



THE UNIVERSITY OF VERMONT
COMPUTER SCIENCE

CS125 / Computability and Complexity / 2023 Spring

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Instructor: Clayton Cafiero

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Office: Innovation E309

Office hours: W 08:30–9:45 AM; Th 4:30–5:45 PM; F 08:00–11:30 AM; or by appointment.

GTA: Steven Baldasty

Email: sbaldast@uvm.edu

TA help desk: S–W, 5:00–7:00 PM

Locations: S: Innovation E204, M: Kalkin 004, T/W: Kalkin 002

Class meetings

Section A: T/Th 08:30–09:45 AM, Innovation E210

Section C: T/Th 02:50–04:05 PM, Kalkin 007

Update 2023-03-18 for balance of semester

The following is adapted from the original syllabus by Isaac Levy.

Overview: This course is a study in automata, the fundamental limits of computing, and complexity theory. Topics include: formal languages, regular expressions, DFA/NFAs, Turing completeness, decidability, complexity classes and the theory of NP completeness.

Important dates

Midterm exam: Thursday 2023-03-09

Final exam, section A: Tuesday 2023-05-09 07:30 AM

Final exam, section C: Tuesday 2023-05-09 04:30 PM

Course materials: Textbook: Sipser, Michael. *Introduction to the Theory of Computation*, 3rd edition. ISBN: 0357670582. E-text rental available from UVM Bookstore. ISBN-13: 978-1118612101. Other materials supplied Blackboard.

It is important that you understand the expectations for class participation, attendance, due dates, instructor availability, and illness. Please review the information in this syllabus carefully so that you know what to expect and how to succeed in this course.

Learning objectives

- Prove properties of languages and automata using formal mathematical methods.
- Collaborate with peers to solve problems and present results.
- Recognize flaws in invalid proofs.
- Trace an automaton's action on a given input (*e.g.*, determine whether a given DFA accepts a given string).
- Design automata (DFA, Turing Machine, *etc.*) or grammar to recognize a specific language or to satisfy a given property.
- Describe the language recognized by an automaton or generated by a regular expression or context-free grammar.
- Understand how reduction techniques are used to prove that certain problems are undecidable.
- Understand relationships between grammars in the context of Chomsky's hierarchy.
- Explain the relationship between the problem spaces of NP-hard, NP-complete, P, NP, decidable and undecidable.

Important websites

- Blackboard, for course materials and announcements.
- Piazza, for asking questions and getting help. See links on Blackboard.
- Gradescope, for submitting assignments and seeing grading feedback.

Course structure: CS125 will be delivered in a hybrid format. In hybrid courses, traditional face-to-face lectures are supplemented by online materials. Prior to each week's lecture, you are expected to have reviewed all book sections, notes, and supplemental videos (if any) and taken the associated quiz on Blackboard.

Pre-lecture review (effective 2023-03-20): On or before each Friday, a set of materials will be posted on Blackboard. It is your responsibility to read the associated sections of the textbook and review all supplementary materials before the next class meeting. Make a list of any questions you have; these will be addressed at the start of class.

Quizzes (10%): After reviewing the pre-lecture material, you complete an associated open note / open book quiz on Blackboard. No make-up or late quizzes will be available. There will be 13 quizzes throughout the semester; the lowest two scores will be dropped.

Activities (15%): The first day of the week will consist primarily of lecture, while the second day of the week will be primarily dedicated to an in-class activity. At the end of second day, submit your work to Gradescope. You must submit a PDF file. If scanning handwritten work, you must use one of the apps from <https://go.uvm.edu/gpdf>. Your grade will be based on effort, not completion. The lowest two scores will be dropped.

Homework (25%): You will have six homework sets; each accounts for 5% of your overall grade. All homework is due by 10:00 PM on the specified due date (typically every Wednesday). Late homework is subject to a 20% penalty for up to 48 hours after the due date. After 48 hours, late submissions will no longer be accepted.

Exams (50%): The course has two exams: a midterm, and a final. Midterm has already taken place. The final exam is closed book, but you may bring up to two pages hand-written notes (both sides OK, but they *must* be hand-written), and you will be provided a sheet of formulae with your exam. The final exam will be administered in pencil and paper format.

Attendance: You are expected to attend class. This will set you on a path to success in this course. In addition, you will automatically fail any in-class activities if you miss class! The UVM attendance policy can be found at <http://catalogue.uvm.edu/undergraduate/academicinfo/rightsandresponsibilities/>. While there is no explicit weighting for your attendance, a good attendance record will be taken into consideration when assigning letter grades in the course (e.g., whether a close score is rounded up to final grade).

If you are not able to attend in-person classes please notify me via email as soon as possible. While I am happy to grant reasonable accommodations due to documented illness or emergencies, you are responsible for making up any work you have missed.

Classroom environment: Our intention is for CEMS to be a place where you will be treated with respect and kindness. We welcome individuals of all ages, backgrounds, beliefs, interests, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability, and other visible and nonvisible differences. All members of the College are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the community. If you ever feel that you have been unfairly treated or judged by an instructor, a mentor, another student, or another member of the CEMS community, please let someone know. Your instructors and advisors in the CEMS Office of Student Services are available to discuss any concerns or you can report an incident of bias through the Campus Bias Response Program.

Grading:

| Component | Weight |
|--------------|-------------|
| Quizzes | 10% |
| Activities | 15% |
| Homework | 25% |
| Midterm | 25% |
| Final | 25% |
| TOTAL | 100% |

Assignment of letter grades will be on a conventional scale. Any grade appeal (assignment, quiz, lab, exam, etc.) must be directed to your grader within one week of the grade being posted.

