CS 385: Algorithms

Department of Computer Science
Fall 2024

Instructor: Philippe Meunier (pmeunier@stevens.edu)
Canvas Course Address: https://sit.instructure.com/courses/73602
Course Schedule: MWF, section A: 10:00am BC203, section B: 11:00am BC203, section C: 1:00pm GN103, section D: 2:00pm GN103
Recitations: Thursday, RA: 11:00am X414, RB: 11:00am BC319, RC: 12:30pm H303, RD: 12:30pm GS024, RE: 2:00pm X114, RF: 2:00pm B715, RG: 3:30pm BC219, RJ: 8:00am P218.
Office Hours:

Philippe: I'm in my office in Gateway South 247 whenever I'm not teaching this course or having lunch. Feel free to stop by whenever you like.

Course Assistants:

Adam El-Sawaf (aelsawaf@stevens.edu): RA, RE
Amartya Kalra (akalra3@stevens.edu): RG
Annanya Jain (ajain72@stevens.edu): RA
Harrison Huston (hhuston@stevens.edu): RD, RJ
Jacob Pellini (jpellini@stevens.edu): RF
Joshua Hizgiaev (jhizgiae@stevens.edu): RG
Katie Ng (knq7@stevens.edu): RF
Mahad Rana (mrana6@stevens.edu): RC
Makena Williamson (mwillia5@stevens.edu): RB, RC
Melissa Ozcan (mozcan1@stevens.edu): RJ
Nicholas Buckley (nbuckley@stevens.edu): RE
Nicholas DiSalvo (ndisalvo@stevens.edu): RD
Zakariyya Scavotto (zscavott@stevens.edu): RB

Prerequisite(s): CS 284

COURSE DESCRIPTION

CS 385 is a course on the design and analysis of algorithms. It covers asymptotic complexity analysis, space-time tradeoffs, standard algorithm design techniques, and classic algorithms that serve as examples of design techniques. This course also develops C++ language programming skills by implementing graph algorithms, numerical algorithms, and complex search and sort algorithms.

STUDENT LEARNING OUTCOMES

After successful completion of this course, students will be able to:

- Calculate the asymptotic running time of standard algorithms.
- Explain the meaning of big Oh, Theta, and Omega notations and use them to reason about the performance of diverse algorithms.
- Use the Master Theorem to prove asymptotic assumptions.
- Implement standard algorithms using graphs and weighted graphs in C/C++. (e.g. DFS, BFS, MST).
- Compare and analyze basic and advanced sorting algorithms.
- Implement advanced search trees such as B-tree, AVL tree, and 2-3 tree.
- Implement numerical algorithms such as Gauss elimination, binary exponentiation, and simplex method.
- Apply standard algorithm design techniques such as the greedy technique, dynamic programming, hashing, space/time trade-offs, reduction, backtracking, and branch-and-bound.
- Design and implement a test plan for each assignment.

COURSE FORMAT AND STRUCTURE

This course is on-campus. To access the course, please visit https://www.stevens.edu/canvas. For more information about course access or support, contact the Technology Resource and Assistance Center (TRAC) by calling 201-216-5500.

Course Logistics

- You, your instructor, and the course assistants are bound by the Stevens Honor System. Students are responsible for reading and understanding the course policies in this syllabus, in announcements made in class, and in announcements made on Canvas and / or through email.
- Since this course involves computer programming, while the vast majority of your work should be original, if at any point you use a (very small!) part of someone else's solution you MUST cite the source of the code. Copying from other sources (online, classmates, ChatGPT, etc.) without citation results in an automatic zero for the assignment and additional possible penalties (including course failure and / or escalation to the Honor Board).
- Except when groups are explicitly allowed, all work must be done individually. You are encouraged to discuss the problems with your classmates but you must not share details of the solutions. If you are unsure whether you have shared too much, discuss the situation with the instructor *before* submitting; it is your obligation to avoid even the appearance of cheating. We will use Moss (https://theory.stanford.edu/~aiken/moss/) on assignments to verify that your code is not too similar to that of other students in the class. If the system indicates a high likelihood of cheating, we will treat it as a violation of the Stevens Honor System.
- Computer programs will be graded on the virtual machine described at the start of the semester. You will receive 0 points on the assignment if it does not compile there.
- Trying to fake any result whatsoever in a programming assignment will get you a grade of zero for the whole assignment.
- Assignments submitted on Canvas will be accepted late but there will be a 2% penalty for each hour past the deadline (counted at the start of the hour).
- If you accidentally submit the wrong assignment or an empty assignment, you can re-submit later but you will still get the usual late penalty described just above.
- After grades are posted, you will have 3 days to inform your grader of a problem. You should also CC your instructor on the email. Do not try to request a grade change after three days, as you should learn from your mistakes in a timely fashion.

