Course Manual

CAS CS 132: *Geometric Algorithms*

Boston University

Spring 2026

Contents

Course Code	`CAS CS 132`
Course Title	Geometric Algorithms
Semester	Spring 2026
Instructor	Nathan Mull
Teaching Fellow	Angelo Poulis
Course Assistants	Gor Matcakian and Helen Zhou
Meeting Time	Tuesday and Thursday, 11:00AM-12:15PM (A1)
Meeting Location	CAS B12
Midterm Date	March 5 (during lecture)
Grade Breakdown	15% Assignments
	15% Labs
	10% Workshops
	20% Quizzes
	20% Midterm Exam
	20% Final Exam

Figure 1: Course overview

Abstract

This is a manual for the course `CAS CS 132`: *Geometric Algorithms*. It contains a general overview of the course and its policies. It does *not* contain specifics about the material covered in the course; this appears on the course webpage. Figure 1 contains an overview of the course.

Week 0 To-Do list

You should complete the following items within the first 48 hours of the start of the semester. Please reach out if you have concerns about any of the items listed.

- ☐ Verify that you have access to a laptop computer during the semester
- ☐ Verify that you know where the lecture is held
- ☐ Verify that you know where the discussion section in which you're registered is held
- ☐ Join Piazza with the following sign-up link
- ☐ Join Gradescope with the following sign-up link (Entry code: 6XXVDP)
- ☐ Familiarize yourself with the course webpage
- ☐ *(Optional)* Add Piazza, Gradescope, and course webpage as bookmarks in your Internet browser
- ☐ Review the course calendar and determine which office hours you're able to attend
- ☐ *(Optional)* Add the course calendar to your own calendar
- ☐ Read this manual in its entirety
- ☐ Submit the assignment on Gradescope confirming that you've read this manual
- ☐ If necessary, review basic programming concepts from `CAS CS 111`: *Introduction to Computer Science* or an equivalent course
- ☐ If necessary, review how to solve systems of linear equations (also called *simultaneous equations*) in 2-4 variables.

General Information

`CAS CS 132`: *Geometric Algorithms* is an introduction to **linear algebra** with a bent towards applications in computer science. One of its primary goals is to prepare students for courses in the computer science curriculum at BU that require linear algebra. Due to the fundamental nature of linear algebra—in machine learning, in graph algorithms, in optimization, in graphics—this list of courses is substantial; the following are recently taught that have `CS132` as a prerequisite:

- `CAS CS 365`: *Foundations of Data Science*
- `CAS CS 440`: *Introduction to Artificial Intelligence*
- `CAS CS 480`: *Introduction to Computer Graphics*
- `CAS CS 506`: *Data Science Tools and Applications*
- `CAS CS 531`: *Advanced Optimization Algorithms*
- `CAS CS 541`: *Applied Machine Learning*
- `CAS CS 581`: *Computational Fabrication*
- `CAS CS 582`: *Geometry Processing*
- `CAS CS 585`: *Image and Video Computing*

It should be made clear at the offset that this is *not* a course on computational geometry in the traditional sense; we will not cover topics like triangulation, mesh generation, geometric data structures, or convex programming.[1] Instead, we'll be covering topics within the scope of linear algebra proper, like matrix factorization, eigenvectors and eigenvalues, Markov chains, linear regression, and singular value decomposition (SVD). The "geometric" part of the course title comes from the way we'll learn to think geometrically, and how linear algebra helps us recognize the utility of conceptualizing data *spatially*. Professor Mark Crovella has a note on this in the preface of the text we'll be using for this course, which we recommend reading at the start of the semester.

This course is run as a hybrid math-and-computer-science course. There are handwritten assignments in the style of a courses like `CAS MA 123`: *Calculus I* and programming assignments in the style of courses like `CAS CS 111`: *Introduction to Computer Science I*. So you'll need to be comfortable both with mathematical formalism and basic programming concepts.

Our primary goal is not to teach specific techniques and tools, but to teach a way of reasoning about data and mathematical structures. However, a deep dive into any mathematical subject requires some amount of rote practice and memorization (of specific techniques and tools). Before continuing we'd simply like

[1] In spite of the out-dated description of the course in our registrar.

to emphasize that we're passionate about this topic, and we hope that, as difficult as this class may be at times, there's some (type 2) fun to be had. We look forward to learning with you all.

