CAS CS 132
Geometric Algorithms
Spring 2015

Meeting Place: CAS 313

Meeting Time: TR 3:30 – 5:00 pm

Instructor: Prof. Mark Crovella

- **Office:** MCS-140E
- **Office Hours:** W 3-4, F 2-3
- **Email:** crovella@bu.edu

Teaching Fellow: Mr. Qinxun Bai

- **Office Hours:** T 5-6:30, F 4-5:30
- **Office Hours Location:** MCS B29
- **Lab Tutoring Hours:** R 5-6, F 2-3
- **Email:** qinxun@bu.edu

Overview of the Course

This course will introduce you to linear algebra from an algorithmic standpoint. Linear algebra is such a useful tool that it is crucially important to a number of areas in Computer Science. For example, if you study optimization, the starting point is linear algebra. If you study computer graphics, the language you use every day is linear algebra. If you study the performance of computer systems, you need linear algebra. If you study algorithms – especially graph algorithms – you will absolutely need linear algebra. If you study data mining, you will use linear algebra all the time.

The dominance of linear algebra arises because it is so fundamental, and in some ways, very simple. It deals with objects that almost always can be interpreted geometrically. So often we can use linear algebra in a very intuitive manner – so much so that many times it is actually the best way to think about geometric problems. But it is also rigorous and so captures situations that sometimes we would overlook if we were proceeding purely intuitively. This is because it is also about solving equations, and finding solutions to various kinds of problems. So the advantage of being basic and fundamental is that it can be used and applied in so many ways.

Readings

The textbook for the course is David C. Lay, *Linear Algebra and Its Applications* (LAA), 4th edition. Many assignments will be taken from the book.

Web Resources

The slides I use are actually executable python scripts, using the `ipython notebook`. If you have ipython notebook, you can download and execute the examples on your own computer, and you can modify them any way you'd like, play around with them, experiment, etc.

The slides I use in lecture are published on `github`. The repository is `https://github.com/mcrovella/CS132-Geometric-Algorithms`. Mr. Bai will describe how to access the repository using `git`, but you can simply download directly from the web site if you prefer.

Reading and Homeworks

1. You have about 10-12 pages of reading for each class. Class will be more understandable if you do the reading first. A good plan is to set aside time on Mondays and Wednesdays to do readings.
2. Homeworks will be assigned on Thursdays.
3. Homeworks are due at 3:30 pm on Tuesdays. This means they are due before the start of Tuesday's class.
4. You can discuss homeworks in section meeting on Mondays. But don't expect that Mr. Bai will be going into detail – instead, he will answer specific questions!
5. Homeworks will be submitted via *websubmit* (instructions in class).

Piazza

We will be using Piazza for class discussion. The system is highly tuned to getting you help fast and efficiently from classmates, Mr. Bai, and myself. Rather than emailing questions to the teaching staff, I encourage you to post your questions on Piazza. Our class Piazza page is at: `https://piazza.com/bu/spring2015/cs132/home`. We will also use Piazza for distributing materials such as homeworks and solutions.

When someone posts a question on Piazza, if you know the answer, please go ahead and post it. However pleased *don't* provide answers to homework questions on Piazza. It's OK to tell people *where to look* to get answers, or to correct mistakes; just don't provide actual solutions to homeworks.

Programming Environment

We will use `python` as the language for teaching and for assignments that require coding.

Clickers

We will be using "Peer instruction" as part of the lectures. This requires you to answer occasional questions during lecture, sometimes after discussion with your classmates.

To support this, we will use clickers for student feedback during lecture. If you don't already have one, you need to get one. It is the Turning Technologies Response Card RF (ISBN 9781934931394). This is the standard "BU clicker" and you can get it at the BU Bookstore. You will need to bring it to every lecture.

Also, to encourage this interactive style of lecture, I will ask you to put away laptops and phones during lecture. Please note that I will post copies of lecture slides online for you to consult after class if you like.

You will also want to bring pencil and paper to lecture. This isn't absolutely critical, but you will find it easier if you can jot a note or two while responding to clicker questions.

Course and Grading Administration

Assignments will be submitted using `websubmit`. Mr. Bai will explain how to submit assignments.

