

Algorithms and Advanced Data Structures

Carnegie Mellon University
School of Computer Science

Computational Biology Department

02-613/15-351/15-650 – Spring 2026

Revised: January 12, 2026
(change since start of classes marked **in orange**)

Class Location and Times:

Lecture: Monday, Wednesday, & Friday, 9:00am–9:50pm (DH 2210)

Recitation: • Friday 1:00pm–1:50pm (POS 145, Undergrad),
• Friday 2:00pm–2:50pm (POS 153, Grad), or
• Friday 3:00pm–3:50pm (DH 1211, Undergrad),

Course objectives: The objective of this course is to study general computational problems and their algorithms, with a focus on the principles used to design those algorithms.
After passing this class, you should be able to:

1. analyze running time for many kinds of algorithms
2. design divide-and-conquer algorithms
3. design dynamic programming algorithms
4. design network flow-based algorithms
5. write linear / integer programs
6. apply large-scale search / heuristic algorithms
7. efficiently store and answer queries about data
8. prove a problem is NP-complete

What about programming? This course is **not** a programming course. It is an algorithm design and analysis course. Part of the point of the course is to learn to be able to think about algorithms separately from programming. The course's focus is on being able to understand algorithms theoretically not empirically. You are of course welcome (and encouraged!) to implement any of the discussed algorithms as a way to help yourself understand them.

What's the difference between 02-613, 15-650 and 15-351? All the courses have the same structure, same lectures, same TAs, etc. Those who are signed up for one of

the graduate numbers (02-613 or 15-650) will have a few additional assignments. The grading curve will also be computed separately in each of the three courses.

Contents

1 Instructional Staff	3
2 Logistics	4
3 Grading	4
3.1 Tests	5
3.2 Recitation Quizzes	5
3.3 Homework	6
3.4 Attendance & Participation	8
3.5 Frequently Asked Questions	9
4 Expectations	9
4.1 Expectations of Students and Instructors	9
5 Academic Integrity	10
5.1 Cheating and Plagiarism	11
6 Resources	12
6.1 Accommodations for Students with Disabilities	12
6.2 Statement of Support for Students' Health & Well-being	12
6.3 Diversity Statement	13

1 Instructional Staff

Instructors

Dr. Dan DeBlasio email: deblasio@cmu.edu
 office: GHC 7707
 office hours: Mondays & Wednesdays 10a–11a
 or by appointment (calendly.deblasiolab.org)

Teaching Assistants (by office hours)

Thu Vu email: ngocminv@andrew.cmu.edu
 office hours: Tuesdays 12:30p-1:30p

Pradnya Jadhav email: prjadhav@andrew.cmu.edu
 office hours: Fridays 3p-4p

Aidan Jan email: ajan@andrew.cmu.edu
 office hours: TBD

Cyrus Tavakol email: czt@andrew.cmu.edu
 office hours: TBD

*all TA office hours in **GHC 7404**.*

2 Logistics

Textbook: Algorithm Design by Jon Kleinberg and Eva Tardos. Addison Wesley, 2005.
ISBN: 0-321-29535-8.

The class has 4 major subunits:

1. Basics

- Minimum Spanning Tree case study (algs & data structures)
- Asymptotic analysis
- Graph search: breadth first, depth first

2. Advanced Graph algorithms

- Topological sorting
- Shortest path: Dijkstra, A*, Bellman-Ford

3. Advanced data structures

- Skip-list
- Splay trees
- B-trees

4. Algorithmic design techniques

- Dynamic programming
- Network flow
- Linear programming
- NP-completeness (concepts and techniques for proofs)
- Approximation algorithms

A tentative schedule can be found on [Google Sheets](#)¹

Communication platforms:

- **Canvas Homepage.** The course homepage will be hosted on Canvas. Canvas will be used for attendance and as a central repository for grades. Students should be automatically enrolled. <https://canvas.cmu.edu/courses/51028>
- **Discussion Forum.** An online forum is provided on Piazza as an area for discussion and questions. The forum will be moderated by the course staff who will respond to questions, but students are encouraged to help each other via discussion. However, assignment specifics should not be discussed — any hints will be provided by the teaching staff. Students should be automatically enrolled. <https://piazza.com/cmu/spring2026/153510261315650>

