UNDER CONSTRUCTION!!!
CS 4102: Algorithms Fall 2021

Tu/Th 12:30 am–1:45 pm	**Tu/Th 2:00–3:15 pm**
Instructor: Mark Floryan	**Instructor:** Tom Horton
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Office: Rice Hall 210	Office: Rice Hall 401
Office Hours: See course website.	Office Hours:

Teaching Assistants: See course website. Office hours will be done primarily using Discord. Join the course's "server:" `https://discord.gg/ycPkfQK9`

Course website: `https://uva-cs.github.io/cs4102-f21/` We will also use of Collab.

Prerequisites: CS 2102 and 2150 with grades of C- or higher, and math knowledge from APMA 1090 or MATH 1210 or MATH 1310. (Prerequisites are important to this course and will be enforced!)

Overview

Course Description: Introduces the analysis of algorithms and the effects of data structures on them. Algorithms selected from areas such as sorting, searching, shortest paths, greedy algorithms, backtracking, divide-and-conquer, and dynamic programming. Data structures include heaps and search, splay, and spanning trees. Analysis techniques include asymptotic worst-case, expected time, amortized analysis, and reductions between problems

Availability: It is important to us to be available to our students, and to address their concerns. If you cannot meet with either of us during our office hours, e-mail us and we will find the time to meet. That being said, like everybody else we are quite busy, so it may take a day or more to find a time to meet. And if you have any comments on the course—what is working, what is not working, what can be done better, etc.—we are very interested in hearing about them. Please send Prof. Floryan, Prof. Horton, or one of the TAs an e-mail or post privately on Piazza to the instructors. When sending email, include "CS4102" in the subjecdt line. If your question could be answered by either professor or even a TA, a post on Piazza to "instructors" may get a faster response.

Course Objectives: Students who complete the course will:

- Comprehend *fundamental ideas in algorithm analysis*, including: time and space complexity; identifying and counting basic operations; order classes and asymptotic growth; lower bounds; optimal algorithms.

- Apply these fundamental ideas to *analyze and evaluate important problems and algorithms* in computing, including search, sorting, graph problems, and optimization problems.
- *Apply appropriate mathematical techniques in evaluation and analysis*, including limits, logarithms, exponents, summations, recurrence relations, lower-bounds proofs and other proofs.
- *Comprehend, apply and evaluate the use of algorithm design techniques* such as divide and conquer, the greedy approach, dynamic programming, and exhaustive or brute-force solutions.
- Be exposed to the fundamental ideas related to the *problem classes NP and NP-complete*, including their definitions, their theoretical implications, Cook's theorem, etc. Be exposed to the design of polynomial reductions used to prove membership in NP-complete.

Textbook: *Introduction to Algorithms, Third Edition* by Cormen, et. al. (ISBN 0262033844). UVA Library makes a digital version of our textbook available online at `https://search.lib.virginia.edu/catalog/u6757775`

Additional Resources: We will make additional optional textbooks and resources available on the course website.

Class Delivery and Covid-19:

Lectures and quizzes will be given in-person. (If the university changes its policy due to changing circumstances, this may change. We will follow university guidance in such matters.) We will do our best to make recordings of lectures available on the Collab site.

We will follow the university's guidance on dealing with Covid, including wearing masks while indoors. See the course website's page on the course's policies on dealing with Covid-19.

Coursework and Grading

The course is divided into 10 **modules**:

- Divide & Conquer: Insertion Sort, Mergesort, Quicksort
- Divide & Conquer: Recurrence Relations
- Divide & Conquer: Advanced Topics
- Graphs: Breadth-first Search (BFS) & Depth Search (DFS)

- Graphs: Kruskal's and Find-Union
- Graphs: Prim's & Dijkstra's
- Greedy Algorithms
- Dynamic Programming
- Network Flow and Ford-Fulkerson
- Bi-Partite Matching & Reductions

Most modules are 2 lectures worth of content (but a few are 3 or 4). The schedule is shown on the website. For each module, there will be:

- 1 homework (written or programming)
- 1 quiz

Quizzes: Each quiz is a short assessment of your knowledge of a module. So quizzes are meant to ensure you have knowledge of the individual topics from lecture to a sufficient degree. There are 3 possible grades for a quiz: incomplete, pass, or high-pass. You will have multiple opportunities to take each quiz (3 attempts for 8, but only 2 for the last two quizzes).

