribution of a function of a random variable.		
5	<07-19 Mon>	§9.1-9.2	Tail bounds and weak law of large numbers. Maximum/minimum of iid random variables.	HW 5	
	<07-21 Wed>		Review for final (optional, come only if you want/need)		Final

Exams

You will be able to download the exam paper when time starts. After you finish, save your solutions (e.g., by scanning or taking a photo) as a PDF and submit on Canvas. You should work on your own for the exam and turn in your solutions within 24 hours.

Midterm one-day take-home, July 9 Fri.

Final one-day take-home, July 21 Wed.

Grades

Grades are based on:
Homework 40%, Midterm 20%, Final 30%, Participation 20%.
This adds up to 110% and your worst category will be worth 10% less.

Minimum requirement for getting 2.0. Summer 2021 continues to be an "extraordinary circumstances quarter". You can get at least 2.0 (equivalent to S) if scoring $\geq$50% on midterm and final, and $\geq$70% on 4 out of 5 homework problem sets.

Expectations and Conduct

DRS If you have accomodations from Disability Resources for Students (DRS), please let the instructor know as soon as possible. If you feel you need special accommodations, contact me or DRS directly. DRS can help accommodate conditions including, but not limited to: mental health, attention-related, learning, vision, hearing, physical, or other conditions. DRS can be contacted at 206-543-8924, uwdrs@uw.edu,(mailto:uwdrs@uw.edu) or their website (http://depts.washington.edu/uwdrs/) .

Diversity Diverse backgrounds, embodiments, and experiences are essential to the critical thinking endeavor at the heart of university education. Therefore, I expect you to follow the UW Student Conduct Code in your interactions with your colleagues and me in this course by respecting the many social and cultural differences among us, which may include, but are not limited to: age, cultural background, disability, ethnicity, family status, gender identity and presentation, citizenship and immigration status, national origin, race, religious and political beliefs, sex, sexual orientation, socioeconomic status, and veteran status.

Academic Integrity We take academic integrity with the utmost seriousness, and will not hesitate to report academic dishonesty to UW and/or penalize you via your grade on the test/homework in question. If you are found to have cheated on a homework/test, you will have invalidated your submission and will receive a zero for the entire homework/test in question.

- Tests: this should be obvious, but you may not use unauthorized test materials, look at other students' tests, or obtain help from others (including online message boards) during a test.
- Homework: some answers to homeworks will be available (back of the book, previous solutions, online, etc). You are encouraged to facilitate your learning in most any integrous manner including reviewing previously worked solutions. You are also encouraged to work with your friends/classmates on the homework. The key to not cheating on homework is simple: *don't plagiarize*. Your submitted solutions must be your own, even if the answer was found elsewhere. The purpose of the homework is to encourage your personal edification and, as such, your submitted solutions must demonstrate *your personal understanding*.

Additional Comments

This is an accelerated course Therefore, attendance is essential and encouraged

Practice Doing lots of homework problems is the best way to learn the material. Read the exercises and solutions if you don't understand the concepts - they should help you. If you don't understand the material, try doing extra problems from any of the reference texts I listed above. Feel free to come to office hours with questions on problems besides the HW.

Career Before returning as a full-time student to finish my PhD, I worked as a professional research statistician and programmer (primarily with R) at a health institute (IHME). If you are interested in learning about my experience as a professional statistician or programmer – possibly out of curiosity for your own career opportunities – feel free to chat with me outside of class!

Recomendation Letters You are *not* recommended to ask a letter from the instructor if you have other options, because the instructor is still a PhD student and his letter would carry little weight.