2.1 Prerequisites

The formal prerequisites for this course are:

- `CAS MA 123`: *Calculus I*
- `CAS CS 111`: *Introduction to Computer Science*

What we are looking for in an incoming student of this course is basic competence in programming and general mathematical maturity at the level of a first course in calculus.[2] We expect proficiency in the programming language Python at the level of a first course in computer science. If you have not used Python, then you'll have to learn it within the first week of the course; we will *not* be covering basic programming concepts.

We also expect that you know how to solve systems of linear equations in 2-4 variables; this topic is covered in most high school algebra curricula, sometimes under the name *simultaneous equations*. We'll provide notes and references to review this material.

2.2 Learning Objectives

From this course we hope that you will:

- Learn the basic concepts of linear algebra, which can be applied to a wide range of fields including abstract algebra, mathematics modeling, numerical analysis, theoretical computer science, data science, machine learning, optimization, and graphics.
- Internalize the language and terminology of linear algebra, particularly how to use this language to discuss concepts in the aforementioned fields of mathematics and computer science.
- Practice using the programming tools which depend on linear algebraic concepts and are ubiquitous in the aforementioned fields.
- Develop the intellectual toolkit required to take more advanced courses in the CS department at BU, and also to self-learn related concepts. In particular, our primary goal is not to memorize (though this is also important) but to *solve problems*.

`CS132` fulfills a single unit in BU Hub areas **Quantitative Reasoning II** and **Digital/Multimedia Expression**. We believe the first distinction is obvious; any use of mathematics to reason rigorously about real-world problems exercises the kinds of skills expected of this Hub requirement. To further emphasize this point: we're not only interested in the mathematics of linear algebra, but also in it's application to problems like population dynamics, market prediction, machine learning, data visualization, and generally a wide range of social and engineering problems.

The second distinction requires justification: as we use linear algebraic tools to analyze problems and systems, we'll also use visualization tools to *see* what our analysis tells us. This is why the "geometric" part of this course is so important: it opens the possibility for us to use our spatial intuitions in situations where these intuitions don't obviously apply. Learn to harness this skill is more art than science.

[2] You don't need to remember the details of calculus in order to be successful in this course.

2.3 Course Structure

Lectures

We hold lectures each week on Tuesday and Thursdays (see the registrar and the course webpage for details). During lecture, we cover the material that is presented in the reading, do live coding examples, and provide practice problems. The material used in the lecture is made available on the course webpage before the lecture meeting. Barring technical difficulties, recordings of the lecture will be made available.

We won't take attendance during lecture (except during worshops—see below for details) but it is highly recommended that you attend, and we refer you to the BU Attendance policy. You'll be expected to participate in lectures by working on practice problems and occasionally discussing topics with the people sitting around you.

Workshops

Six lectures during the semesters will be run as workshops. This means that you will be expected to do some at-home learning beforehand; we will spend a majority of the lecture time working on an in-class activity in groups. We will take attendance insofar as you will have to submit the required material by the end of lecture.

Discussion Sections

We hold discussion sections each week on Monday (see the registrar and the course webpage for details). The discussion sections have two purposes. On some weeks they will introduce the programming-based labs (see below for details). On other weeks there will be proctored quizzes (see below for details). As with lectures, we won't take attendance during discussion sections, but it is highly recommended that you attend.

2.4 Resources

Material

We'll primarily be using the online text written by Professor Mark Crovella for this course. The text is a jupyter notebook which you can access online. All supplementary material will be made available on the course webpage.

Much of the material in this online text is based on the textbook *Linear Algebra and its Applications* by David Lay, Steven Lay and Judi McDonald. We recommend taking a look at this textbook if you need extra practice, particularly because of the number of exercises in it. We'll also occasionally refer to Interactive Linear Algebra, a beautiful text out of Georgia Tech by Dan Margalit and Joseph Rabinoff. Neither of these texts are formal requirements of the course.

Programming

The programming in this course is done in Python with the libraries: NumPy, SciPy, NetworkX, scikit-learn, and matplotlib. You're required to set this up on you personal machine or on a machine that you'll have access to throughout the semester. You'll have an opportunity to do this in your first discussion section. Please attend office hours and use Piazza if you need help troubleshooting. If you're worried about access

to technology, please contact us as soon as possible and we can see what we can do, though we cannot make any guarantees.