3 Grading

The course will be split into three (3) modules (*mostly* aligning with subunits 1, 2&3, then 4 above); each of will contain: 4-5 homework assignments, 4-5 recitation sessions,

¹<https://docs.google.com/spreadsheets/d/1Bj7UPvCL287iHKX0SAgScLVKcds37rRcWeNeo0AzQyA>

and a test. Based on existing knowledge of the material in each module students can choose² between two grading schemes:

20% written homework 5% oral homework 15% recitation quizzes 60% test	100% test
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The 3 modules scores will then be averaged to compute a student's final grade.

Alternate grading If a student attends all recitations and turns in all homework assignments (other than the allowed drops) students will be eligible for an alternate grading scheme computed as follows:

$$\frac{2 \cdot M_{low} + 3 \cdot M_{mid} + 4 \cdot M_{high}}{9}$$

where M_{low} , M_{mid} and M_{high} are the lowest, middle, and highest module scores.

3.1 Tests

Note the time of the midterms

The 3 module tests are scheduled for:

- 18 February 2026, 7:00pm-9:00pm, (Material covered weeks 1-5)
- 1 April 2026, 7:00pm-9:00pm, (Material covered weeks 5-9) and
- the university exam period (Material covered weeks 1-14)³

3.2 Recitation Quizzes

Recitation quizzes will be held at the start of each recitation session and will cover material contained on the previous week's homework. These quizzes will take 25 minutes and contain one question at the level of a midterm exam question. Students may not use any additional material (including phones, laptops, etc.) during that 25 minutes.

- If a student is satisfied with their response, they can turn in the quiz then for up to full credit.
- If the student feels they need more time to construct a satisfactory response, they can submit a response by Monday morning (before class) via Gradescope for up to 80% credit.

²in reality, the method that provides the highest score will be chosen automatically

³Note that the last test will be comprehensive

The response will be graded on correctness.

If a student does not attend recitation, the quiz question will be released Friday afternoon, and they have the same opportunity for 80% credit.

In line with the 3 allowed recitation absences (see below), students must inform the instructor before Monday morning if they would like to use a recitation token, only one token can be used per module.

3.3 Homework

3.3.1 Oral Homework

Throughout the semester, several homework assignments will be oral (non-written), and nothing will be submitted via gradescope.

You will be asked to work in groups of 3 students, each of the oral homework assignments will have 3 questions. During your time with an instructor they will choose one person to answer each question. That person will have 15 minutes and a whiteboard available, only the instructor may ask questions during this time. After the 15 minutes (or when the explanation is complete), the other team members may help and/or make corrections to the solution presented. A grade will be assigned based on the explanation of all 3 problems with variance given when incorrect solutions are corrected.

The timeline for oral homework are as follows, assume oral homework sessions are Wednesday-Friday (call these days T+1-T+3):

- **Day T-8 (Tuesday):** The homework assignment will be released on as normal
- **Day T-6 (Thursday, 00:00):** Time slot sign-ups will be released on Canvas
- **Day T-5 (Friday, 23:59):** Time slot sign-ups close
- **Day T-2 (Monday):** Instructor assignments and room locations will be sent to teams

3.3.2 Written Homework

Homework assignments are due (via Gradescope) at the end of the day on Thursday, the next homework will be assigned by Friday morning. **No late homework will be accepted — turn in what you have completed.** If you will miss class, turn in the homework early.