Quizzes will be given in-person in your scheduled lecture time as follows:

Tue, Sep. 21	Mod 1-3 (first attempts)
Thu, Oct. 7	Mod 1-3 (second attempt), 4-5 (first attempt)
Tue, Nov. 16	Mod 4-5 (second attempt), 6-8 (first attempt)
Thu, Dec. 2	Mod 6-8 (second attempt), 9-10 (first attempt)
Final Exam period, Tue, Dec 14, 7:00 pm	Mod 1-10 (final attempts)

Homeworks: Homeworks fall into two categories: "written" and "programming." Programming homeworks can use Python, Java or C++. Some assignments will require a write-up in addition to code. Written homeworks may include small problems, runtime analysis, proofs, etc. See section about LaTeX below.

Grading: This course has a system for determining grades that is unlike many courses, and is fully explained on the course website under "Course Logistics." Full details are explained there, but here are the major points.

- We will use a grading approach based on a an approach called *masterry learning*. Our approach tries to model the CS department's official policy on what course grades should mean, found at `http://ugrads.cs.virginia.edu/grading-guidelines.html`
- Quizzes are scored at one of three levels: incomplete, pass, or high-pass.
- Homeworks are scored at one of two levels: incomplete or pass.
- With some limitations, a quiz or homework that can be done again to earn a higher score.

- Your final letter grade is determined by how many modules you pass. Also, earning high-passes on module quizzes can raise your grade a bit more.
- The website has a table showing what you need to achieve to reach a particular letter grade.

This system is unlike that of most courses in CS you've taken, and we expect you will have questions throughout the semester. We believe it will benefit students in the course. We'll do our best to clear up any confusion throughout the course. We do reserve the right to tweak this grading system in small ways if we think it will correct a problem or better serve the class as a whole.

LaTeX: Written assignments must be typeset with LaTeX, a professional formatting system. Tutorials on how to use LaTeX will be made available when the first written problem set is released. LaTeX is easily installable on many computers:

- Overleaf, `http://overleaf.com`: a Web-hosted LaTeX editor which behaves much like Google Docs.
- Cygwin (which you saw in CS 2150) has LaTeX packages that can be installed
- MiKTeX provides a stand-alone installer for Windows and Mac, `miktex.org`
- Ubuntu and CentOS provide TeXLive packages in their repos
- LyX, TexShop, and TeXStudio are GUI editors available either through the MiKTeX and TeXLive repos or available as separate downloads.

We strongly recommend using Overleaf, `http://overleaf.com`, since it contains all the necessary packages and works in-browser. We generally will not accept LaTeX documents with images of text or formulas; **you must typeset the formulas in LaTeX**, not in another program and have them exported as images.

Submission System: All homeworks will be submitted via GradeScope. Details will be explained later in the course.

Homework Late Policy: For homeworks, there will be a suggested date to submit each homework (before the first attempt at the quiz on that module). Any homework can be submitted as late as the deadline posted on the course website (near the end of the semester).

Regrades: We believe that the re-submission policies in this course will make re-grade requests much less frequent. However, if you believe a quiz or homework was not graded correctly, we will allow you to make such a request. The exact procedure and policy will be announced later in the term.

Collaboration Policy

Quizzes: Quizzes are always individual assignments; collaboration with others is not allowed. Any solutions that share similar text or code will be considered in breach of this policy.