Course Communication

Course announcements and discussions will happen on Piazza. If you're unfamiliar with Piazza, see their support page for information and tutorials. Some policies regarding the use of Piazza:

- *Don't ask homework questions directly.* Formulate a question which will aid in your understanding, and will hopefully help others as well.
- *Don't give homework solutions directly.*
- *Piazza is as useful as it is active.* Teaching fellows and course assistants will be answering questions on Piazza, but don't hesitate to answer questions yourself.

Make sure to set notifications correctly so you can keep up with updates regarding the course. "I didn't see the Piazza post about it" is never a valid excuse for missing a piece of information.

Submission

We'll be using Gradescope for assignment and lab submissions. If you are unfamiliar with Gradescope, see their Get Started page for information and tutorials.

Evaluation

The grading breakdown for this course is given in Figure 3.1. The sites of evaluation are detailed below. Your raw percentage will be determined according to this breakdown and your final letter grade is guaranteed to be at least what is determined by Wheelock College's Grading Scale.[1] But, to borrow a phrase from Professor Mark Bun: "to correct for the possibility of [quizzes] and exams being more difficult than anticipated, letter grades may be (significantly) increased above these guarantees." Specifically, we may retroactively curve exam and quiz grades using a linear scale.[2]

3.1 Assignments

Assignments are released weekly on Thursdays and are due a week later on the following Thursday by 8:00PM. See Gradescope and the calendar on the course webpage for details. Assignments consist of written problems and are to be submitted as a pdf file via Gradescope. There are 12 assignments total. We drop your lowest two assignment grade, so only 10 assignments count towards your final grade in the course. We don't accept late assignments under any circumstances.

You'll notice that, despite the fact that there are many assignments, they account for a very small portion of your final grade. This is, in part, necessitated by the recent advances in LLMs which can easily solve problems we ask on homework assignments, but it's also a conscious decision we've made to ensure that students are engaging with the material beyond what can be reasonably asked in a homework assignment. You should think of the assignments in this course as *accountability checks* in that they require to engage with the material each week. But the more effort you put into learning and internalizing the material in the assignments the more successful you'll be in the other evaluation sites of the course like the quizzes and exams.[3]

[1] Formally we're part of the College of Arts and Sciences (CAS), but this grading scale is standard.

[2] See this article for details if you're interested.

[3] We understand that this approach to evaluation is not universally liked, and that in-person evaluation can be challenging. We take this into consideration when we calibrate the difficulty of the material and the workload we expect.

15%	Assignments (12 total, 2 dropped)
15%	Labs (6 total, 1 dropped)
10%	Workshops (6 total, 1 dropped)
20%	Quizzes (6 total, 1 dropped)
20%	Midterm Exam
20%	Final Exam

Figure 3.1: Grade breakdown

3.2 Labs

Labs are released every other week on Mondays and are due a week and a half later on the following Thursday by 8:00PM (so that the deadline coincides with the assignment deadline). See the calendar on the course webpage for more details. Labs consist of a programming task, as well as a write-up on the results of the programming task. There are 6 labs total. We drop your lowest lab grade, so only 5 labs count towards your final grade in the course. We don't accept late labs under any circumstances.

The course staff will go over the basic concepts of the labs (and will help you begin the lab) in the discussion sections which fall on lab release dates. We highly recommend you attend these sessions, as they will provide useful context for completing the labs.

3.3 Workshops

Each workshop will have an in-class assignment that you will be required to submit at the end of the lecture period. There are 6 workshops total. We drop your lowest workshop assignment grade, so only 5 workshop assignments count towards your final grade.

3.4 Quizzes

Quizzes occur every other week on Mondays during discussion sections. They consist of 1-4 problems that are similar to the problems that have appeared on previously submitted assignments. If you've completed the assignments and practiced the concepts therein, you're expected to have no problem on the quizzes. There are 6 quizzes total. We drop your lowest quiz grade, so only 5 quizzes count towards your final grade in the course.

Quizzes are 30 minutes long, unless you have disability accommodations which allow for more time, in which case you will be allowed more time. Due to the volume of quizzes and the size of the course we cannot accommodate a separate time and space to take the quizzes.