Students may drop two (2) written homework assignments through the semester with no penalty, at most one per module. *No other exceptions to homework submissions will be allowed.* Students must notify the instructional staff of drops *before* grades are released for that homework if something was submitted, or *within two weeks of the deadline if nothing was submitted.*

What to turn in:

- Answers to homework problems should be written concisely and clearly. Homeworks must be submitted as PDFs. Instructions for submission will be posted on the course webpage. Mathematical notation must be formatted as such (your document should have something like $H_e(x)$ not $H_e(x)$).
- Homework problems that ask for an algorithm should present: a clear English description without pseudocode, an argument that the algorithm is correct, and an analysis of the running time. Note: your goal is to explain the algorithm to a human, not a computer — as such detailed pseudocode or source code is usually *not* the best way to explain an algorithm.

It's a good idea to structure the response to these questions with those three sections explicitly labeled:

- Algorithmic Description
- Correctness Argument
- Running-time Argument

Consultation with your peers

- For written homework you may discuss homework problems with classmates. You must list the names of the class members with whom you worked at the top of your homework. **You must write up your own solution independently!**
 - “Independently” means — at least — that you cannot look at another person’s homework,
 - you cannot have them look at yours to see if it is correct,
 - you cannot take detailed notes from a discussion and edit them into your homework, and
 - you cannot sit in a group and continue discussing the homework while writing it up.

The intent of this rule is: you can gather around a whiteboard with your fellow students and discuss how to solve the problems. Then you must all walk away and write the answers up separately. Note: it’s really the exams that count for most of your grade, so there’s little benefit in writing down a homework answer that you don’t understand.

You may *never* use, look at, study, or copy any answers from previous semesters of this course.

Cheating policy

All work must be the submitting student's own. Unauthorized collaboration or **plagiarism** will result in a negative grade (e.g., a homework worth 100 points will be factored in as a -100 points towards the violating student's final grade) and will be reported to the student's academic advisor and dean.

See Section 5.

Use of Generative AI for Written Homework. It is understood that Generative AI can be a useful tool in clarifying existing writing. That said, multiple studies have shown that while perception of learning when aided by AI in upper level CS courses increases, the demonstrated learning does the opposite. To best support students' own learning, all graded assignments in this course should be completed by the student themselves. The use of AI should be limited to clarifying writing and not fully answering questions.

Students should refrain from using AI tools to generate any content directly (text, video, audio, images, code, etc.) for an assignment or classroom exercise. Passing off any AI generated content as a student's own (e.g., cutting and pasting content into written assignments, or paraphrasing AI content) constitutes a violation of CMU's academic integrity policy⁴.

For any questions about using generative AI in this course please email or talk to the instructions staff.

Regrading of Assignments In the event that an assignment was graded incorrectly, request for regrading must be made in writing within one week of receiving the graded material through the Gradescope regrade system. By asking for the assignment to be regraded, the whole assignment will be regraded and it is possible that fewer points may be awarded than the previous grade in light of new consideration.

3.4 Attendance & Participation

Lecture Attendance in lectures is not explicitly graded, but anything covered in lecture may be included in homework assignments and exams. This includes material not covered in the course readings or in the lecture notes and slides distributed online. You do not need permission to miss a lecture, and can use your judgment about when something else takes priority for you, but you should not expect to do well in the class if you do not see and pay attention to the lectures. Students are expected to read assigned material before lectures and to attend all lectures.

All classes will be live. To minimize disruptions and in consideration of your classmates, I

⁴<https://www.cmu.edu/policies/student-and-student-life/academic-integrity.html>

ask that you please arrive on time and do not leave early. If you must do either, please do so quietly. Laptop use is discouraged — their use detracts significantly from the benefit of coming to class (wouldn't it have been more fun to spend an hour surfing Facebook at home?) and also provides a distraction for other students.

Recitation Attendance is mandatory and forms part of the grade. Students may miss 3 recitations without penalty.

3.5 Frequently Asked Questions

Is there some extra work I can do to improve my grade?

No, we cannot make exceptions to the course work and grading policy. If you are concerned about your grade, please see me or one of the TAs ASAP. There will be no exceptions to this policy during or after the class has completed.

I have to be out of town, and I would like an extension on my homework. Can I have one?