Weekly schedule of topics
(tentative and subject to change):

| Week | Week of | Topics covered | Tasks |
|------|---------|--|----------------------|
| 01 | 15 Jan | Mathematical terminology and proofs | quiz 01 |
| 02 | 22 Jan | Introduction to automata | quiz 02, homework 01 |
| 03 | 29 Jan | Finite automata—DFAs and NFAs | quiz 03 |
| 04 | 05 Feb | Regular expressions | quiz 04, homework 02 |
| 05 | 12 Feb | Non-regular languages and the Pumping Lemma | quiz 05 |
| 06 | 19 Feb | Context-free grammars | quiz 06, homework 03 |
| 07 | 26 Feb | TBD | quiz 07 |
| 08 | 05 Mar | Midterm review | |
| 09 | 19 Mar | Introduction Turing Machines | quiz 08, homework 05 |
| 10 | 26 Mar | Variants of Turing Machines / Church-Turing Thesis | quiz 09 |
| 11 | 02 Apr | Decidability and the <i>Entscheidungsproblem</i> | quiz 10, homework 06 |
| 12 | 09 Apr | Reducibility | quiz 11 |
| 13 | 16 Apr | Computational complexity | quiz 12 |
| 14 | 23 Apr | Complexity classes: P, NP, NP-Complete, NP-Hard | quiz 13 |
| 15 | 30 Apr | Additional topics TBD | |

Course evaluations: Students are expected to fill out a course evaluation at the conclusion of the course. This evaluation is anonymous and is not released to the instructor until after grades are finalized. We use these evaluations and comments to improve our classes! All feedback—good, bad, or indifferent—is warmly encouraged.

Academic integrity: The Department of Computer Science enforces the Code of Academic Integrity Policy as outlined in the Code of Rights and Responsibilities and University Policies. At the first suspicion of violation of this policy, the case will be immediately forwarded to the Coordinator of Academic Integrity. Sanctions for a violation can lead to a grade of XF in the course. Additional violations can result in dismissal from the University.

While collaboration is permitted and encouraged on in-class activities, unless explicitly specified, collaboration on labs, quizzes, exams and homework is strictly prohibited. Using an AI-content generator (such as ChatGPT) to complete coursework is a form of academic dishonesty. If you have any questions ...ASK!

Students are prohibited from publicly sharing or selling academic materials that they did not author (for example: class syllabus, outlines or class presentations authored by the professor, practice questions, text from the textbook or other copyrighted class materials, *etc.*); and students are prohibited from sharing assessments (for example homework or a take-home examination). Violations will be handled under UVMs Intellectual Property policy and Code of Academic Integrity. Please note that “sharing assessments” may also include course materials that students share on websites such as Chegg and Course Hero.

Accommodations: In keeping with University policy, if you have a documented disability and are interested in utilizing ADA accommodations, you should contact Student Accessibility Services (SAS), the office of Disability Services on campus for students. SAS works with students and faculty in an interactive process to explore reasonable and appropriate accommodations, which are communicated to faculty in an accommodation letter.

Contact SAS: A170 Living/Learning Center; +1 802 656 7753; access@uvm.edu; or visit <https://www.uvm.edu/access>.

If you are entitled to use the Exam Proctoring Center, please book reservations at least four days in advance.

Promoting health and safety: If you are concerned about a UVM community member or are concerned about a specific event, we encourage you to contact the Dean of Students Office (+1 802 656 3380). If you would like to remain anonymous, you can report your concerns online by visiting the Dean of Students website at <https://www.uvm.edu/studentaffairs>.

Wellbeing resources:

- Center for Health and Wellbeing: <https://www.uvm.edu/health>
- Counseling and Psychiatry Services (CAPS): +1 802 656 3340
- Food Insecurity Assistance: <https://www.uvm.edu/health/food-insecurity-uvm>

Your identity at UVM: Students at UVM can specify the first name and pronoun they want used on campus. All students at the University of Vermont can indicate their preferred first name and pronoun to the University community regardless of whether or not they have legally changed their names. Choosing a preferred name in the Banner system will automatically change which name appears in many internal locations such as class lists, grade reports, and unofficial transcripts.

For information on how to update your preferred name and personal pronouns as well as keeping your legal name private: <https://www.uvm.edu/registrar/preferred-name-and-pronoun>.

General education requirements: This course fulfills the Qualitative Reasoning (QR) requirement of the Fall 2020 revision of the Catamount Core curriculum. See <https://www.uvm.edu/generaleducation/quantitative-reasoning>.

COVID-19: UVM expects students, faculty, and staff to remain compliant with all COVID-19 recommendations and measures in place for UVM, the State of Vermont, and the City of Burlington.

Class format changes: The University of Vermont reserves the right to make changes in the course offerings, mode of delivery, degree requirements, charges, regulations, and procedures contained herein as educational, financial, and health, safety, and welfare considerations require, or as necessary to be compliant with governmental, accreditation, or public health directives.

Religious holidays: Students have the right to practice the religion of their choice. In order to receive extensions or excused absences, you should submit via email your documented religious holiday schedule for the semester within the first two weeks of class. Reasonable extensions will be granted where assignment deadlines conflict with religious holidays.

Statement on alcohol and other drugs: We want you to get the most you can out of this course. Therefore, you are expected to familiarize yourself and abide by the University's policies with regard to alcohol, cannabis, tobacco, and other drug use.¹ Please do everything you can to optimize your learning and to participate fully in this course.

Changes to this document: This document is subject to change. Any such change will be communicated via class email and with an announcement on Blackboard. The latest version of the syllabus will always be available on Blackboard.

DRAFT

¹See: <https://www.uvm.edu/sites/default/files/UVM-Policies/policies/drugandalco.pdf>