3.5 Midterm Exam

The midterm exam is held during lecture. It is be a written exam, and is meant to verify that you are prepared to apply ideas from linear algebra to real-world applications in the second half of the course. You should expect the midterm exam to be more difficult than the quizzes.

3.6 Final Exam

The date of the final exam will be determined later in the semester. It will be a written exam and is meant to verify that you've internalized the basic concepts of the course, and can also apply them to solve novel problems. You should expect the final exam to be the same difficulty as the midterm exam.

Policies

There are a number of policies associated with this course, some specific to the course and others which hold more generally in the university.

4.1 Diversity Statement

Our aim is to present material in a way that respects the diversity of the student body. If we fail to do this, please make us aware. Any suggestions are welcome and appreciated. We also expect students to appreciate and respect the unique opportunity they have to participate in a diverse student body like ours.

4.2 Disability Statement

If you require disability accommodations, please contact us as soon as possible. You should provide us with the appropriate documentation, available through the Disability and Access Services. In order to receive accommodations, you *must* be in contact with us.

If there's a policy that we're failing to comply with, please reach out with suggestions. And if you'd like accommodations that aren't covered by existing services or policies, feel free to contact us and we can see what we can do. We want everyone to feel able to fully participate in the course.

4.3 Sexual Misconduct

Please read the Sexual Misconduct Policy and review the entire page for information on talking to someone confidentially about experiences of sexual misconduct, filing a report, and any other relevant information. Above all, you should feel safe, and able to be productive. If this is not the case, please reach out to us or someone else immediately.

The members of the course staff are considered "mandated reporters" and are required to report cases of sexual misconduct. Therefore, **we cannot guarantee the confidentiality of a report**. We must provide our Title IX coordinator with relevant details such as the names of those involved in the incident. The university will consider a request for confidentiality and respect it to the extent possible.

With that in mind, if you come to any of us with questions or concerns, we will handle the situation to the best of our ability and connect you with available resources.

4.4 Academic Integrity

Please read the Academic Conduct Code and review the entire page for information about what constitutes academic dishonesty and what penalties arise as a result of violations of this code. This is taken very

seriously at BU and we take it seriously in this courses. There are a couple policies about which we'll be strict:

- You must submit your own work for all assignments and labs. Submitting the same file as another student, or something notably similar (e.g., identical wording or code in large parts of the solution) is considered academic misconduct and will be handled accordingly.
- Copying or information-sharing regarding in-class evaluations like quizzes and exams is considered academic misconduct and will be handled accordingly.

If you work with others, consult materials found on the Internet, or use an AI assistant, you should cite your sources. This is a useful skill in any setting, and so we recommend being as conservative as possible regarding citations. In an assignment, these citations should appear next to every corresponding problem (in comments if the submission is code). Some examples:

- I discussed problem 1 and 2 with Leah Smith. She helped me understand X and Y aspects of the problem.
- I saw the stack overflow post `stackoverflow.com/questions/6681284/python-numpy-arrays` which informed my solution.
- I helped Zihan Guo with problem 4. I told them to try using X.
- I asked ChatGPT "what's the largest eigenvalue of this matrix?"

When in doubt, err on the side of longer, more descriptive citations. We do not consider missing or poor citations is a direct act of academic misconduct, but we will consider this grounds for further investigation in suspicious cases. Above all, use your best judgment and remember:

- We care about your success in this course. We provide a number of avenues to ask for help, please use them.
- You will have to answer questions on quizzes and exams without external aids (and in interviews when you apply for a job).
- If you don't know how to start thinking about a problem, it's okay to ask for pointers in office hours and on Piazza.
- We have safeguards (like dropped homework assignments) in the case you are unable to complete an assignment. In other words, don't submit someone else's work when you can drop an assignment.

4.5 Generative AI

The problem of generative AI in higher education will likely occupy us for the next decade or so. The role of these tools in our lives is still an open question, one with many possible answers. But these tools exists, and the university, for better or for worse, has made them more accessible with the introduction of TerrierGPT, to which all students of the university have access. As such, all courses (including ours) are changing their policies. Keep in mind that this is all an experiment. We don't know if our policy makes sense in the long term (or even now). But it's our attempt to come to terms with the appearance of these tools in our courses.

