CMPU 240

Language Theory and Computation

Spring 2019

Tuesday & Thursday, 4:35–5:50 p.m.
Sanders Physics 105

Prof. Jonathan Gordon

cs.vassar.edu/~cs240

OVERVIEW

This course introduces students to the theory of computation, the mathematical foundation of computer science. We will consider what is an appropriate mathematical model of a computer, what types of computations are and are not possible in a model, and the inherent complexity of certain computations. Although considering computers as abstract mathematical objects may on the surface seem unrelated to "real" computing, many concepts you will encounter are fundamental to important areas of computer science including compiler design, hardware design, computational linguistics, and even the syntax of the UNIX `grep` and `awk` commands.

During the course, you will gain an understanding of the intimate connection between computation and language recognition. We will study several classes of abstract machines, including finite automata, pushdown automata, and Turing machines, along with several classes of languages, such as regular and context-free languages. In addition, we will look at problems like the Halting Problem that are not amenable to a computer solution.

Course Goals

By the end of the course, you should understand:

- the relationships between languages (problems) and machines
- the inherent limits of what can be computed
- the application of theoretical topics to practical problems
- how to create rigorous arguments using various proof techniques

The course provides essential background for CMPU 331, Compiler Design; ideally, you should take CMPU 331 the next semester. It is also a good foundation for CMPU 336, Computational Linguistics.

Prerequisites: CMPU 102 and CMPU 145

CALENDAR

The calendar with lecture notes, assigned readings and exercises, and exams is on the course website and will be updated throughout the semester.

CLASS SESSION

The class sessions are intended to augment and support the material in your readings by providing an opportunity for in-depth discussion of topics, working through examples, and the chance for you to ask questions.

The material covered each week builds on what was covered in prior weeks. As such, it is essential that you attend every lecture and keep up with the reading assignments.

Lectures will begin and end on time, and students are expected to arrive before lectures begin. Students should not talk to each other during lecture. A student who wishes to ask a question should raise his/her hand and wait to be recognized. Students' cell phones should be turned off (or set to "do not disturb") during lectures.

TEXTBOOK

Introduction to the Theory of Computation, third edition
Michael Sipser

The textbook is on reserve at the library. Note that previous editions – and the "international" third edition – will have different problem numbers.

ASSIGNMENTS

One goal of this course is to develop your facility to manipulate language formalisms, so completion of weekly assignments is extremely important.

Assignments and due dates will be listed on the course calendar on the webpage. All assignments are due at the beginning of class on the indicated days and should be turned in directly to me. Late assignments will be accepted with a 10% penalty, but only up until the start of the next class.

When computing your final grade for the course, your lowest homework score will be dropped. Note that strong effort as you get better will make up for poorer performances in previous weeks.

Example solutions to all problems will be posted on the course website.

As with all policies, homework policies are intended to be fair to everyone involved in the course, so I will do my best to enforce them fairly. Please feel free to ask me any questions about specific cases that may emerge over the semester.

Each problem will be graded along the following lines:

0 Didn't do anything

1 Incomplete or mostly incorrect

2 More or less incorrect but you're on the right track; or, correct but muddled in the argument.

3 Correct logic and written coherently. Might have a missing step or two.

4 Wow! I think you really get it.

Neatness counts! Two points (on the 0–4 scale) will be automatically deducted from any assignment that does not meet the following requirements:

- Indicate your final solution clearly.
- Show all the steps used to arrive at your solution.
- Put your name and the assignment number / page number at the top right corner of all pages, e.g., "Assn. 1/1", "Assn. 1/2", etc.
- Type your work or write legibly on 8½ × 11″ lined paper.
- Hand in clean copy – i.e., don't hand in messy work where parts have been crossed out, etc.
- Staple papers together in the top left corner.
- Do not hand in paper with frayed edges torn from a notebook.

