Course Information

Course Overview

Are there "laws of physics" in computing? Are there fundamental restrictions to what computers can and cannot do? If so, what do these restrictions look like? What would make one problem intrinsically harder to solve than another? And what would such restrictions mean for our ability to computationally solve meaningful problems?

In CS103, we'll explore the answers to these important questions. We'll begin with an introduction to mathematical proofs and discrete structures, which will enable us to model problems that arise in computer science. In the course of doing so, we'll explore mathematical logic, discrete structures, and the mathematical nature of infinity.

We'll continue by exploring finite automata (mathematical models of computers with finite memory) and from there will explore context-free grammars and Turing machines (mathematical models of computers with unbounded memory). As we explore these models, we'll see their strengths and their weaknesses and will explore questions like "what does it mean to solve a problem?" and "why does this problem seem to resist a solution?" Finally, we'll conclude with a quick introduction to complexity theory and explore what we know – and what we don't – about efficient computation.

In the course of the quarter, you'll see some of the most impressive (and intellectually beautiful) mathematical results of the last 150 years. You'll see what proof-based mathematics is all about and will gain confidence using mathematics to model and solve problems. You'll learn about various discrete structures that arise throughout computer science. You'll learn how to think about computation itself and how to show that certain problems are impossible to solve. Finally, you'll get a sense of what lies on the frontier of computer science, especially with regards to the $\mathbf{P} \stackrel{?}{=} \mathbf{NP}$ problem.

Instructors

Cynthia Lee (cbl@cs.stanford.edu)
Office: Gates 190

Keith Schwarz (htiek@cs.stanford.edu)
Office: Gates 178

TAs

Guy Amdur (gamdur@stanford.edu) *(Head TA)*

Amy Liu
Chioma Agu
Diego Hernandez
Gobi Dasu
Hugo Valdivia
Ivan Suarez Robles
Laetitia Shao
Matthew Mistele
Nick Guo
Shalom Rottman-Yang
Sudarshan Seshadri

Website

The course website is cs103.stanford.edu and it's loaded with resources for this course. There, you'll find all the handouts and lecture slides, along with additional links you may find useful. I would suggest periodically polling the website to stay on top of any important developments in the course.

Email The course staff can be reached at cs103-win1718-staff@lists.stanford.edu. Please don't hesitate to email us! We're here because we genuinely love this material and want to share it with you. If you have any questions on the material, or if you're interested in exploring more advanced content, please get in touch with us. We'd be happy to help out.

Piazza We have a class Piazza forum you can use to ask questions about the material and to get help and advice on the problem sets and discussion problems. Our policies regarding Piazza use are covered in our Problem Set Policies handout.

Lectures Mondays, Wednesdays, and Fridays, 3:00 – 4:20 in Hewlett 200. Lectures will not be recorded this quarter. Attendance is highly encouraged; a portion of your grade will be based on in-class participation.

Units If you are an undergraduate, you need to enroll in CS103 for five units (this is department and university policy). If you are a matriculated graduate student, you may enroll for anywhere between three and five units, depending on what best fits into your schedule. Regardless of how many units you are enrolled for, the course content and requirements will be the same. The unit flexibility is simply to make life easier for graduate students.

Five-unit courses at Stanford vary greatly in their difficulty. Based on past student experiences, you should expect that this course probably will require a time investment proportional to its unit load. Expect to put in a total of 15 hours each week – including lecture time – working on CS103. We'll offer a lot of support through office hours, extra practice problems, and practice exams, and if you're willing to put in the effort to learn the material, the course staff will be behind you every step of the way.

Prerequisites CS103 has CS106B/X as a prerequisite or corequisite. This means that if you want to take CS103, you must either have completed or be concurrently enrolled in one of CS106B or CS106X (or have equivalent background experience).

Over the course of the quarter, we will be giving out a number of programming assignments to help you better understand the concepts from the course. Those assignments will assume a familiarity with C++ and programming concepts (especially recursion) at a level that's beyond what's typically covered in CS106A. The timing on these assignments is designed so that they'll sync up with what's covered in CS106B/X.

Although CS103 is a course on the mathematical theory behind computer science, the only actual math we'll need as a prerequisite is high-school algebra. We'll build up all the remaining mathematical machinery we need as we go. We've released another handout detailing the mathematical prerequisites for this course, so if you have any questions, check it out and see what you find!

If you're interested in taking this course but feel that you might not have a sufficient mathematical background, you may want to check out our add-on course, CS103A, which is discussed later in this handout.

Office Hours Cynthia, Keith, and the TAs will be holding *lots* of office hours during the week so that you can stop by and ask questions about the material. Feel free to stop on by if you need any help. We'll post a schedule later this week.

CS103A

CS103A is an optional, one-unit add-on course for CS103. CS103A meets once a week for two hours and offers extra review and practice problems related to the current course content. If you're interested in taking CS103 but feel like you might need a little bit of extra practice and review, we'd strongly recommend checking out CS103A.

