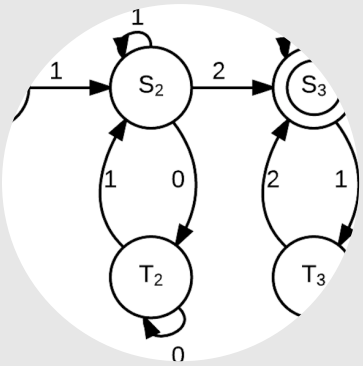

Theory of Computation

CS 345

Instructor Info

Moses Boudourides

Student hours: Tuesday & Thursday: 4:00-6:00pm

KINSC L 104

https://www.haverford.edu/users/mboudourid

mboudourid@haverford.edu

Course Info

Prereq: $\Big((\text{CS}106 \vee \text{CS}107) \wedge \text{CS}231 \wedge (\text{jr} \vee \text{sr}) \Big) \vee$ consent

Tuesday and Thursday

1:30-4:00pm

Hilles 108

TA Info

Shi Jie Samuel Tan

Sunday 7:00-9:00pm

Hilles 108

stan1@haverford.edu

Zaynab Ghazi

Tuesday 7:00-9:00pm

Hilles 108

zghazi@brynmawr.edu

Overview

We will study several models of computation (i.e., different kinds of idealized computing devices) in order to understand what problems can and *cannot* be solved with each model. At the end of the course, we will use this work on models of computation as a foundation for introducing the theory of computational complexity.

- Unit 1: Finite automata and regular languages.
- Unit 2: Pushdown automata and context-free grammars.
- Unit 3: Turing machines and decidable languages; undecidabilty.
- Unit 4: Elements of computational complexity.

Course Structure

The course is going to be in-person. Students are expected to participate and prepare for each class meeting by doing assigned reading in the textbook. Class meetings will be a mix of traditional lecture and group problem-solving. There will be weekly written homework, two midterm exams, and a final exam.

Learning Objectives

Upon completion of this course, you will

- become familiar with core topics in theoretical computer science;
- gain an appreciation of how theoretical CS relates to the practical side of CS;
- practice *mathematical thinking*, including problem solving, and communicating, reading, and writing in the precise language of mathematics.

Textbook

Sipser, Michael. *Introduction to the Theory of Computation*. 3rd ed., Cengage Learning, 2012. ISBN: 9780357670583.

- The College bookstore is offering a six-month e-book rental.
- Physical copies are widely available for sale online.
- A scan of the textbook is on the course Moodle page. (Note: the scan is not searchable — you may prefer a proper e-book.)

Grading Scheme

10% Participation
20% Written homework
40% Midterm Exams (two, 20% each)
30% Final Exam

Intake Survey

There is an online intake survey linked from the course Moodle page. Please fill out this survey as soon as possible.

Homework Extensions Policy

For delays up to 12 hours, there will not be a penalty. For delays from 12 to 24 hours, there will be a penalty of 10 points subtracted from the total score. For delays from 24 hours to 36 hours, there will be a penalty of 20 points subtracted from the total score. Any further delays would not be accepted unless the student requests for a 3 days extension prior to the submission.

Attendance policy

Attendance in the discussion and the lab sessions is required and is an essential part of the learning process. I do realize that you may need to miss class occasionally, so you will be allowed up to three no-questions asked absences. Additional absences will be reported to your Deans.

FAQs

Where can I find the day-to-day information for the course, e.g., reading assignments, lecture videos, homework, etc.?

Moodle! The course Moodle page will be kept up to date with all of the information you need— check early and often.

Where can I read the Collaboration Policy for this course?

Moodle! Please read the policy and ask questions if it is not clear.

Classroom Norms

Inclusion principle

It is my strong belief that as a community, mathematicians and computer scientists need to do a much better job of making our disciplines more accessible to people of all races, genders, sexual identities, class backgrounds, abilities, and other visible and non-visible differences. While it is a priority for me to make the class accessible and inclusive to students of all identities, I do not claim to know the best way to do this, and I welcome collaboration and feedback from all students.

Growth, not ability

There is a prevalent belief that success in theoretical computer science is a matter of ability — you are either "good" or "bad" at abstract/mathematical reasoning, and if you are "bad" at it, then you will always be bad at it no matter how hard you try. This is a demonstrably false belief, and the Math and CS communities bear a lot of responsibility for perpetuating this myth. In reality, abstract/mathematical reasoning is just like any other skill: you can improve more and more with practice.

You should measure your success in this class by how much your understanding of the concepts has improved over the course of the semester. The material is by no means easy, and you should expect to struggle! When you struggle, you are learning and growing. Not all people show their struggle in the same way, so you should be wary of judging your progress against your perceptions of your peers.

Respecting each other

We are not all coming to this class with the same privileges, resources, time, and knowledge. It's not equally easy for all of us to speak up; the voices of historically underrepresented/marginalized students are most easily drowned out. It's important to keep these facts in mind when working with each other on homework assignments and during class meetings. Here are some concrete examples of respectful and positive collaborative behavior:

- Making sure everyone who wants it has the opportunity to speak frequently. This can mean checking in with each other to make sure everyone is following along and contributing when they have an idea.
- Respecting people's pronouns and other aspects of their identity.
- Making sure that everyone's ideas are acknowledged when writing up the final solution to a problem. When working in groups, solutions often evolve organically; you may think that you found a solution yourself, but perhaps you only arrived there because of something that someone else said. Pay attention to what people are saying and try to learn from one another.

