CS109 Syllabus

I. Teaching Team

**Lecturer:** Amrita Kaur  
Email: amritak [at] stanford.edu  
Office Hours: TBD

**CA:** Joel Ramirez Jr.  
Email: joel101 [at] stanford.edu

**CA:** Georgia Sampaio  
Email: gsamp [at] stanford.edu

II. Course Overview

While the initial foundations of computer science began in the world of discrete mathematics (after all, modern computers are digital in nature), recent years have seen a surge in the use of probability as a tool for the analysis and development of new algorithms and systems. As a result, it is becoming increasingly important for budding computer scientists to understand probability theory, both to provide new perspectives on existing ideas and to help further advance the field in new ways.
CS109: Probability for Computer Scientists starts by providing a fundamental grounding in combinatorics, and then quickly moves into the basics of probability theory. We will then cover many essential concepts in probability theory, including particular probability distributions, properties of probabilities, and mathematical tools for analyzing probabilities. Finally, the last third of the class will focus on data analysis and machine learning as a means for seeing direct applications of probability in this exciting and quickly growing subfield of computer science. This is going to be a great quarter and we are looking forward to the chance to teach you.

Learning Goals

Our goal in CS109 is to build foundational skills and give you experience in the following areas:

1. Understanding the combinatorial nature of problems: Many real problems are based on understanding the multitude of possible outcomes that may occur, and determining which of those outcomes satisfy some criteria we care about. Such understanding is important both for determining how likely an outcome is, but also for understanding what factors may affect the outcome (and which of those may be in our control).

2. Working knowledge of probability theory: Having a solid knowledge of probability theory is essential for computer scientists today. Such knowledge includes theoretical fundamentals as well as an appreciation for how that theory can be successfully applied in practice. We hope to impart both these concepts in this class.

3. Appreciation for probabilistic statements: In the world around us, probabilistic statements are often made, but are easily misunderstood. For example, when a candidate in an election is said to have a 53% likelihood of winning does this mean that the candidate is likely to get 53% of the vote, or that that if 100 elections were held today, the candidate would win 53% of them? Understanding the difference between these statements requires an understanding of the model in the underlying probabilistic analysis.

4. Applications: We are not studying probability theory simply for the joy of drawing summation symbols (okay, maybe some people are, but that’s not what we’re really targeting in this class), but rather because there are a wide variety of applications where probability allows us to solve problems that might otherwise be out of reach (or would be solved more poorly without the tools that probability can bring to bear). We’ll look at examples of such applications throughout the class.

5. An introduction to machine learning: Machine learning is a quickly growing subfield of artificial intelligence which has grown to impact many applications in computing. It focuses on analyzing large quantities of data to build models that can then be harnessed in real problems, such as filtering email, improving web search, understanding computer system performance, predicting financial markets, or analyzing DNA.
Course Topics

Here are the broad strokes of the course (in approximate order). We cover a very broad set of topics so that you are equipped with the probability and statistics you will see in your future CS studies!

- Counting and probability fundamentals
- Single-dimensional random variables
- Probabilistic models
- Uncertainty theory
- Parameter estimation
- Introduction to machine learning

Prerequisites

The prerequisites for this course are CS103, CS106B, and Math 51 (or equivalent courses). Probability involves a fair bit of mathematics (set theory, calculus, and familiarity with linear algebra), and we’ll be considering several applications of probability in CS that require familiarity with algorithms and data structures covered in CS106B. Here is a quick rundown of some of the mathematical tools from CS103 and Math 51 that we’ll be using in this class: multivariate calculus (integration and differentiation), linear algebra (basic operations on vectors and matrices), an understanding of the basics of set theory (subsets, complements, unions, intersections, cardinality, etc.), and familiarity with basic proof techniques. We’ll also do combinatorics in the class, but we’ll be covering a fair bit of that material ourselves in the first week. Past students have managed to take CS106B concurrently with CS109 and have done just fine. CS103 is the pre-requisite that we rely on the least. Students have done well even without having taken CS103.

III. Course Structure

Units

If you are an undergraduate, you are required to take CS109 for 5 units of credit (this is by department and university policy, no exceptions). If you are a graduate student, you may enroll in CS109 for 3 or 4 units if it is necessary for you to reduce your units for administrative reasons. Taking the course for reduced units does not imply any change in the course requirements.

Lectures

We will be holding lectures on MWF from 1:30-3:15pm in Gates B1. Come to learn the material and engage in interesting problems collectively with the class! Recorded lecture videos will also be available on Canvas shortly after lecture ends.
Attendance

It has been observed over many quarters that attending classes highly correlates with doing well in the course and mastering the material. One of the main reasons behind this is that it helps keep you from falling behind. To encourage class attendance, we are giving everyone the opportunity to have up to 5% of their course grade (knocked off the final exam) come from participation. To get the full 5%, you would need to come to every lecture. If you get this full 5%, your final exam only counts for 25% of your grade instead of 30%. If you come to half the lectures, then your final counts towards 27.5% of your grade, etc. This means that (unless you get a perfect score on the final) every lecture you attend helps your final grade!