All materials from CS103A will are available to everyone enrolled in CS103. Check out the CS103A course website (https://cs103a.stanford.edu) to get the most recent sets of practice problems.

Readings

There are online course notes for the first few weeks of material. They go into a *lot* more depth than what we're going to end up covering in CS103, but hopefully you'll find them useful for getting a deeper understanding of the material. The course notes are still a work in progress, so please feel free to contact us with corrections of all sorts – logic errors, grammatical issues, formatting problems, etc. We also will release a bunch of handouts over the quarter to provide additional supplementary reading material. Additionally, we'll release a number of graphical guides to various concepts covered throughout the quarter.

There are two *recommended* textbooks for this quarter. The first is ***How to Read and Do Proofs*** by Daniel Solow, which is a great resource for learning how to approach mathematical problem-solving. The second is ***Introduction to the Theory of Computation, Third Edition*** by Michael Sipser. You might find this book useful in the second half of the quarter. Some of the readings in the syllabus are taken from this book, but we will not directly test you on any material in Sipser that is not covered as well in lecture or the problem sets.

There are copies of each of these books in reserve in the Engineering Library.

Problem Sets

There will be ten total problem sets in CS103, given out about once per week. With the exception of Problem Set 0, which must be done individually, you are welcome to work on them individually or in pairs. Our full policies with regards to problem sets (late policy, regrades, etc.) are in the Problem Set Policies handout.

Exams

In addition to problem sets, there will be a two midterm exams and a final exam. The first midterm exam will be held on Monday, February 5th from 7PM – 10PM and the second on Monday, February 26th from 7PM – 10PM, both locations TBA. The final exam will be held on Monday, March 19th from 3:30PM – 6:30PM, location TBA.

In accordance with university policy, with the exception of OAE accommodations, we will not offer any alternate final exam times. If you are unable to take the final exam at the stated time, you will need to take this class in another quarter.

Additionally, with the exception of OAE accommodations, we generally do not offer alternate midterm exam times. You should not enroll in CS103 unless you can make all three of the exam times.

Grading

We compute grades in CS103 by aggregating your raw scores on all of the course components, then applying a final grading curve determined at the end of the quarter.

The problem sets will account for 25% of your grade. Your assignment score is computed as

$$\text{Assignment Score} = \text{Points Earned / Non-Extra-Credit Points Possible}$$

The two midterm exams are collectively worth 35% of your overall course grade. Your midterm score is computed by weighing your two midterm scores as follows:

$$\text{Midterm Score} = {}^{2}/_{3} \cdot \text{Higher Midterm Score} + {}^{1}/_{3} \cdot \text{Lower Midterm Score}$$

For example, if you earned a 75% on the first midterm and a 90% on the second midterm, your midterm score would be an 85%. If you earned a 100% on the first midterm and a 50% on the second midterm, your midterm score would be an 83.3%.

The final exam is worth 35% of your grade in CS103. That component is evaluated as

$$\text{Final Exam Score} = \text{Points Earned / Points Possible}$$

The last 5% of your grade is allocated to in-class participation. Starting the Friday of the first week of class, we will use Poll Everywhere to ask questions in lecture. Your score for participation will be determined as

$$\text{Participation Score} = \text{Min(Lectures Where You Answered All Questions, 23) / 23}$$

Essentially, you can miss three lectures without taking a hit to your participation score. If you would prefer not to be evaluated based on participation, you can opt to waive this component of your grade and have your final exam count for 40% of your course grade. We'll send out information about how to do this in Week 10.

Aside from the midterm calculation described above, we do *not* curve grades on individual assignments or exams. Rather, we use raw point totals weighted by the amounts given above to compute everyone's raw total score, then curve raw total scores. Historically, we've used the median raw score as the B/B+ cutoff.

Unlike some other courses, we will ***not*** drop your lowest problem set score and do not offer any make-up work. Your raw score is computed purely by weighting your raw scores by the above amounts, and we determine final grades purely based on those raw scores and without taking any other factors into account.

Honor Code

We want to foster a collaborative and supportive atmosphere in CS103. This is why, for example, we have so many office hours sections and why we let you work in pairs on the assignments. We expect you to abide by the letter and the spirit of the Stanford Honor Code in CS103. You are required to read and abide by the policies detailed in our handout on the Honor Code as it applies in CS103, which among other things discusses our expectations for what is and is not permissible collaboration on the problem sets.

We hope that you will respect the Honor Code, comport yourself with integrity, and work to create a learning environment where everyone feels supported.

Incomplete Policy

If you have a serious medical or family emergency and cannot complete the work in this course, you may contact Cynthia (not Keith, and not the TAs) to request an incomplete. We reserve incompletes only for emergencies, so we do not grant incomplete grades for poor performance on the assignments or exams, nor do we offer incompletes for busy work schedules.

In order to be eligible for an incomplete, you must have completed all of the assignments (except possibly the most-recently-due assignment) and must have a performance that is roughly on par with a B- overall grade.