I will do my best to check in with students during the semester, but you should also reach out to me if you have concerns about class dynamics. If at any time in the semester you are not in a study group but want to be in one, please let me know and I will help you find a group. If at any time in the semester, you find yourself in a group-work situation where people aren't feeling respected, please let me know as well.

Academic Integrity

Our community thrives on relationships between students and faculty that are based on trust and respect. It is a student's responsibility under the Honor Code to understand professors' expectations and what it means to do academic work with integrity. In particular, please read the *Collaboration Policy* for this course that is posted on Moodle. If anything is unclear, please ask!

FAQs

Where can I find up to date information about Student Hours?

Moodle! The course Moodle page will be kept up to date with all of the information you need— check early and often.

Help! Where can I go if I am feeling overwhelmed or am having trouble keeping up with schoolwork?

Talk to me in Student Hours, and also consider the following additional resources:
- the Office of Academic Resources,
- Access and Disability Services,
- Counseling & Psych Services.

Student Hours

Note: "Student hours" is a fashionable term for what use to be called "office hours".

Instructor's Student Hours

Details of my student hours will be posted on Moodle. Please come to ask questions! I have set aside this time specifically to help you learn and be successful in the course. All questions are welcome in student hours (and in class, too!). Big-picture questions beyond "How do I solve this problem?" are highly encouraged. If you are unable to attend scheduled student hours, please email me for an appointment.

TAs' Student Hours

Each TA will have two student hours per week to discuss homework and other aspects of the course. See Moodle for an up-to-date schedule.

Support Resources

Your ability to thrive academically can be impacted by your personal well-being, and various stressors may impact you over the course of the semester. If the stressors are academic, I welcome the opportunity to discuss them with you so that we can find solutions together. If the stressors are not academic, but rather are related to emotional health, finances, physical health, relationships, learning strategies or differences, or other areas of your life, I hope you will consider reaching out to the many resources available on campus. These resources include CAPS (free and unlimited counseling is available), the Office of Academic Resources, Health Services, Professional Health Advocate, Religious and Spiritual Life, the Office of Multicultural Affairs, the GRASE Center, and the Dean's Office. Additional information can be found at the web site of the deans' office.

Accommodations for Students with Disabilities

Additionally, Haverford College is committed to creating a learning environment that meets the needs of its diverse student body and providing equal access to students with a disability. If you have (or think you have) a learning difference or disability — including mental health, medical, or physical impairment — please contact the Office of Access and Disability Services (ADS) at hc-ads@haverford.edu. The Director will confidentially discuss the process to establish reasonable accommodations. It is never too late to request accommodations — our bodies and circumstances are continuously changing.

Students who have already been approved to receive academic accommodations and want to use their accommodations in this course should share their accommodation letter and make arrangements to meet with me as soon as possible to discuss how their accommodations will be implemented in this course. Please note that accommodations are not retroactive and require advance notice in order to successfully implement.

If, at any point in the semester, a disability or personal circumstances affect your learning in this course or if there are ways in which the overall structure of the course and general classroom interactions could be adapted to facilitate full participation, please do not hesitate to reach out to me.

It is a state law in Pennsylvania that individuals must be given advance notice that they may be recorded. Therefore, any student who has a disability-related need to audio record this class must first be approved for this accommodation from the Director of Access and Disability Services and then must speak to me. Other class members need to be aware that this class may be recorded.

Assignments and due dates

- The due day for written homework will be determined soon and posted on Moodle. All submission will be via Moodle.
- There will be brief online assignments posted on Moodle. These are "warm up" and "check-in" activities, and are to be completed before each class session, after you have read the corresponding reading assignment.

Class Schedule

Please note the date of the midterms below; more details about the Midterms will be provided later. Except for the the dates of the midterms, you should consider the information in this schedule to be *projected* only and subject to change; the decisive week-by-week schedule will be posted on Moodle.

MODULE 1: Finite Automata	
Week 01, 01/17 – 01/21: Intro to the course	Ch. 0
Week 02, 01/24 – 01/28: Deterministic Finite Automata (DFA)	1.1
Week 03, 01/31 – 02/04: Non-deterministic Finite Automata (NFA); NFA ⇜⇝ DFA	1.2
Week 04, 02/07 – 02/11: Regular Expressions (RE); RE ⇜⇝ NFA	1.3
Week 05, 02/14 – 02/18: Non-regular languages	1.4
MODULE 2: Push-down Automata	
Week 06, 02/21 – 02/25: Context-free grammars (CFG) Midterm 1 (timed, take-home; out Th., 02/24, due M 02/28 by 11:59pm EST)	2.1
Week 07, 02/28 – 03/04: Push-down Automata (PDA); PDA ⇜⇝ CFG	2.2
Week 08, 03/07 – 03/11: Pause; Non-context-free languages	2.3
MODULE 3: Turing Machines	
Week 09, 03/14 – 03/18: Turing Machines and variants	3.1, 3.2
Week 10, 03/21 – 03/25: Decidable Languages	3.3, 4.1
Week 11, 03/28 – 04/01: Undecidability Midterm 2 (timed, take-home; out Th., 03/31, due M 04/04 by 11:59 EST)	4.2
Week 12, 04/04 – 04/08: Reducibility	5.1, 5.3
MODULE 4: Complexity	
Week 13, 04/11 – 04/15: Time Complexity	7.1–7.4
Week 14, 05/10 – 05/13: Space Complexity (as time allows[1])	8.1–8.3

[1] Pun intended.