CSCI 5100: Theory of Computation

Calvin Deutschbein

Spring, 2025

E-mail: **cdeutschbein@lagrange.edu**   Web: **https://cd-public.github.io/compute/**
Residency January 23 - 26, 2025   Date Range: 1/13/25 - 3/7/25

Modality and Credit Hour Compliance

Residency We will meet in person at LaGrange College from 8 AM to 6 PM on 1/24-25/2025 and from 8 AM to 12 Noon on 1/26/2025. These lectures will also be recorded and posted on the course website. This is 22 of the 37.5 contact hours resulting in 3 credit hour course.

Asynchronous I will upload a weekly lecture video to YouTube, with link posted to the course website on GitHub pages, every Monday from 1/13/25 to 3/3/25. This is 15.5 of the 37.5 contact hours resulting in a 3 credit hour course. Separately, I will be available asynchronous via email for terminating and Discord for persistent communication.

Deliverables Students will be responsible for developing a Quarto Book hosted on GitHub pages including results in LaTeX, Python and Graphviz for the theory of computation and the theory of complexity. Results will be due every Monday. I will target 12 hours of effort each across weekly problem sets resulting in a 2-3 hours homework per contact hour ratio in accordance with credit hour policy.

Course Description

Study of abstract models of computation, unsolvability, complexity theory, formal grammars and parsing, and other advanced topics in theoretical computer science.

Course Materials

- Course materials at **https://cd-public.github.io/compute/**

- Optional Textbook: Sipser, Michael. Introduction to the Theory of Computation. 3rd ed. Cengage Learning, 2012. ISBN: 9781133187790

- Supplemental Material: **Prof. Sipser's Lecture Notes**

Prerequisite

B.S. Computer Science or equivalent.

Course Objectives

LaGrange College Student Learning Outcomes (LC SLO):

1. Students will demonstrate <u>creativity</u> by approaching complex problems with innovation and from

2. Students will demonstrate <u>critical thinking</u> by acquiring, interpreting, synthesizing, and evaluating information to reason out conclusions appropriately.

3. Students will demonstrate proficiency in <u>communication</u> skills that are applicable to any field of study.

Student Learning Outcomes (SLO) for CISC 5100
All learning objectives pursuant to LC SLO {1,2,3} and to be assessed by homework assignments.

1. **Automata and Language Theory (12.5 contact hours)**

   - **SLO 1:** Define and differentiate between finite automata (DFA, NFA, GNFA) and regular expressions, and demonstrate the equivalence between these models.
   - **SLO 2:** Describe the capabilities and limitations of push-down automata (PDA) and context-free grammars (CFG), and apply the pumping lemma to prove that certain languages are not context-free.

2. **Computability Theory (12.5 contact hours)**

   - **SLO 3:** Explain the concept of a Turing machine and its significance in computability theory.
   - **SLO 4:** Discuss the Church-Turing thesis and its implications for the limits of computation.
   - **SLO 5:** Define and distinguish between decidable and undecidable problems, and provide examples of each.
   - **SLO 6:** Understand and apply concepts like the halting problem, reducibility, and the recursion theorem to analyze the computability of problems.

3. **Complexity Theory (12.5 contact hours)**

   - **SLO 7:** Define and analyze the time and space complexity of algorithms using appropriate measures.
   - **SLO 8:** Understand the significance of complexity classes P, NP, PSPACE, and NP-completeness, and discuss the implications of the P versus NP conjecture.

Assignments and Assessment

- Assignments in this course will have the sole purpose of student learning. Students will:
  - Begin the course with a grade of an "A".
    * Be expected to attend class.
    * Be expected to participate in class.
    * Be expected to complete assignments.
  - Be contacted privately by the course instructor in the unusual event they are not meeting expectations.
    * Not have an expectation of perfection.
    * Not lose points or a grade without discussion.
    * Have a chance to explain their engagement with the course.
  - Receive feedback collectively from the instructor and individually from peers.
    * Be entitled to individual feedback from the instructor at any time.
    * Receive narrative rather than quantitative feedback.
    * Receive positive and constructive feedback only.