- During exams, you are not permitted to use notes, books, or computing or communication devices unless a different policy is specifically announced by the instructor.
- There are no make-up exams. Talk to your instructor if you foresee a problem.
- During lecture and recitation sessions please refrain from using mobile phones.
- Attendance is mandatory, both for lectures and recitations. In particular attendance will be checked for all quizzes.
- Final letter grades will be scaled according to class-wide grade clustering.
- You are more than welcome to ask questions as often as you want, by email or in person, and we will always be happy to help. The amount of help provided will be directly proportional to the amount of time left before the deadline. Please don't wait until one hour before an assignment is due to send us a message; it'll be too late for us to provide help and too late for you to truly learn the material.
- Please do not ask us at the end of the semester to find creative ways to increase your grade. If you suspect that you are not doing well, come see us to rectify the situation as soon as possible so that you will have a good grade at the end of the semester.

TENTATIVE COURSE SCHEDULE

Week	Topics
1	Course introduction; review of fundamental data structures; overview of algorithm design process; introduction to C++ development
2	More C++: pointers, references, collections, classes
3	Analysis framework: Big-O, Theta, Omega; analysis of non-recursive algorithms; solving recurrence relations using backwards substitution
4	Bitwise and bitshift operators; brute force algorithms; exhaustive search
5	Elementary sorting algorithms
6	Graph representations; graph algorithms: DFS, BFS, topological sorting
7	Analysis of recursive algorithms; Master Theorem
8	Divide and conquer algorithms: binary search, mergesort, quickselect, quicksort; counting sort, radix sort
9	Russian peasant multiplication; binary reflected Gray codes; lexicographic permutations; fast multiplication of large numbers
10	Binary trees; recursive tree algorithms
11	Red-black trees; 2-3 trees
12	Transform and conquer algorithms: Horner's method, left-to-right binary exponentiation; dynamic programming: coin-row, robot coin collection, 0-1 knapsack, all pairs shortest paths
13	Greedy algorithms: Dijkstra, Prim, Huffman; Kruskal / union-find algorithm
14	Iterative algorithms: max flow

COURSE MATERIALS

Textbooks:

- Introduction to the Design and Analysis of Algorithms, 3rd edition, by Anany Levitin, Pearson, 2012.
- Programming: Principles and Practice Using C++, 2nd edition, by Bjarne Stroustrup, Addison-Wesley, 2014.

GRADING PROCEDURES

Grades will be based on:

- Programming assignments: 40%
- Homework assignments and in-class quizzes: 10%
- Three in-class tests: 30%
- Final exam: 20%

Academic Integrity: Undergraduate Honor System
Enrollment into the undergraduate class of Stevens Institute of Technology signifies a student's commitment to the Honor System. Accordingly, the provisions of the Stevens Honor System apply to all undergraduate students in coursework and Honor Board proceedings. It is the responsibility of each student to become acquainted with and to uphold the ideals set forth in the Honor System Constitution. More information about the Honor System including the constitution, bylaws, investigative procedures, and the penalty matrix can be found online at http://web.stevens.edu/honor/.

The following pledge shall be written in full and signed by every student on all submitted work (including, but not limited to, homework, projects, lab reports, code, quizzes and exams) that is assigned by the course instructor. No work shall be graded unless the pledge is written in full and signed.

"I pledge my honor that I have abided by the Stevens Honor System."

Students who believe a violation of the Honor System has been committed should report it within ten business days of the suspected violation. Students have the option to remain anonymous and can report violations online at www.stevens.edu/honor.