NOTE: IMPORTANT: Late assignments **WILL NOT** be accepted. However, your final grade will be based on the top 10 homeworks submitted (out of 12).

Final grades will be computed based on the following:

60% Homework assignments. The top 10 homework grades (out of the 12 assigned) will be used to compute this score.

5% Attendance and In-class participation via clicker.

10% Midterm

25% Final (Cumulative)

To get full credit for class participation by clicker, you need to use the clicker on 85% of the questions that are posed in lecture. So if you miss a question here or there, or forget your clicker one day, don't worry as long as you come to lecture consistently.

The exact cutoffs for final grades will be determined after the class is complete, but you can assume that they will approximately follow the typical pattern in which scores of 85-100 are in the A range (A-, A, A+), 70-85 are in the B range (B-, B, B+), and 60-70 are in the "counting" C range (C, C+).

This grading policy implies the following:

1. You need to consistently work the problem sets each week. Plan to set aside a regular time each week to do them.

2. The final, which is cumulative, is important to getting a good final grade. You could conceivably miss or fail the midterm and still do reasonably well (but I don't recommend counting on this strategy).

Academic Honesty

You may discuss homework assignments with classmates, but you are solely responsible for what you turn in. Collaboration in the form of discussion is allowed, but all forms of cheating (copying parts of a classmate's assignment, plagiarism from books or old posted solutions) are NOT allowed. We – both teaching staff and students – are expected to abide by the guidelines and rules of the Academic Code of Conduct (which is at `http://www.bu.edu/dos/policies/student-responsibilities/`).

You can probably, if you try hard enough, find solutions for homework problems online. Given the nature of the Internet, this is inevitable. Let me make a couple of comments about that:

1. If you are looking online for an answer because you don't know how to start thinking about a problem, talk to Mr. Bai or myself, who may be able to give you pointers to get you started. Piazza is great for this – you can usually get an answer in an hour if not a few minutes.

2. If you are looking online for an answer because you want to see if your solution is correct, ask yourself if there is some way to verify the solution yourself. Usually, there is. You will understand what you have done *much* better if you do that.

3. If you are looking online for an answer because you don't have enough time and are getting close to the assignment deadline, think about this:

   (a) what you are doing is intellectually dishonest,

   (b) you are going to have to solve problems like this on the midterm and final, and

   (c) you can miss up to two homeworks without penalty.

   So ... it would be better to simply submit what you have at the deadline (without going online to cheat) and plan to allocate more time for homeworks in the future.

Course Schedule

IMPORTANT: It is important to do the reading *before* the class on which it is based. All readings are from LAA.

Date	Topics	Reading	Assigned	Due
1/20	NO CLASS			
1/22	1: Linear Equations	1.1	H1	
1/27	SNOW DAY			H1
1/29	2: Row Reduction	1.2	H2	
2/3	3: Vector Equations	1.3		H2
2/5	4: $Ax = b$	1.4, 1.5, 1.6	H3	
2/10	5: Linear Independence	1.7		H3
2/12	6: Linear Transformations	1.8	H4	
2/17	Substitute Monday - NO CLASS			
2/19	7: The Matrix of a Linear Transform	1.9	H5	H4
2/24	8: Matrix Operations	2.1		H5
2/26	9: Matrix Inverse	2.2	H6	
3/3	10: Invertible Matrices	2.3		H6
3/5	11: Matrix Factorizations	2.5		
3/10	Spring Break			
3/12	Spring Break			
3/17	Midterm			
3/19	12: Computer Graphics	2.7	H7	
3/24	13: Subspaces of $\mathbb{R}^n$	2.8		H7
3/26	14: Dimension and Rank	2.9	H8	
3/31	15: Eigenvectors and Eigenvalues	5.1		H8
4/2	16: The Characteristic Equation	5.2	H9	
4/7	17: Diagonalization	5.3		H9
4/9	18: Eigenvectors and Linear Transforms	5.4	H10	
4/14	19: Applications of Eigendecomposition	4.9, 10.2		H10
4/16	20: Inner Product, Length	6.1	H11	
4/21	21: (Guest lecture) Orthogonal Sets	6.2		H11
4/23	22: Projections	6.3	H12	
4/28	23: Least Squares	6.5		H12
4/30	24: Linear Models	6.6		