Syllabus
CMSC 415: Theory of computation

Fall 2016

Time:	TR 2pm
Room:	Ruffner 352
Website:	`http://cs.longwood.edu/courses/cmsc415/`

Continues to develop the theoretical frameworks introduced in CMSC 208 such as language and automata theory, and the computability of functions. Topics include complexity analysis through reductions, NP-completeness, hierarchy of languages, and the Church-Turing thesis. Prerequisite: CMSC 208. 3 credits.

Professor:	Don Blaheta
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Office hours:	Mon 10–11am; Wed 11am–noon; Thu 10–11am; Fri 1–2pm

Overview

Computation theory is an exploration of the question of what it even means for something to be computable. Some of the earliest results that can now be identified as computer science—at the time seen as mathematical or philosophical facts—are in the area of theory of computation. Other areas of theory are questions that remain open after more than a half-century of work. In this course, we will ask some of these questions and develop an appreciation and understanding of the answers that the early computer scientists produced for them.

Book and resources

The primary textbook is Michael Sipser, *Introduction to the theory of computation*. Either 2nd or 3rd edition is fine. (2e: ISBN 978-0-534-95097-2; 3e: ISBN 978-1133-18779-0)

In addition, there may be some readings and additional materials posted to the course website.

Course objectives

At the end of this course, the successful student will be able to:

1. specify languages, at different levels of the Chomsky hierarchy, using standard formal notation such as automata and grammars;
2. write mathematical proofs of computational theorems;
3. formally define "algorithm" and related terms, and explain their importance to computer science;
4. evaluate whether a problem is *NP*-complete and explain why the question $P \stackrel{?}{=} NP$ is important.

Graded work

Homework. Most days, some homework will be assigned. Mostly this will be "graded" by just checking it in as we critique it in class; some may be collected as well for more detailed feedback and scoring. — Collaborative

Mastery exam. Some of the prerequisite material is sufficiently fundamental that I require you to really master it; this exam has a high bar to pass, but can be retaken. See below for details. — Non-collaborative

Exams. There will be two more conventional exams: one at midterm and one for the final. My current plan is for each to have a take-home component that you'll work on over the weekend, which you'll bring with you to the in-class portion of the exam. — Non-collaborative

Advanced work. At the end of the course, you'll do some group work on an area of computational theory that is not otherwise covered in the course. See below for details. — Group work

Breakdown

Homework	20%	
Mastery exam	10%	(all or nothing; can retake)
Midterm exam	20%	
Final exam	30%	
Presentation and demo	20%	

Grading scale

I tend to grade hard on individual assignments, but compensate for this in the final grades. The grading scale will be approximately as follows:

A−	[85, 90)	A	[90, 100)	[1]	
B−	[70, 75)	B	[75, 80)	B+	[80, 85)
C−	[55, 60)	C	[60, 65)	C+	[65, 70)
D−	[40, 45)	D	[45, 50)	D+	[50, 55)

While there will be no "curve" in the statistical sense, I may slightly adjust the scale at the end of the term if it turns out some of the assignments were too difficult.

Mastery exam

There's a lot of material from CMSC 208 that we're not going to spend much time on but is deeply prerequisite to the material in this course. You just gotta get this stuff right. A "pass" on the mastery exam is getting at least 95% correct (and will count as 100% in the gradebook); a "not yet passed" gets a temporary zero in the gradebook BUT you will be able to keep retaking it until you pass it. You'll have two chances to take it during regular class time; if you don't pass by the second one, it is your responsibility to schedule time with me to retake it.

If you do not pass the mastery exam, your maximum grade for the course will be a D+, regardless of your scores on other assessments.

[1] Alas, no A+, unfortunately.

Presentation and demo

The last few weeks will be a project wherein you will investigate an area of computational theory and report on what you have learned. Topics are drawn from sections of the book that we won't otherwise cover:

- §2.4 (in 3e): Deterministic PDLs, deterministic CFGs
- §6.4: Information theory
- Ch 8. Space complexity
- §10.1: Approximation algorithms
- §10.2: Probabilistic algorithms
- §10.5: Parallel algorithms

However, other topics are possible as interest dictates.

You'll work in groups of 2–3 people, producing two things: a demo, and a presentation. The demonstration will be a runnable program in the language of your choice; in general it will show some problem solved first by "brute force" and then again, faster or better or differently, illustrating your concept. The presentation will start with 30 minutes or so of explanation and worked examples, followed by leading the class through additional exercises or problems or otherwise discussing the concept.

