CS 5012 Foundations of Computer Science
Fall 2024

Instructor:
Dr. Mai Dahshan
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Primary Textbooks (Free digital access through UVA library):

- Introduction to Algorithms (4th ed.), Cormen, Leiserson, Rivest, Stein. The MIT Press, ISBN: 9780262046305 (https://ebookcentral-proquest-com.proxy1.library.virginia.edu/lib/uva/detail.action?docID=6925615)
- Handbook of Discrete and Combinatorial Mathematics: Discrete Mathematics and its Applications (2nd ed.), Rosen et al., ISBN-13: 978-1584887805
- (optional): Book of Proof (3rd ed.), Hammack. ISBN: 978-0-9894721-3-5
- Supplemental readings/material may be assigned and will be made available.

Course Description

This course serves as an introduction to data structures and algorithms using Python. Learners will deepen their understanding of the foundational concepts behind the Data Science tools they use, approaching them from a computer scientist's perspective. By leveraging this knowledge, students will be able to enhance the effectiveness and efficiency of their code and analytical tools. The course offers a thorough exploration of data structures such as arrays, linked lists, stacks, queues, trees, graphs, and hash tables, along with essential algorithms for searching, sorting, and optimization, including recursion, dynamic programming, and greedy methods.

Students will develop the ability to analyze the time and space complexity of algorithms, allowing them to make informed decisions about the most suitable data structures and algorithms for various scenarios. The course places a strong emphasis on practical application, featuring numerous coding exercises, problem-solving sessions, and projects that mirror real-world challenges. By the course's end, students will be well-prepared to design and implement efficient algorithms, optimally utilize data structures, and apply these skills in software development.

While the course introduces a wide range of concepts, it doesn't delve deeply into each one due to time constraints. A more profound understanding of these topics will be achieved in subsequent Data Science courses and through individual practice. As a graduate-level course, CS5012 relies heavily on self-directed learning and further exploration of the concepts introduced, encouraging students to continue their practice independently.

Course Objectives

By the end of the course, students should be able to:

- Select, computationally assess, and deploy appropriate and efficient data structures and algorithms to solve Data Science problems
- Define and use logic, data structures, and algorithms to solve problems
- Connect, transform, and reduce real-world problems to classical problem frameworks to make use of existing, efficient algorithmic solutions.
- Independently explore advanced or supplementary topics to attain a deeper and complimentary understanding of topics.
- Reflect on peer-feedback, instructor-feedback, experiences, and lessons-learned related to the use of data structures and algorithms to make continual improvements and updates to methodologies applied
- Have a working knowledge of the algorithm complexity class hierarchy in order to gain perspective of the scope of the field and its contextual application to Data Science
- Understand the important considerations for proper database design

Course Topic Details:
The topics covered in this course include the following, presented in the approximate order in which they will be taught. This list of topics is to be considered a reference that can be adjusted through the course of the semester to address changing needs.

Time schedule	Topic	Note
Week 1 (8/26 – 9/1)	Course overview and Python review	
Week 2 (9/2 – 9/8)	Computational Complexity	
Week 3 & 4 (9/9 - 9/22)	Basic Data Structures and Algorithms	
Week 5 (9/23 – 9/29)	Hash Tables	
Week 6 (9/30 – 10/6)	Trees and Graphs	
Week 7&8 (10/7 – 10/20)	Balanced Trees Midterm	
Week 9&10 (10/21 – 11/3)	Advanced Algorithms I	
Week 11 (11/4 – 11/10)	Advanced Algorithms II	
Week 12 (11/11 – 11/17)	Classic CS Problems	
Week 13&14 (11/18 – 12/1)	Time Complexity Hierarchy Thanksgiving	
Week 15 (12/2 – 12/8)	Introduction to Databases	
Week 16 (12/9- 12/15)	Final Exam	

Course Requirements

As a prerequisite, a student should have taken the following courses:

- Calculus
- Probability/statistics
- Linear algebra
- An introductory course in Python programming
    - You might want to briefly review your notes from the Python course (e.g., DS 5100 repo here)
        - In addition to the basics, make sure you understand and feel comfortable using classes, functions, recursion

Computer

You are **encouraged** to bring a functioning laptop with you to every class. This laptop must have a functioning internet connection and be able to connect to Canvas. You can use this laptop to practice the coding examples covered in class.