Homeworks: You are encouraged to collaborate with up to 2 other students in the course on each homework, but all work submitted must be your own independently written solution. While you may discuss techniques and collectively solve the problems in your group, you may **not** share any files or look at each others' write-up or code. For instance, sharing source code files or Overleaf or Google Docs is **not** allowed. Likewise, pair programming or sharing the debugging of code are **not** allowed. Any solutions that share similar text or code will be considered in breach of this policy. You **must** list the names and computing IDs of all of your collaborators in your submitted `tex`, `py`, and `java` files.

Do not seek published or online solutions for any assignment or exam. Any submission which is discovered to be similar to a published solution or one found online will be considered in breach of this policy. If you use any published or online resources (they must not include solutions) when completing your assignments, be sure to cite them.

Note that it is a violation of this policy to submit a problem solution that you are unable to explain orally to a member of the course staff, and we reserve the right to spot-check for this requirement.

Penalty: Assignments or quizzes where violations of this policy occur will receive a **zero** grade for that entire assignment or exam, as well as a **full letter-grade** penalty on the course grade. Second infractions will result in a **failing (F)** grade in the course. Any infractions will also be submitted to the Honor Committee if deemed appropriate.

Additional Information

Special Circumstances: The University of Virginia strives to provide accessibility to all students. If you require an accommodation to fully access this course, please contact the Student Disability Access Center (SDAC) at (434) 243-5180 or `sdac@virginia.edu`. If you are unsure if you require an accommodation, or to learn more about their services, you may contact the SDAC at the number above or by visiting their website `http://studenthealth.virginia.edu/sdac`.

For this course, we ask that students with special circumstances let us know as soon as possible, preferrably during the **first week of class**.

Religious Accommodations: It is the University's long-standing policy and practice to reasonably accommodate students so that they do not experience an adverse academic consequence when sincerely held religious beliefs or observances conflict with academic requirements. Students who wish to request academic accommodation for a religious observance should submit their request in writing to Prof. Hott or Prof. Horton as far in advance as possible. If you have questions or concerns about academic accommodations for religious observance or religious beliefs, visit

`https://eocr.virginia.edu/accommodations-religious-observance`

or contact the University's Office for Equal Opportunity and Civil Rights (EOCR) at `UVAEOCR@virginia.edu` or 434-924-3200. Accommodations do not relieve you of the responsibility for completion of any part of the coursework missed as the result of a religious observance.

Safe Environment: The University of Virginia is dedicated to providing a safe and equitable learning environment for all students. To that end, it is vital that you know two values that we and the University hold as critically important:

1. Power-based personal violence will not be tolerated.
2. Everyone has a responsibility to do their part to maintain a safe community on Grounds.

If you or someone you know has been affected by power-based personal violence, more information can be found on the UVA Sexual Violence website that describes reporting options and resources available – `www.virginia.edu/sexualviolence`.

As your professor and as a person, know that we each care about you and your well-being and stand ready to provide support and resources as we can. As a faculty member, we are responsible employees, which means that we are required by University policy and federal law to report what you tell us to the University's Title IX Coordinator. The Title IX Coordinator's job is to ensure that the reporting student receives the resources and support that they need, while also reviewing the information presented to determine whether further action is necessary to ensure survivor safety and the safety of the University community. If you would rather keep this information confidential, there are Confidential Employees you can talk to on Grounds (See `http://www.virginia.edu/justreportit/confidential_resources.pdf`). The worst possible situation would be for you or your friend to remain silent when there are so many here willing and able to help.

Well-being: If you are feeling overwhelmed, stressed, or isolated, there are many individuals here who are ready and wanting to help. The Student Health Center offers Counseling and Psychological Services (CAPS) for all UVA students. Call 434-243-5150 (or 434-972-7004 for after hours and weekend crisis assistance) to get started and schedule an appointment. If you prefer to speak anonymously and confidentially over the phone, Madison House provides a HELP Line at any hour of any day: 434-295-8255.

Syllabus Note: This syllabus is to be considered a reference document that may be adjusted throughout the course of the semester to address necessary changes. This syllabus can be changed at any time without notification; it is up to the student to monitor the website for news of any changes. Final authority on any decision in this course rests with the professor, not with this document.