You are encouraged to hand in assignments using the typesetting language LaTeX, which is a standard tool for publishing research in computer science. You may find it easiest to use Overleaf (overleaf.com) to edit LaTeX in a web browser. A template file for assignments is available on the course webpage.

Cooperation policy

Permitted, but if you do cooperate, the solutions must be written up individually, not copied. If you cooperate with another student, indicate this on your assignment.

Academic integrity

Receiving and copying solutions from any source (a classmate, a friend, a published text, an online source, etc.) is disallowed. Note that using material from sources (other than those explicitly given as course resources) as "inspiration" and submitting derivative solutions is considered copying. Please read "Going to the Source", available from the Dean of the College website. Inappropriate use of sources (including people) will be reported to the Academic Panel.

EXAMS

There will be three exams. The first two exams will be in-class or take-home and will focus on material from the immediately preceding segment of the course. The third exam will be regularly scheduled and will focus primarily on later material but may also include material from earlier in the course.

COURSE GRADES

The elements of the course will be weighted approximately as follows:

Written assignments	35%	(about eight problem sets)
Quizzes	5%	
Exam 1	20%	
Exam 2	20%	
Exam 3	20%	

How to succeed in CMPU 240 by really trying

This course includes a lot of detailed information that supports the "big ideas" that we will gain an understanding of during the course. Here are some suggestions for approaching the course material and lectures that can help guarantee that you get the most out of it.

- Read the required material *before* the class where it will be presented. This way, you are reinforcing what you already understand with another explanation. If you come to class without the reading, the material will be very hard to absorb in one sitting.
- Start the assignments several days before they are due. The problems are the kind that can benefit from going away and coming back later when you are stuck.
- Study and do assignments with others from the class when you can. Obviously, your assignments should reflect your own work, but getting an explanation of a concept from a peer is often an effective way to make it sink in.
- Focus on the main concepts and not just the details. For example, don't just memorize the steps to convert a DFA to an NFA, but understand how the conversion works in principle. The steps then become easy to remember.
- Talk to me if you have any questions! I am here to help.

Academic accommodations

Academic accommodations are available for students registered with the Office for Accessibility and Educational Opportunity (AEO). Students in need of disability (ADA/504) accommodations should schedule an appointment with me early in the semester to discuss any accommodations for this course that have been approved by the Office for Accessibility and Educational Opportunity, as indicated in your AEO accommodation letter.

Title IX

Vassar College is committed to providing a safe learning environment for all students that is free of all forms of discrimination and sexual harassment, including sexual assault, relationship abuse, and stalking. If you (or someone you know) has experienced or experiences any of these incidents, know that you are not alone. Vassar College has staff members trained to support you in navigating campus life, accessing health and counseling services, providing academic and housing accommodations, helping with legal protective orders, and more.

Please be aware all Vassar faculty members are "responsible employees," which means that if you tell me about a situation involving sexual harassment, sexual assault, relationship abuse, or stalking, I must share that information with the Title IX Coordinator. Although I have to make that notification, the Title IX office will only provide outreach by email. You will control how your case will be handled – you don't have to read or respond to the email, and it is completely up to you whether to pursue a formal complaint. Our goal is to make sure you are aware of the range of options available to you and have access to the resources you need.

If you wish to speak to someone privately, you can contact any of the following on-campus resources:

- Counseling Service (counselingservice.vassar.edu, 845-437-5700)
- Health Service (healthservice.vassar.edu, 845-437-5800)
- Nicole Wong, SAVP (Sexual Assault and Violence Prevention) director (savp.vassar.edu, 845-437-7863)
- SART (Sexual Assault Response Team) advocate, available 24/7 by calling the CRC at 845-437-7333 and asking for SART

The SAVP website (savp.vassar.edu) and the Title IX section of the EOAA website (eoaa.vassar.edu/title-ix) have more information, as well as links to both on- and off-campus resources.

ACKNOWLEDGMENTS

This course includes extensive material developed by Nancy Ide.