Course Structure

This course adopts an active learning approach, with a focus on minimizing lecture time and incorporating think-pair-share activities. To get the most out of the course, it is recommended that you review the module content in advance. Each module is made up of a lesson, and each lesson includes multiple activities. These activities include quizzes, in-class exercises, and homework programming assignments. Reviewing the module in-class activities ahead of time is also recommended.

I. **Quizzes**

   Quizzes are closed book

II. **Homework programming assignments**
    - Should be your own work. You may collaborate on ideas.
    - Late Homework Assignments: 10% of the total grade will be deducted per day, where the day means 11:59 p.m. cutoff. After five days late, it will be marked as 0 points.
    - **MAKE SURE TO SUBMIT THE CORRECT FILE. Incorrect files are subject to the Late HW Policy.**

III. **In-class Activities (ICA)**
    - In-class activities aim to enhance your understanding of presented concepts while working in groups
    - ICAs will not be collected after the due date.
    - **MAKE SURE TO SUBMIT THE CORRECT FILE**

IV. **Exams**
    - There will be two exams: a midterm and a final.
    - **Exams are closed book**

Assessment

Grades for the course are based on the following distribution. Please resolve any issues about assigned grades as soon as possible after the grade release.

Component	Percentage of Grade
Homework Programming Assignments	30%
Quizzes	20%
In-class Activities (ICA)	20%
Exams (2)	30%

Final Letter Grade

Your final letter grade will be determined by the following scale:

Letter Grade	Upper bound	Lower bound
A+	100	98
A	97.999	93
A-	92.999	90
B+	89.999	87

B	86.999	83
B-	82.999	80
C+	79.999	77
C	76.999	73
C-	72.999	70
D+	69.999	67
D	66.999	63
D-	62.999	60
F	59.999	0

Class Management:

General

- Please feel free to join the office hours (with me and TA's) to discuss any issues. Also, we can arrange a mutually agreeable time outside of the office hours.
- Email is the best way to get in touch with the instructor. Please include "CS 5012" in the subject line of your email.
- Please do not hesitate to contact me if you have any problems, concerns, questions, or issues regarding the course, material, or anything else in the class.
- Please do not hesitate to talk to me if there are situations in your life that are affecting your performance in the class or your life here at UVa. I might not be able to help, but I might know of resources that might help.

Creating a Positive Class Environment

Your success in this class depends on others! These are your classmates, your instructor, and the teaching assistants. Learning is a fundamentally social process and learning communities thrive when they value what every individual has to share. You each bring in knowledge and experiences about how to create a positive course environment, which you might need to challenge or build upon to help you succeed in this course. We will work together to create an environment where each person is valued as an individual, and where you can learn and contribute with your full potential, whatever your sex, gender, race, ethnicity, sexual orientation, religion, disability status and other aspects of your identity. Creating a positive environment is a learning process, because social and cultural norms influence our behavior in ways we are or aren't aware of (positive or negative), so we are all going to make mistakes in how we treat others. I am working on learning how to respond appropriately and promptly when I make or witness such mistakes.

When I personally make mistakes or miss an opportunity to respond, please let me know privately either in person (visiting office hours) or by email. You should always remember that our cultural or other difference should act as a strength, and not a hurdle, to how we work and communicate with each other. This is a learning opportunity to everyone and I will be grateful for your constructive feedback, which helps me learn and improve.

This Syllabus

This syllabus is to be considered a reference document that can and will be adjusted through the course of the semester to address changing needs. This syllabus can be changed at any time without notification. It is up to the student to monitor this page for any changes. Final authority on any decision in this course rests with the professor, not with this document.