College Policies

ADA Statement

In compliance with Section 504 of the Rehabilitation Act and the Americans with Disabilities Act, LaGrange College will provide reasonable accommodation of all medically documented disabilities. If you have a disability and would like the College to provide reasonable accommodations of the disability during this course, please notify Ms. Lindsay Shaughnessy, Director of the Panther Academic Center for Excellence (PACE) and Coordinator of Accessibility Services at accessability@lagrange.edu or 706-880-8652. PACE is located in the Moshell Learning Center amp; Tutoring Lab in the Lewis Library.

Academic Support

Academic Support Academic support at LaGrange is provided through Panther Academic Center for Excellence (PACE), the Writing Center, and the advising deans. PACE provides peer tutoring, testing services, accessibility services, and other academic support as needed. For more information about PACE, please contact Mr. Steve Kenner (skenner@lagrange.edu). The Writing Center gives all writers a space to explore the potential of their ideas via peer review. For information about the Writing Center, contact Dr. Justin Thurman (jthurman@lagrange.edu).

Academic Integrity Policy

Each student is bound by the LaGrange College Honor Code which is stated as follows:

> As a member of the student body of LaGrange College, I confirm my commitment to the ideals of civility, diversity, service, and excellence. Recognizing the significance of

personal integrity in establishing these ideals within our community, I pledge that I will not lie, cheat, steal, nor tolerate these unethical behaviors in others.

The full text of the LaGrange College Honor Code along with policies and procedures in cases of academic dishonesty can be found at http://www.lagrange.edu/resources/pdf/honorcode12-13.pdf.

Academic Integrity Policy

Email and LaGrange college accounts will be used in accordance with the following student handbook statement:

> "Students are expected to treat their campus [email] accounts as a business account. Faculty and administrators rely on these accounts to disseminate important information regarding College protocol and events therefore, students are responsible for any College information sent out over campus email."

Consequently, personal email addresses will not be used for instructor/student email contact except in event a service interruption. The preferred method of contact will instead be by the official campus email. I target a 24 hour maximum response time on school days and 48 hours maximum response time on all emails while the course is active.

As an adjunct, my LaGrange email may not persistent indefinitely. I maintain a persistent professional email at mailto:calvindeu@gmail.com which can also be used in event service interrupts to the campus network or for professional references after the conclusion of the course.

Netiquette

When leaving comments or asking questions in the forums of an online course, one is reminded to observe a few rules of internet etiquette:

- All caps locks and/or multiple exclamation points typically imply anger. You should not use such emphases unless it accomplishes a learning objective.

- Vulgarity, rudeness, and/or disrespect are complete unacceptable and will not be tolerated.

- Emoticons (such as ':)' for a 'smiley face') are fine for use in relaxed submissions (forum threads and posts).

- In general, do your best to use proper spelling, grammar, and punctuation. Writing correctly works to ensure that your meaning is conveyed.

Technology Requirements

It is technically possible to complete the assessed work on this course working fully within a web-browser through a combination of cloud services and other technologies, the methodologies for which are left to the interested student as an exercise. That said, I recommend each student utilize the following technology stack:

- A local installation of Python, at least 3.8, ideally more recent.

- A local installation of VS Code.

- A local installation of Quarto.

- A local installation of a version control client compatible with GitHub.

- A local installation of major desktop webbrowser, likely Firefox, Chrome, Safari, or Edge.

- A remote GitHub account affilitated with an official LaGrange.edu email address.

Technical Support

I will independently offer technology support for the technology stack used to support this course. Contact me directly unless you have technical issues arising within LaGrange.edu realms, in which case you should reach out via email to mailto:support@lagrange.edu or call 706.880.8053. Precise technical writing is a core learning objective (LC SLO 3) for this course, and should be modeled in all technical support interactions.

Agreement by Continued Enrollment

...

Note on attending asynchronous attendance:

I am confident I have formulated the assessment tools such that attendance or non-attendance by individuals, as measured by viewing of asynchronous lectures, will be obvious to me as an instructor. As such, I have folded my attendance considerations into the assessment formulation. It is trivial as an instructor to assess the level of engagement with asynchronous learning resources, and you should regard it as more, not less, clear what a student's level of participation is for asynchronous instruction.