MATH 3100: INTRODUCTION TO PROBABILITY

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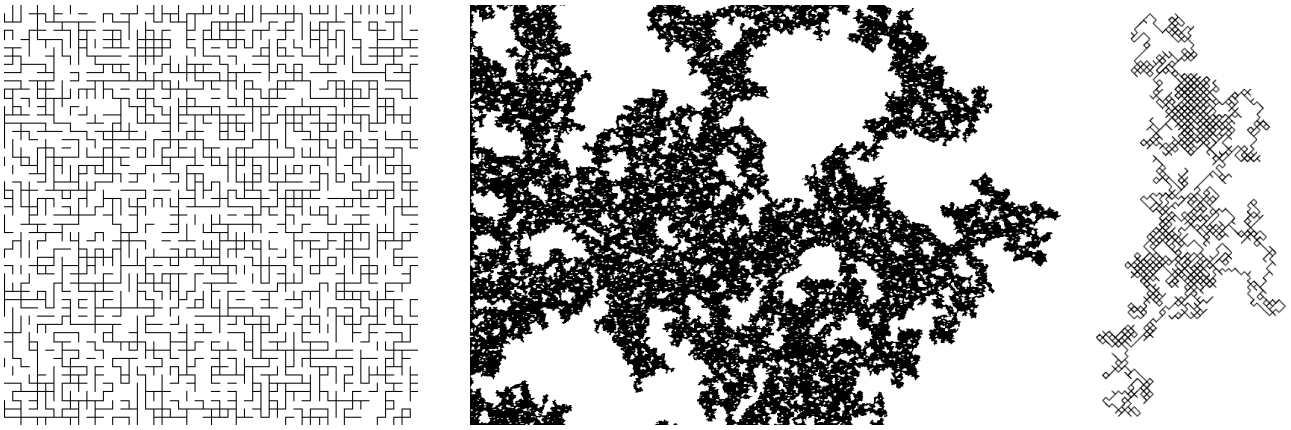
FALL 2020
SECTIONS 002 AND 003

this syllabus is a stub, and will contain full details by August 25

1. *A mathematical study of randomness*

How random is everything around us, and what chance do we have of understanding it? What to do when you're not certain, and how to do it right? How many falling stars will you see as you walk outside one beautiful night?

Probability theory is a mathematical study of uncertainty. It is a rigorous foundation of statistics — and many areas of human knowledge operate in a language of statistics nowadays (yes, and robots use it, too!). The course introduces fundamental concepts, ideas, and techniques of probability theory. It will provide you with the foundational mathematical knowledge needed to address the questions above and will help you develop intuition about randomness.



Examples of random structures: bond percolation close-up (left), at a larger scale (center), and a random walk (see also a simulation of a random walk). Note: this PDF has green clickable links, like in the previous sentence.

What you will get from this course.

1. Mastery of basic probability concepts:
- (a) What is a probability space and how to translate commonly-sounding problems into this language;
- (b) How to count (in an advanced way) to compute probabilities;
- (c) What is a random variable, a probability distribution, and what are their main quantitative properties;
- (d) How commonly encountered probability distributions (binomial, Poisson, exponential, Gaussian) look like and behave, what are their properties, and in which situations they typically arise.

2. How large random systems behave, and what the bell-shaped curve  has to do with this.

Date: Compiled on Friday 21st August, 2020, 13:15.
An up to date syllabus is always on GitHub at https://github.com/lenis2000/Syllabi/blob/master/Syllabus_3100_f20.pdf. For direct PDF download use this link. LaTeX source with *changes* to the syllabus is here (click "History").

3. How to describe and quantify the mutual dependence of random events, and how to use such a description to infer properties of "hidden" random events.
4. How to apply probability theory to model real-life processes like queues (consisting of people or requests at an internet server).
5. How to collaborate on solving probability problems in pairs, small groups, and online, and present solutions clearly and efficiently.
6. In what ways probability theory is connected to science, engineering, and other branches of knowledge.

Prerequisite. You should have taken at least one semester of calculus (MATH 1320 level): the study of random variables often requires single and double integrals and infinite series.

What this course is and what it is not. This course in probability *theory* belongs to pure mathematics, with rigorous definitions, calculations, and proofs. However, the objects which we study are motivated by real-life applications, and so pure mathematical arguments often appeal to our common sense understanding of these objects. There will be opportunities to explore (and discover new) connections of the theory studied in the course with the real world.

Also, this course does not thoroughly discuss *applications to statistics* Probability theory focuses on developing the mathematical side, and statistics applies these mathematical theories to real data (coming from observations). In this course we will not discuss how to analyze data coming from observations — there are courses in statistics for that.

2. *Necessary information*

2.1. **Meeting times.**

	Section 002	Section 003
Class times	TuTh 11:00AM - 12:15PM	TuTh 12:30PM - 1:45PM
Midterm 1	TBA	TBA
Midterm 2	TBA	TBA
Final exam	Thursday, **December 10, 2020** 9:00AM-12:00PM	Wednesday, **December 02, 2020** 2:00PM-5:00PM

Instructor: Leonid Petrov
Course communication: We use `Piazza`, see Section 4
Office hours: TBA, and by appointment.

You can automatically schedule an office hours appointment at this page (please don't make an appointment for regular office hours). You can make as many appointments as you need throughout the semester. Each appointment must be made at least 3 hours prior to the time of the appointment.