To facilitate taking attendance, I will provide a unique code during each lecture that you should enter into that lecture's corresponding Canvas assignment. SCPD and remote students will also be given the opportunity to receive credit for "attending" lecture. Instead of attending lecture, remote students need to watch lecture videos and enter the code on the Canvas assignment, within 24 hours of the video being posted in order to get attendance credit. You should only complete the Canvas assignment and claim attendance credit if you watch the entire lecture video within 24 hours of the video being posted.

Sections

Each week for one hour, you will meet in a small group with one of our outstanding CAs and work through problems. If you have taken any of the CS106 classes, our sections will be very similar—except with more probability. Sign-ups for sections will go out on Wednesday, June 22 and will be open until 5:00pm on Saturday, June 25. We will let you know which section you are in by Monday, June 27 and you will have your first section during Week 2.

Section attendance and participation is required for all students. Your participation grade is based on how much you engage with section; a student who engages and helps others will receive a better score than one who shows up late and doesn’t participate. If you are unable to attend your regular section, you may makeup the section by attending another CA’s section in the same week. Before you do so however, please email your CA and the CA with whom you wish to makeup your section to request permission to make this switch.

Problem Sets

During the course, there will be six problem sets assigned. We put a lot of love into these problems so that they can help train you to become gifted practitioners of probability and computer science. Use them as practice. Doing well on the problem sets is the best way to prepare for life after CS109 (and the exams).
Each student is to submit individual work on the problem sets. You may discuss with other students and course staff, but you must cite all discussion on your individually written final write-up of the problem set. After grades are released, you have one week to file a regrade request if you think that points were deducted incorrectly. We reserve the right to regrade your entire pset.

We strongly encourage you to type up your problem sets using LaTeX, which is the interchangable markup language for typing math on a computer. Being able to use LaTeX is an extremely valuable skill that you will likely utilize again and again in your future classes and research. To encourage the use of LaTeX in this class, we will give a small amount of extra-credit on each pset if you type your pset answers using LaTeX.

Late Policy (Problem Sets)

We anticipate that during this quarter, there may be unforeseen circumstances that make it difficult to turn in homework assignments on time. Our philosophy is to treat you as adults. We have a generous late policy to reflect the many different needs that may come up for our diverse set of students. However, the course will end for everyone on the same date. As such if you are late on one problem set, you will have to work extra hard to catch up. Time management can be hard and we encourage you to give it the full respect it deserves. In practice, falling behind often impacts midterm and final exam scores.

Due Date: All problem sets are due at 1:00pm Pacific on the on-time deadline listed on the assignment writeup. If you submit an assignment by the on-time deadline listed on the assignment writeup, you receive a small extra credit on-time bonus, typically 1% of your final problem set grade. Of course being on time has other benefits—when you do your work is closer to when you learned the material.

Grace Period: All students will be automatically granted a penalty-free "grace period" for submission on all problem sets. The grace period of 48 hours allows you to submit the assignment after the original deadline, with no impact on the final grade. This grace period is meant to give built-in flexibility for any unexpected snags—however, we strongly recommend that students submit by the original deadline if possible, in order to avoid falling behind (and to get extra credit!).

Long Extension: CS109 is a fast-paced class and if you need a longer extension then you may fall behind on future problem sets (or the midterm / final). Having said that, you might have a medical or personal situation which requires an "as long as possible" extension. We will give you up until the date when we release solutions. This time is set on a per pset basis but generally is four to five days after the problem set was due. If you plan on taking one of these extensions, please email the teaching team to let us know.
**After the Hard Deadline:** What if you are not done by the time we release solutions? In general we do not accept work after the solutions have been posted and TAs start grading. As such you should make sure you don’t accidentally miss this very hard deadline! Having said that, I understand that life can be wild, especially in these times. If something comes up and you need a longer extension, come talk to me, and I’ll do what I can to make your life easier while being fair to everyone else.

**Exams**

**Midterm:** The midterm will be a take-home, open-notes, 2-hour long exam that is administered online through Gradescope. The exam will be released at 4pm on Friday, July 15th and will be available until 1pm on Monday, July 18th. You are free to take the exam during any two-hour long block in this window. Once you start the exam, you must complete and submit your responses within two hours. The latest we’ll accept submissions will be at 1pm Pacific time on July 18th, so make sure you start by 11am to give yourself enough time to complete the exam.

