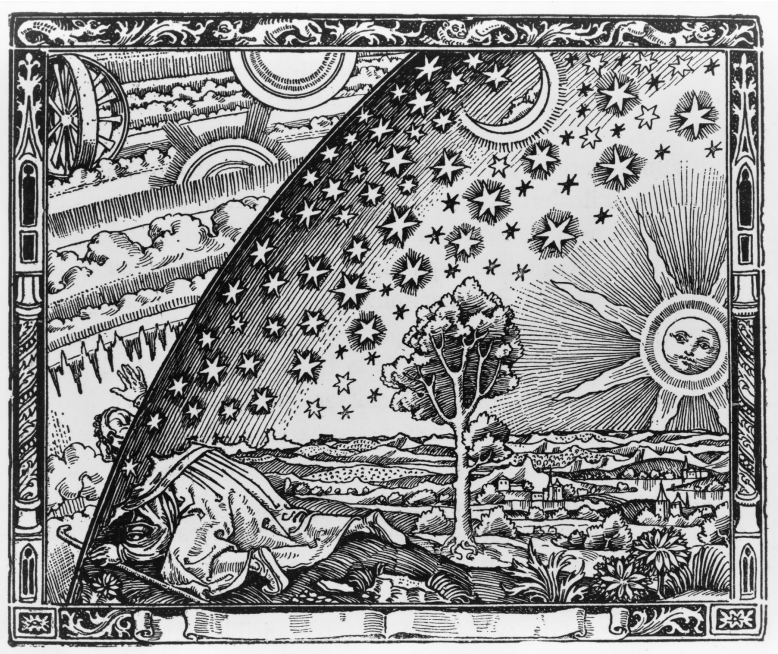
CS4510 Automata and Complexity

Spring 2026

2-3:30PM WF Weber SST III 2



People

- Lecturers:
  - Abrahim Ladha
- TAs:
  - Luca Giantonio
  - Frank Qiang
- These are subject to change as TAs may need to reschedule. See EdStem for updates.
- Office hours are located at outside CCB203, an open area on the second floor of CCB.
- Abrahim's Office hours: My Office is in CCB 207B, second floor. I have an open door policy. If my door is open, you may come in and ask any questions. I am also extremely responsive on piazza. Please use me as a resource, even for simple quick questions.
- We are extremely responsive on Ed Discussion, and you are encouraged to post your questions there so common questions may have a shared answer. We are also responsive via email.

Course Information

This course answers two main questions:

- What are the fundamental limits of computation?
- What makes some problems easy, and others hard?

The first question is the study of the area of **Computability theory**. Most of its questions are solved, which is what makes this subject fun. We are concerned with such extremal, almost philosophical questions. What even is computation? What even is a computer? Are all problems solvable? We will

explore several models of computation and explore their relative power, and weaknesses.

The second question is the study of **Complexity theory**. Most of its questions are unsolved. This subject does not have a happy ending (and perhaps won't, in our lifetimes) but this contrast is what makes it interesting. We may not know how to solve certain questions, but ironically, we know a lot about how hard these questions are.

I like to think of this course as a finale to your CS degree. It is simultaneously the most important and least important course you will take. It is the least important as it doesn't develop any single technical skill. It is the most important, as it develops your ability to conceptualize and theorize. This is the course where you will learn why computer science gets to be called a science. It puts the rest of your degree into context.

This course has a lot of pre-reqs, some of which I would disagree should be a requirement. All you really need is good proof skills, like those found CS2050. If you think you might be rusty, please refresh chapter zero of the Sipser book.

The book for the course is Introduction to the Theory of Computation by Michael Sipser. It is an excellent textbook, can't count how many times I've read it. The notes and lectures for the course are the authoritative reference, but it is expected you follow along with Sipser's book. Later on, I may reference the Arora-Barak and Li-Vitanyi books.

Evaluation

- Exams:
  - 3 Exams each worth 15%
  - 1 Final, worth 15%
  - your lowest of the four is dropped
- 10+ Homeworks, worth 45%
  - Will be released weekly
  - your lowest homework will be dropped.
  - Each homework will also have a 3% bonus if you use the provided Latex template.
- Final project, worth 10%
  - There will be more information towards the end of the semester
  - You will have to record a video covering some topic related to this course.
  - teams of up to size three, and videos atleast 15 minutes in length

Schedule

This is subject to change.

Class	Subject	Other
01/14/26	Introduction	
01/16/26	Nondeterminism	
01/21/26	Regular Expressions	
01/23/26	The Pumping Lemma	
01/28/26	Context-Free Grammars	
01/30/26	Syntactic Structures	
02/04/26	Push Down Automata	
02/06/26	Equivalence of PDAs and CFGs	

Class	Subject	Other
02/11/26	Exam 1	
02/13/26	Turing Machines	
02/18/26	The Church-Turing Thesis	slides, required reading1, required reading 2, required reading 3
02/20/26	Turing Completeness	
02/25/26	Countability	
02/27/26	Foundations of Mathematics	
03/04/26	Godel Incompleteness	
03/06/26	Undecidability	
03/11/13	Art of Reduction	
03/13/26	Post's Correspondence Problem	
03/18/26	Exam 2	
03/20/26	Kolmogorov Complexity	
04/01/26	Complexity Classes	
04/03/26	NP	
04/08/26	PSPACE	
04/10/26	Relativization	
04/15/26	Circuits	
04/17/26	Polynomial Hierarchy	
04/22/26	Karp-Lipton Theorems	
04/24/26	Exam 3	
05/06/26	Final Exam 2:40-5:30PM	

Other Resources

Besides the notes here, There are additional references:

- NOTES
- Summer recorded lectures

Statement of Intent for Classroom Inclusivity

As a member of the Georgia Tech community, I am committed to creating a learning environment in which all of my students feel safe and included. Because we are individuals with varying needs, I am reliant on your feedback to achieve this goal. To that end, I invite you to enter into dialogue with me about the things I can stop, start, and continue doing to make my classroom an environment in which every student feels valued and can engage actively in our learning community.

Integrity Statement

Submission of any work not your own can result in anything from a zero on the assignment to a report to OSI.