Syllabus

CIS 420/520 Automata Theory

When: Mon, Wed, Fri 9-9:50 AM
Where: 105 Esslinger

Contact Information

Instructor: Heidi Dixon
Office Hours: Mon, Wed, Fri 10-10:45AM
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I am never in my office. In fact, I may not even have an office this term. This makes it hard to just drop by and get help outside of office hours. However, I am often on campus or in Deschutes. **Please feel free to text me or call.** I really don't mind and it's easy to set up impromptu office hours this way. I don't always answer if I don't recognize the number and don't know who it is. It's best if you start with a text and say who you are in the message. Then once I have you in my address book I can tell you are in my class.

Course Description

What types of problems can be solved by a computer and what types cannot? There are certain tasks that may always elude computational solutions, like effectively managing a kindergarten class. There are other theoretical limitations to the power of computation that are not obvious. There are things we'd like to compute that don't appear to have practical solutions, like breaking RSA encryption. There are many important problems that seem like they could be solved by a computer when in fact such solutions are mathematically impossible. For example, we cannot use a computer to predict whether a particular computer program will fail to terminate. Knowing where these boundaries lie and how to negotiate them is an essential skill for computer scientists.

In this class we will study the mathematical foundations of computation. We'll begin with the simple models provided by finite automata and regular expressions. We'll move on to study grammars and pushdown automata. Finally, we'll conclude with Turing machines. Through these models we'll explore both the power of computation and its limitations. We will work on technical writing and producing well written proofs. We'll work towards building a high-level understanding of the different models and making connections between theoretical results.

Class Communication

Class communication will be through Piazza. You can look up our class and join online.

Text

Introduction to the Theory of Computation. by Michael Sipser.

If you don't have the third edition make sure to check problem numbers with someone who does. The numbering on some homework problems has changed.

Assignments

This is a homework class. The final will be a take home and therefore is just a glorified homework that is weighted slightly more than the others. Take each homework seriously.

WORKING IN GROUPS

For most assignments you may work in groups and I encourage you to do so. Exceptions to this rule are the first three assignments and the final. I will always remind you ahead of time if you need to do an assignment individually, typically by including that information on the actual assignment write up. If you do work in a group, you need to write up your solutions individually. Please list the names of the people you worked with on your write up. You may ask peers to proof read your solution.

FORMATTING

Graduate students need to typeset their homework in LaTex or comparable typesetting program. Undergrads can type their assignments or hand write them, scan them and send me pictures. The science library has a fancy scanner available for student use. Sometimes a carefully taken smartphone photo will do the trick. Just make sure they are readable.

DUE DATES / LATE POLICY

There are two late policies.

1. HARD - Assignment is due at 5:00 on the due date. No late assignments will be accepted. This is the policy for the final exam and for Assignment 2. We will be discussing Assignment 2 in class. If I receive your assignment after the in class discussion of the answers then I can't give you credit for your work.
2. SOFT- Assignment is due at 5:00 on the due date. However, I will continue to accept assignments up to one week past the due date without a grade penalty. **If an assignment is received late you will receive a grade but I am no longer obligated to write feedback comments on how you might improve your solutions and proofs. Late papers may**

not be graded and returned promptly if they miss the first round of grading. I won't accept papers more than a week late unless there are extenuating circumstances.

HOMEWORK RESUBMISSION

Proof problems from the homework assignments may be revised and submitted a second time. Problems that don't require a proof cannot be resubmitted. I will take the average of the two grades. This is strictly optional. All second submissions are due two weeks after the initial assignment due date. If you don't pass in a first submission on time then you may not pass in a resubmission. The goal here is to support people who want to achieve a higher standard of writing, not people who struggle with deadlines.

REFLECTIVE WRITING

I will occasionally ask you to complete a few short answer questions in a Google form about how the course is going, what topics are clear and which topics need clarification. They should only take 2-5 minutes to fill out. There will always be an open question where you can leave whatever constructive feedback you want about the class. You can always send an additional nameless copy of the form if you want to send anonymous feedback. These surveys will not be graded, but will be marked as completed or not completed.

Course Goals

PROOF WRITING

Proof writing is a cross between solving a math problem and writing an essay. There is an initial problem solving phase where we explore the question and come up with a solution. Then there is a second phase where the solution is formalized and written down. In my experience, students typically have perfectly good arguments in their heads, but struggle to write them down formally. We will approach the second phase of proof writing like essay writing. We'll learn how to define our terms, use notation and structure our arguments. We'll look at where proofs go wrong and learn how to fix them. The homework resubmission policy rewards students who take the time to correct their mistakes get things right. Everyone should leave this class with confidence in their ability to put together a solid proof.

THE BIG PICTURE

In addition to learning the gritty details of models of computation, we'll focus on integrating these details into the larger framework of theoretical computer science. What does each proof or result mean and how do all the pieces fit together into a coherent set of ideas?

Grading

Homework Assignments	70%
Reflective Writing	5%
Class Participation	5%
Take Home Final Exam	20%

Academic Honesty

Many of the Sipser problems are on the internet. Please don't copy solutions from the internet.

Preparation

This class pulls students with varied backgrounds and levels of preparation. This is normal for 400/500 level classes. If you are having trouble, if you feel overwhelmed or unsure if the class is right for you, please come and talk to me. We can take a look at where you are struggling, fill in any wholes in your background and make a plan so you can succeed. If you have taken an automata theory class before and need some additional challenges come and talk to me. We can find new and interesting topics for you to explore. The goal is to move every one as far forward as possible from their individual starting point.

Tentative Schedule

Week 1	• Deterministic Finite Automata • Nondeterministic Finite Automata
Week 2	• Nondeterminism • Closure Results for Regular Languages • Regular Expressions
Week 3	• DFAs to Regular Expressions • Pumping Lemma
Week 4	• Grammars • Diagonalization & the Cardinality of Infinite Sets
Week 5	• Push Down Automata • Equivalence of Grammars and PDAs
Week 6	• Pumping Lemma for Context Free Languages • Turing Machines • Russell's Paradox
Week 7	• Multitape Turing Machines • Nondeterministic Turing Machines • Enumerators
Week 8	• Universal Turing Machines • Broken Turing Machines • Undecidability
Week 9	• Reductions • Rice's Theorem
Week 10	• Gödel's Incompleteness Theorem