Academic Integrity

The School of Data Science relies upon and cherishes its community of trust. We firmly endorse, uphold, and embrace the University's Honor principle that students will not lie, cheat, or steal, nor shall they tolerate those who do. We recognize that even one honor infraction can destroy an exemplary reputation that has taken years to build. Acting in a manner consistent with the principles of honor will benefit every member of the community both while enrolled in the Engineering School and in the future. Students are expected to be familiar with the university honor code, including the section on academic fraud (http://www.student.virginia.edu/ honor/proc/fraud.html). Each assignment will describe allowed collaborations, and deviations from these will be considered Honor violations. If you have questions on what is allowable, ask! Unless otherwise noted, exams and individual assignments will be considered pledged that you have neither given nor received help. (Among other things, this means that you are not allowed to describe problems on an exam to a student who has not taken it yet. You are not allowed to show exam papers to another student or view another student's exam papers while working on an exam.) Sending, receiving or otherwise copying electronic files that are part of course assignments are not allowed collaborations (except for those explicitly allowed in assignment instructions). Assignments or exams where honor infractions or prohibited collaborations occur will receive a zero grade for that entire assignment or exam. Such infractions will also be submitted to the Honor Committee if that is appropriate. Students who have had prohibited collaborations may not be allowed to work with partners on remaining homework assignments.

SDAC and Other Special Circumstances

If you have been identified as a Student Disability Access Center (SDAC) student, please let the Center know you are taking this class. If you suspect you should be an SDAC student, please schedule an appointment with them for an evaluation. The recommended accommodations will be provided for those students identified by the SDAC. Please contact your instructor one week before an exam so we can make accommodations.

If you are affected by a situation that falls within issues addressed by the SDAC and the instructor and staff are not informed about this in advance, this prevents us from helping during the semester, and it is unfair to request special considerations at the end of the term or after work is completed. So we request you inform the instructor as early in the term as possible your circumstances. If you have other special circumstances (athletics, other university-related activities, etc.) please contact your instructor and/or TA as soon as you know these may affect you in class.

Technical Support

Technical Specifications: Computer Hardware

Operating system: Microsoft Windows 8.1 (64-bit) or Mac OS X 10.10
Minimum hard drive free space: 100GB, SSD recommended
Minimum processor speed: Intel 4th Gen Core i5 or faster
Minimum RAM: 8GB

Technical Support Contacts

UVaCollab: collab-support@virginia.edu
UVA Policies

SDS Grading Policies

The standing of a graduate student in each course is indicated by one of the following grades: A+, A, A-; B+, B, B-; C+, C, C-; D+, D, D-; F. B- is the lowest satisfactory grade for graduate credit.

Attendance

Students are expected to attend all class sessions. Instructors establish attendance and participation requirements for each of their courses. Class requirements, regardless of delivery mode, are not waived due to a student's absence from class. Instructors will require students to make up any missed coursework and may deny credit to any student whose absences are excessive. Instructors must keep an attendance record for each student enrolled in the course to document attendance and participation in the class.

University Email Policies

Students are expected to check their official UVa email addresses on a frequent and consistent basis to remain informed of University communications, as certain communications may be time sensitive. Students who fail to check their email on a regular basis are responsible for any resulting consequences.

Mid-Term and End-of-Class Evaluations

Students may be expected to participate in an online mid-term evaluation. Students are expected to complete the online end-of-class evaluation. As the semester comes to a close, students will receive an email with instructions for completing this. Student feedback will be very valuable to the school, the instructor, and future students. We ask that all students please complete these evaluations in a timely manner. Please be assured that the information you submit online will be anonymous and kept confidential.

University of Virginia Honor System

All work should be pledged in the spirit of the Honor System at the University of Virginia. The instructor will indicate which assignments and activities are to be done individually and which permit collaboration. The following pledge should be written out at the end of all quizzes, examinations, individual assignments and papers: “I pledge that I have neither given nor received help on this examination (quiz, assignment, etc.)”. The pledge must be signed by the student. For more information, visit www.virginia.edu/honor.

Special Needs

It is my goal to create a learning experience that is as accessible as possible. If you anticipate any issues related to the format, materials, or requirements of this course, please meet with me outside of class so we can explore potential options. Students with disabilities may also wish to work with the Student Disability Access Center to discuss a range of options to removing barriers in this course, including official accommodations. Please visit their website for information on this process and to apply for services online: sdac.studenthealth.virginia.edu. If you have already been approved for accommodations through SDAC, please send me your accommodation letter and meet with me so we can develop an implementation plan together.