This semester, we've re-weighted evaluation sites in order to maintain the policy that *LLMs and AI assistances are allowed for use on assignments and labs*. It has taken us some time to decide on this policy, and

we're still not completely sure that it'll work for us, but it seems inevitable based on the current state of the field.

Of course, part of the reason we've introduced this policy is that these tools are becoming ubiquitous. It's not unlikely that you'll be *expected* to use AI assistants in your future job. Likewise, *nearly all questions that we can ask you on assignments can be easily solved by existing models.* This is why we have quizzes: it's not enough to produce the work for assignments, you have to demonstrate it in a closed-book setting.

An obligatory concluding remark: that existing models can solve our assignments does not negate the value in knowing how to do them without the help of external tools. To draw an imperfect analogy, we don't learn a new language in order to have memorized a vast collection of words and grammar rules, but in order to *internalize* the language, and learn how to *interact* with it and in it. This is our goal in this course and beyond. AI tools can be incredibly useful in the process of learning and internalizing, but the internalizing is what we really want to achieve, so we can look at a problem and *sense* the underlying structure to which we can apply our knowledge from this course.

4.6 Additional Attendance Policies

As we've noted, we won't take attendance in our course. Instead, we remind you that, according to the Attendance policy at BU, you're required to attend the courses in which you're registered.

Absence Due to Religious Observance

According to the BU policy on Absence Due to Religious Observance: you "shall be excused from any such examination or study or work requirement, and shall be provided with an opportunity to make up such examination, study, or work requirement that may have been missed because of such absence on any particular day; provided, however, that such makeup examination or work shall not create an unreasonable burden upon such school."

Bereavement

According to the BU policy on Student Bereavement: you "should be granted up to five weekdays of bereavement leave for the death of an immediate family member." Your advisor should help you coordinate your leave.

4.7 Additional Grading Policies

Regrade Requests

Regrade requests may be submitted on Gradescope for up to one week after receiving the grade for an evaluation site. Regrade requests will only be considered in the case that the grader has made a mistake in grading. Any regrade requests which solely appeal for a higher grade will not be considered.

Grading Grievances

According to the BU policy on Grade Grievances: you may "contest a final course grade received in a unit-bearing Boston University course when that grade is alleged by the student to be arbitrary." Read the policy for more information. We recommend contacting us before submitting a formal appeal.

Incomplete Grades

According to the BU policy on Incomplete Coursework: "An incomplete grade (I) is used only when the student has conferred with the instructor prior to the submission of grades and offered acceptable reasons for the incomplete work. An incomplete grade may be appropriate when the student has participated in and completed requirements representing a majority of the course, and circumstances prevent the student from completing remaining requirements by the conclusion of the course." In particular, **you must contact us before the last day of the semester in order to receive an incomplete grade.**

Closing Remarks

Quite a bit goes into organizing a course as well as taking a course. In light of my comments on citations, I'll note that much of what's in this document is based on similar documents (often taken without permission) by Mark Crovella, Mark Bun, Jonathan Appavoo, Preethi Narayanan, Ravi Chugh, Andrew McNutt, and others we may be missing. All told, we hope that most of this logistical information will be overshadowed in your memory by the concepts of the course, and that we can focus on having a good time doing math and programming.

5.1 Course Agreement

In addition to a manual, we also consider this document a contract. The following is what you must agree to in order to remain in this course.

> *By enrolling in this course, I am agreeing to the policies outlined in this document, and I will uphold them to the best of my ability. I will also, generally speaking, try to be a reasonable person and be nice and good and respectful to the people around me taking—and running —the course. In return, I expect a high-quality learning experience and respect from those around me taking—and running—the course.*

5.2 University Resources

There are quite a few BU resources, it can sometimes be overwhelming. Here's a small list of the ones we think are important. If you're struggling in this course due to personal/health conditions, we can't guarantee we can help, but if you're comfortable reaching out, feel free to send us an email and we can see if we can point you towards the correct resources. If you're not comfortable reaching out to us, that's okay too, hopefully this list can help you find what you need. Also, keep in mind you can post anonymously on Piazza if you want to ask for help without including your name.

- Disability and Access Services
- Student Health Services
- Outreach and Prevention
- Behavioral Medicine
- Survivor Support (SARP)
- Educational Resources Center
- International Students & Scholars Office