No. This is a very large class, and it is not possible to accommodate individualized deadlines for everyone. You can always turn your homework in early (if the link is not available, please ask a TA). You can also always turn your homework in remotely since we will use Canvas to submit homeworks.

4 Expectations

- Please note, the use of cell phones is not permitted during lecture. These should be left in a backpack or not brought to class.
- Laptop computers may be used for taking notes or for in-class assignments but cannot be used for other activities during lecture.
- No student may record any classroom or laboratory activity without the express written consent of the instructor. If a student believes that they are disabled and needs to record or tape classroom activities, they should contact the Office of Equal Opportunity Services, Disability Resources to request an appropriate accommodation.

Please keep in mind that these guidelines are necessary to maintain an environment that is safe and conducive for learning.

4.1 Expectations of Students and Instructors

The instructors and teaching assistants have the right to expect the following of students: (Adapted and modified from those developed by [Howard Culbertson at Southern](#)

Nazarene University).

1. Students will arrive to class on time and will be prepared for the lecture.
2. Students will turn in assignments on time (see policy on assignment due dates).
3. Students will immediately inform the instructor or the teaching assistants if extenuating circumstances prevent the student from attending a lecture.
4. Students will follow the code of conduct regarding academic integrity, cheating, plagiarism, and collaboration as outlined in the syllabus.
5. Students will seek assistance when they need it.
6. If contacted by the instructor or teaching assistant, students will respond within 24 hours during the week and 48 hours on weekends.

The students have the right to expect the following of the instructor and teaching assistants:

1. A syllabus that describes class procedures, policies, and a course description will be provided.
2. Class sessions that will start and end on time.
3. Any changes to the course schedule will be provided to the students within 48 hours of the change.
4. The instructor will be available outside class either during their posted office hours or during other pre-arranged times.
5. If contacted by a student, the primary instructors or teaching assistants will respond within 24 hours during weekdays and 48 hours on weekends.

5 Academic Integrity

(See: <https://www.cmu.edu/policies/student-and-student-life/academic-integrity.html>)

Students in all CMU programs, because they are members of an academic community dedicated to the achievement of excellence, are expected to meet the highest standards of personal, ethical, and moral conduct possible. These standards require personal integrity, a commitment to honesty without compromise, as well as truth without equivocation, and a willingness to place the good of the community above the good of the self. Obligations once undertaken must be met, commitments kept. Rarely can the life of a student in an academic community be so private that it will not affect the community as a whole or that the standards above do not apply. The discovery, advancement, and communication of knowledge are not possible without a commitment to these standards. Creativity cannot exist without acknowledgment of the creativity of others. New knowledge cannot be developed without credit for prior knowledge. Without the ability to trust that these principles will be observed, an academic community cannot exist. The commitment of its faculty, staff and students to these standards contributes to the high respect in which the CMU degree is held. Students must not destroy that respect by their failure to meet these standards. Students who cannot meet them should voluntarily withdraw from this course.

5.1 Cheating and Plagiarism

Students in at CMU are engaged in preparation for professional activity of the highest standards. Each profession constrains its members with both ethical responsibilities and disciplinary limits. To assure the validity of the learning experience a university establishes clear standards for student work. In order to deter and detect plagiarism, online tools and other resources are used in this class. In any presentation, creative, artistic, or research, it is the ethical responsibility of each student to identify the conceptual sources of the work submitted. Failure to do so is dishonest and is the basis for a charge of cheating or plagiarism, which is subject to disciplinary action.

Cheating includes but is not necessarily limited to:

1. Plagiarism, explained below.
2. Submission of work that is not the student's own for papers, assignments, or exams.
3. Submission or use of falsified data.
4. Theft of or unauthorized access to an exam.
5. Use of an alternate, stand-in or proxy during an examination.
6. Use of unauthorized material including textbooks, notes or computer programs in the preparation of an assignment or during an examination.
7. Supplying or communicating in any way unauthorized information to another student for the preparation of an assignment or during an examination.
8. Collaboration in the preparation of an assignment. Unless specifically permitted or required by the instructor, collaboration will usually be viewed by the university as cheating. Each student, therefore, is responsible for understanding the policies of the department offering any course as they refer to the amount of help and collaboration permitted in preparation of assignments.
9. Submission of the same work for credit in two courses without obtaining the permission of the instructors beforehand.