Course delivery: TBA

2.2. **About the instructor.** I am an Associate Professor in the Department of Mathematics at UVA, and I've been here since 2014. My research area is probability theory (very appropriate for this course!). More precisely, I am using exact formulas to study large random systems. I also like computer simulations of random systems like `this one`. I'm happy to tell you more if you're interested.

2.3. **Textbook.** Anderson, Seppäläinen, Valkó, *Introduction to Probability*, 1st Edition.
ISBN-13: 978-1108415859; ISBN-10: 9781108415859.
See also Section 5 below for discussion of how we'll use the textbook, and for other helpful resources.

3. *Assessing your learning*

Learning mathematics means *doing* mathematics: during class meetings, on your own, and in groups. In this course, doing mathematics mainly amounts to solving problems. The following aspects are assessed in this course:

TBA

Letter grades. The scale by which course percent grades are turned into course letter grades will most likely be the following:

Grade	$A+$	A	$A-$	$B+$	B	$B-$	$C+$	C	$C-$	$D+$	D	$D-$
Minimum %	100	93	89	86	82	79	76	72	69	66	62	59

I reserve the right to slightly change this grade scale after the final exam. This may be needed to better incorporate into the letter grade possible fluctuations in the difficulty level of midterms and the final.

4. *Communication*

4.1. **Email.** My email address is petrov@virginia.edu.

4.2. **Piazza.** TBA

4.3. **Collab.** TBA.

If you have anonymous comments on anything related to the course, you can make them via Collab.

5. *How to succeed in the course*

5.1. **General things.** The best way to learn in the course is to watch all recorded lectures and take notes to retain the material in memory; come to all discussion meetings; and do all the homework problems on your own or in collaboration. This will prepare you well for tests.

5.2. **Main textbook.** The textbook *Introduction to Probability* by Anderson, Seppäläinen, and Valkó is an excellent resource to gain understanding of the course material. Some notes about it:

- I strongly encourage you to read the textbook in parallel with watching the lectures. It includes many examples and extra exercises which augment the concepts discussed in class.
- The textbook contains much more material than will be covered in classes, so it makes sense to watch lectures and come to discussions to note which parts are omitted (and so won't be in tests).

5.3. **Additional textbooks.**

(1) *"Probability" by Jim Pitman* is a reasonable alternative textbook.
(2) *Free textbook "Introduction to Probability" by Grinstead and Snell.* Download: `https://math.dartmouth.edu/~prob/prob/prob.pdf`; Accompanying web page: `https://www.dartmouth.edu/~chance/teaching_aids/books_articles/probability_book/book.html`.

These textbooks contain additional problems and material. They may be helpful if you want a deeper understanding of some concepts, or if you want to read exposition of the familial material in a different style, which might be very helpful for better learning.

(It absolutely not required that you buy or read these books.)

5.4. **Extra reading.** The popular book *"How Not to Be Wrong: The Power of Mathematical Thinking" by Jordan Ellenberg* discusses how math touches every aspect of real life, and has numerous examples related to probability and statistics. I can recommend this nice book as a parallel reading. Some examples I learned from this book might be mentioned in class. (It absolutely not required that you buy or read this book.)

5.5. **Other resources.** There is a number of online resources which may help you while doing the homework: Khan Academy, Wikipedia, and many other places contain lots of basic material on probability theory. Google Search in general is also a valuable resource.

5.6. **Office hours.** I am available during office hours to answer questions on the content of the course, clarify various points, and I can also help you with homework assignments. Besides regular office hours, you can automatically schedule appointments, see Section 2.

5.7. **Math Collaborative Learning Center.** The Math Department Collaborative Learning Center is available for helping students in this course: see `https://math.virginia.edu/undergraduate/MCLC/` for more information and schedule.

5.8. **Piazza.** TBA

5.9. **Collaboration on homework assignments.** Group work on homework problems is allowed and strongly encouraged. Discussions are in general very helpful and inspiring. Class meetings will also contain ample time for group work on homework problems. Nevertheless, before talking to others, get well started on the problems, and contribute your fair share to the process.

When completing the written homework assignments, everyone must write up his or her own solutions in their own words, and cite any reference (other than the textbook and class notes) that you use. Quotations and citations are part of the Honor Code for both UVa and the whole academic community.

It is very important that you truly understand the homework solutions you hand in, otherwise you may be unpleasantly surprised by your test results.

6. *Approximate course schedule*

Add/drop information: https://www2.virginia.edu/registrar/reginst1208.html

[week 1] 8/25, 8/27.
[week 2]

7. *Policies*

7.1. **Late/make up work.** Each assignment will have due date and time. Late assignments are not accepted. There will also be no make up for the midterm test. However, if you have special needs, emergency, or unavoidable conflicts, please let me know as soon as possible, so we can arrange a workaround.

7.2. **Special needs.** All students with special needs requiring accommodations should present the appropriate paperwork from the Student Disability Access Center (SDAC). It is the student's responsibility to present this paperwork in a timely fashion and follow up with the instructor about the accommodations being offered. Accommodations for test-taking (e.g., extended time) should be arranged at least 5 business days before an exam.

7.3. **Honor Code.** The University of Virginia Honor Code applies to this class and is taken seriously (in particular, see Section 5.9 on homework collaboration). Any honor code violations will be referred to the Honor Committee.