The presented topics will be tested, in some form, on the final exam.

Points for the project will be split 50/50 between the presentation and the implementation. The group will be assigned a grade, and then ± adjustments made to individual scores to reflect individual contributions.

Wk		T	R	
	August			
1		**23** — Introduction Review of 208	**25** Chs. 0, 1 Review Mastery test	
			September	
2	*	**30** — Additional 208 review	**1** §1.4 Pumping lemma Mastery test retake	
3		**6** §2.1 CFGs	**8** — CFGs	
4		**13** — CFGs	**15** §2.2 PDAs	
5		**20** §2.3 Non-CF languages	**22** §3.1 Turing machines	
6		**27** §3.2 Turing machines and variants	[VP debate prep **no class**]	
	October			
7		[VP debate **no class**]	**6** TBA Lambda calculus	**
8		**11** TBA Lambda calculus Y Combinator	**13** §3.3 Algorithms, formally	***

* **29 August**: Deadline to add/drop classes (5pm)

** **7 October**: Deadline to elect pass/fail option (5pm)

*** **14 October**: Deadline to withdraw from a class (5pm)

Wk	T	R
	October	
9	**18** — Midterm exam	**20** Ch. 4 Decidability The halting problem Topic prefs due
10	**25** — The halting problem	**27** §5.1 Reducibility
	November	
11	**1** §5.2 Reducibility Post Correspondence Problem	**3** §7.1 Time complexity
12	**8** §§7.2–7.3 Time complexity P, NP; P = NP?	**10** §§7.4–7.5 NP-completeness
13	**15** — Advanced topic Presentations	**17** — Advanced topic Presentations
14	**22** — Advanced topic Presentations	[Thanksgiving **no class**]
		December
15	**29** — Advanced topic Presentations	**1** — Advanced topic Presentations

Final exam: Mon 5th, 6:30–9pm

Policies

Support

I'm in my office a lot (not just during posted office hours). Feel free to come in and ask questions (or just to talk). If you can't catch me in my office, email is probably your best bet.

Honor code policy

Above all, I ask and expect that you will conduct yourself with honesty and integrity—and not to ignore the other ten points of the Honor Code, either. Take pride in what you are capable of, and have the humility to give credit where it is due.

The two main forms of academic dishonesty are "cheating" and "plagiarism". "Cheating" is getting help from someplace you shouldn't, and "plagiarism" is presenting someone else's idea as if it's your own. If you ever find yourself inclined towards either of these, know that there are always other, better options. Persevere! See my website[2] for some discussion and examples of how to steer clear of these problems, and feel free to come talk to me if you need help finding some of those other options (even if it's for another course).

Cheating or plagiarism (on any assignment) will normally receive a *minimum* penalty of a lowered *course* grade, ranging up to an F in the course. Cases will also be turned in to the Honor Board. But: I believe in your potential, and I hope that you will, or will grow to, observe this policy not simply to evade punishment but positively as a matter of character.

Accommodations

If you have any special need that I can accommodate, I'm happy to do so; come speak to me early in the term so we can set things up. If you have a documented disability, you should also contact Longwood's Office of Disability Resources (Graham Hall, x2391) to discuss some of the support the college can offer you. All such conversations are confidential.

[2] `http://cs.longwood.edu/~dblaheta/collab.html`

Attendance and late policy

Attendance is required, and assignments must be turned in on time. That said, if you have a good reason to miss class or hand something in late, I tend to be fairly liberal with extensions if you ask in advance. (Good reasons do include assignments due for other classes.) (And medical and family emergencies are exempted from the "in advance" part, of course. But contact me ASAP.)

Frequent absence will result in a lowered participation grade; habitual absence may in extreme cases result in a failing grade for the class. *Unexcused* late assignments will normally be given a zero.

Inclement weather policy

I don't plan to cancel class for weather unless the entire college shuts down. If you are commuting or are otherwise significantly affected by a weather event, use your own best judgement; and if you do miss class for this reason, contact me as soon as possible to make up missed work.

Early bird policy

Nobody's perfect, and on occasion an assignment gets written a little unclearly (or, once in a while, with an actual error in it). If you catch one and bring it to my attention early, so that I can issue a clarification or correction to the rest of the class, there'll be some extra credit in it for you.