**Final:** The final exam will be a traditional in-class, pencil on paper, closed-book, closed-notes, closed-computer exam. The final exam is Friday, August 12th from 3:30pm-6:30pm. For a variety of reasons (including university policy), there will be no alternate time for the final exam, so please be sure you can take it during the officially scheduled time. If you are taking the class remotely, you can either come to Stanford to take the final exam in-person or you can take the exam remotely through a proctoring arrangement that is comparable to what SCPD requires (more information on that can be found here).

**Grading**

The grade for the course will be determined according to the following breakdown:

<table>
<thead>
<tr>
<th>Component</th>
<th>Final Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Sets (6 x 8%)</td>
<td>48%</td>
</tr>
<tr>
<td>Lecture Attendance</td>
<td>0-5%</td>
</tr>
<tr>
<td>Section Participation</td>
<td>7%</td>
</tr>
<tr>
<td>Midterm</td>
<td>15%</td>
</tr>
<tr>
<td>Final</td>
<td>25-30%</td>
</tr>
</tbody>
</table>

**Tentative Calendar**

A tentative list of all in and out dates for both assignments and for assessments can be found on the CS109 website. Understand that these are tentative, but we’ll notify you of any changes well in advance.
IV. Course Resources

Optional Textbook


This is an optional textbook, meaning that the text is not required material, but students may find Ross offers a different and useful perspective on the important concepts of the class. Suggested, optional reading assignments from the textbook (10th Ed.) are in the schedule on the course website. The 8th, 9th, and 10th editions of the textbook are all fine for this class.

All students should retain receipts for books and other course-related expenses, as these may be qualified educational expenses for tax purposes. If you are an undergraduate receiving financial aid, you may be eligible for additional financial aid for required books and course materials if these expenses exceed the aid amount in your award letter. For more information, review your award letter or visit the Student Budget website.

"Working" Office Hours

To help make you more successful in this class, the course staff will hold "working" office hours. The idea is to encourage you to work on your problem sets at these office hours, so you can immediately ask any questions that come up while working on your problem sets. While you are certainly not required to attend any of these working office hours, they are simply meant to encourage you to interact with the course staff more often in order to help you better understand the course material. Besides, our job is to help everyone learn the material for this class, and being more accessible to you when you are actually working on your assignments (rather than when you just have a problem) will help the course go more smoothly for you (and it'll be more fun for us).

You can find more information about office hours and how to access them on our website.

Student Q&A Forum

We’re using Edstem for the class forum, and if you’re enrolled for the course through Axess, you should already be registered for CS109: Summer 2022 on Edstem. If you have a question that might be of interest to other students, please post there for a speedy response. Note, however, that you should never include snippets of code or answers directly from your own homework submissions, since that’s against the honor code.
Accommodations

Students who may need an academic accommodation based on the impact of a disability must initiate the request with the Office of Accessible Education (OAE). Professional staff will evaluate the request with required documentation, recommend reasonable accommodations, and prepare an Accommodation Letter for faculty. For students who have disabilities that don’t typically change appreciably over time, the letter from the OAE will be for the entire academic year; other letters will be for the current quarter only. Students should contact the OAE as soon as possible since timely notice (for example, at least a week before an exam) is needed to coordinate accommodations. Students should also send your accommodation letter to instructors as soon as possible. If you require additional, or different, accommodations specific to the Summer 2022 learning environment, please contact your OAE adviser.

V. Honor Code

Each student is expected to do their own work on the problem sets and exams in CS109. Students may discuss problem sets with each other as well as the course staff. Any discussion of problem set questions with others should be noted on a student’s final write-up of the problem set answers. Each student must turn in their own write-up of the problem set solutions. Excessive collaboration (i.e., beyond discussing problem set questions) can result in honor code violations. Questions regarding acceptable collaboration should be directed to the class instructor prior to the collaboration.

It is a violation of the honor code to copy problem set or exam question solutions from others, or to copy or derive them from solutions found online or in textbooks, previous instances of this course, or other courses covering the same topics (e.g., STATS 116 or probability courses at other schools). Copying of solutions from students who previously took this or a similar course is also a violation of the honor code. Finally, a good point to keep in mind is that you must be able to explain and/or re-derive anything that you submit.

It is a violation of the honor code to share or solicit the lecture attendance codes with/from any other student. If you submit a lecture attendance code, you are attesting to the fact that you either attended lecture in-person or watched the entire lecture video (within 24 hours of the video release).

Please read our full Honor Code Policy, which specifically prohibits you from soliciting or taking solutions from other students or websites like Stack Overflow and Chegg.

Looking Forward to a Great Quarter

Genuinely, teaching CS109 is a profound joy. Thanks for coming to learn with us. We can’t wait!