Plagiarism includes, but is not limited to, failure to indicate the source with quotation marks or footnotes where appropriate if any of the following are reproduced in the work submitted by a student:

1. A phrase, written or musical.
2. A graphic element.
3. A proof.
4. Specific language.
5. An idea derived from the work, published or unpublished, of another person.

Any disciplinary actions regarding charges of cheating or plagiarism will follow the procedures of the home university of the student involved.

Collaboration vs. Cheating Collaboration is defined by Merriam-Webster's Collegiate Dictionary (10th edition) as "to work jointly with others or together, especially in an intellectual endeavor." Much of the work that is performed in this laboratory (and in

biomedical research as a whole) is collaborative in nature. Therefore, collaboration in this class is encouraged during the execution of the labs. In addition, discussion regarding the content of homework assignments is also encouraged.

Discuss the course material, concepts, and assignments with other students in the class is encouraged. **However, each student must eventually submit his/her own unique work (e.g., laboratory notebook, final report).** If any collaboration was used to complete an assignment, record the names of the collaborators and the nature of the collaboration. Any attempt to submit work that is not the student's own work will be considered an act of cheating. In addition, any student who knowingly supplies their homework assignment for review to another student is violating the cheating policy and will be subject to disciplinary action.

ANY VIOLATION OF THIS POLICY WILL NOT BE TOLERATED AND THE PENALTY WILL BE FAILURE IN THE COURSE.

Any questions regarding this policy should be directed to the instructors.

6 Resources

6.1 Accommodations for Students with Disabilities

If you have a disability and have an accommodations letter from the Disability Resources office, we encourage you to discuss your accommodations and needs with me as early in the semester as possible. We will work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, we encourage you to contact them at access@andrew.cmu.edu.

6.2 Statement of Support for Students' Health & Well-being

Take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress. All of us benefit from support during times of struggle. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is almost always helpful. If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website at <http://www.cmu.edu/counseling/>. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.

If you or someone you know is feeling suicidal or in danger of self-harm, call someone immediately, day or night:

CaPS: 412-268-2922

Re:solve Crisis Network: 888-796-8226

Suicide and Crisis Lifeline: 988

If the situation is life threatening, call the police

On campus: CMU Police: 412-268-2323

Off campus: 911

6.3 Diversity Statement

We must treat every individual with respect. We are diverse in many ways, and this diversity is fundamental to building and maintaining an equitable and inclusive campus community. Diversity can refer to multiple ways that we identify ourselves, including but not limited to race, color, national origin, language, sex, disability, age, sexual orientation, gender identity, religion, creed, ancestry, belief, veteran status, or genetic information. Each of these diverse identities, along with many others not mentioned here, shape the perspectives our students, faculty, and staff bring to our campus. We, at CMU, will work to promote diversity, equity and inclusion not only because diversity fuels excellence and innovation, but because we want to pursue justice. We acknowledge our imperfections while we also fully commit to the work, inside and outside of our classrooms, of building and sustaining a campus community that increasingly embraces these core values.

Each of us is responsible for creating a safer, more inclusive environment.

Unfortunately, incidents of bias or discrimination do occur, whether intentional or unintentional. They contribute to creating an unwelcoming environment for individuals and groups at the university. Therefore, the university encourages anyone who experiences or observes unfair or hostile treatment on the basis of identity to speak out for justice and support, within the moment of the incident or after the incident has passed. Anyone can share these experiences using the following resources:

Center for Student Diversity and Inclusion: csdi@andrew.cmu.edu, (412) 268-2150

Report-It online anonymous reporting platform: reportit.net username: tartans password: plaid

All reports will be documented and deliberated to determine if there should be any following actions. Regardless of incident type, the university will use all shared experiences to transform our campus climate to be more equitable and just.