ACCOMMODATIONS

Stevens Institute of Technology is dedicated to providing appropriate accommodations to students with documented disabilities. The Office of Disability Services (ODS) works with undergraduate and graduate students with learning disabilities, attention deficit-hyperactivity disorders, physical disabilities, sensory impairments, psychiatric disorders, and other disabilities to help students achieve their academic and personal potential. They facilitate equitable access to the educational programs and opportunities offered at Stevens and coordinate reasonable accommodations for eligible students. These services are designed to encourage independence and self-advocacy with support from the ODS staff. The ODS staff will facilitate the provision of accommodations on a case-by-case basis.

For more information about Disability Services and the process to receive accommodations, visit https://www.stevens.edu/student-diversity-and-inclusion/disability-services. If you have any questions please contact the Office of Disability Services at disabilityservices@stevens.edu or by phone: 201.216.3748.

Disability Services Confidentiality Policy
Student Disability Files are kept separate from academic files and are stored in a secure location within the Office of Disability Services. The Family Educational Rights Privacy Act (FERPA, 20 U.S.C. 1232g; 34CFR, Part 99) regulates disclosure of disability documentation and records maintained by Stevens Disability Services. According to this act, prior written consent by the student is required before our Disability Services office may release disability documentation or

records to anyone. An exception is made in unusual circumstances, such as the case of health and safety emergencies.

INCLUSIVITY

Stevens Institute of Technology believes that diversity and inclusiveness are essential to excellence in academic discourse and innovation. In this class, the perspective of people of all races, ethnicities, gender expressions and gender identities, religions, sexual orientations, disabilities, socioeconomic backgrounds, and nationalities will be respected and viewed as a resource and benefit throughout the semester. Suggestions to further diversify class materials and assignments are encouraged. If any course meetings conflict with your religious events, please do not hesitate to reach out to your instructor to make alternative arrangements.

You are expected to treat your instructor and all other participants in the course with courtesy and respect. Disrespectful conduct and harassing statements will not be tolerated and may result in disciplinary actions.

Name and Pronoun Usage

As this course includes group work and class discussion, it is vitally important for us to create an educational environment of inclusion and mutual respect. This includes the ability for all students to have their chosen gender pronoun(s) and chosen name affirmed. If the class roster does not align with your pronouns and/or name, please inform the instructor of the necessary changes.

Religious Holidays

Stevens is a diverse community that is committed to providing equitable educational opportunities and supporting students of all ethnicities and belief systems. Religious observance is an essential reflection of that rich diversity. Students will not be subject to any grade penalties for missing a class, examination, or any other course requirement due to religious observance. In addition, students will not be asked to choose between religious observance and academic work. Therefore, students should inform the instructor at the beginning of the semester if a requirement for this course conflicts with religious observance so that accommodations can be made for students to observe religious practices and complete the requirements for the course.

MENTAL HEALTH RESOURCES

Part of being successful in the classroom involves a focus on your whole self, including your mental health. While you are at Stevens, there are many resources to promote and support mental health. The Office of Counseling and Psychological Services (CAPS) offers free and confidential services to all enrolled students who are struggling to cope with personal issues (e.g., difficulty adjusting to college or trouble managing stress) or psychological difficulties (e.g., anxiety and depression). Appointments can be made by phone (201-216-5177), online at https://stevensportal.pointnclick.com/confirm.aspx, or in person on the 2nd Floor of the Student Wellness Center.

EMERGENCY INFORMATION

In the event of an urgent or emergent concern about your own safety or the safety of someone else in the Stevens community, please immediately call the Stevens Campus Police at 201-216-5105 or on their emergency line at 201-216-3911. These phone lines are staffed 24/7, year-round. For students who do not reside near the campus and require emergency support, please contact your local emergency response providers at 911 or via your local police precinct. Other 24/7 national resources for students dealing with mental health crises include the National Suicide Prevention Lifeline (1-800-273-8255) and the Crisis Text Line (text “Home” to 741-741). If you are concerned about the wellbeing of another Stevens student, and the matter is *not* urgent or time sensitive, please email the CARE Team at care@stevens.edu. A member of the CARE Team will respond to your concern as soon as possible.