

# “Comical” Linear Algebra and Google’s Search Engine

---

Mentor: Jeshu Dastidar, [jdastidar@ucdavis.edu](mailto:jdastidar@ucdavis.edu)

Spring 2025

*“You come to grad school and you think you’re going to prove the Poincaré Conjecture. And then six years later your thesis comes down to computing the entries of a three-by-three matrix.”*

– Vinay Kathotia, motivational speech to incoming Berkeley math grads, 1995.

## Seminar Description

This seminar will be a gentle introduction to *linear algebra*, a branch of math that studies linear equations and their properties; (part of) what makes this gentle is we will be reading a book that is a manga, hence the “comical” in the title. Linear algebra is essential in many areas of STEM fields and has many practical applications (even leading to PhD theses, see the quote above). We will strive toward one such application and get a glimpse into Google’s search engine and how they rank the web pages!

## Prerequisites

There are no strict requirements, mainly curiosity. It will help to know about functions, graphing, and some precalculus. Ideally, you have not taken Math 22A: Linear Algebra since it overlaps with this seminar by a lot and covers these topics in-depth plus more.

## Sources

The Manga Guide to Linear Algebra by Shin Takahashi and Iroha Inoue. Here’s a [sample of Chapter 2](#). I’ll also provide some notes, you don’t need to buy anything.

## Format and Expectations

We will meet once a week as a group for 90 minutes (time/date will be set based on our availability). During these meetings, we will have mini-lectures, small group discussions, and opportunities to collaborate on practice problems and activities. You can volunteer to present practice problems to the group.

I will give readings from the book, which will be like reading a comic and should hopefully be fun and leisurely. I’ll sometimes suggest optional exercises, don’t feel obligated to do them if you do not have time. Your credited coursework should come first and I hope to keep the time commitment outside of seminar meetings minimal.

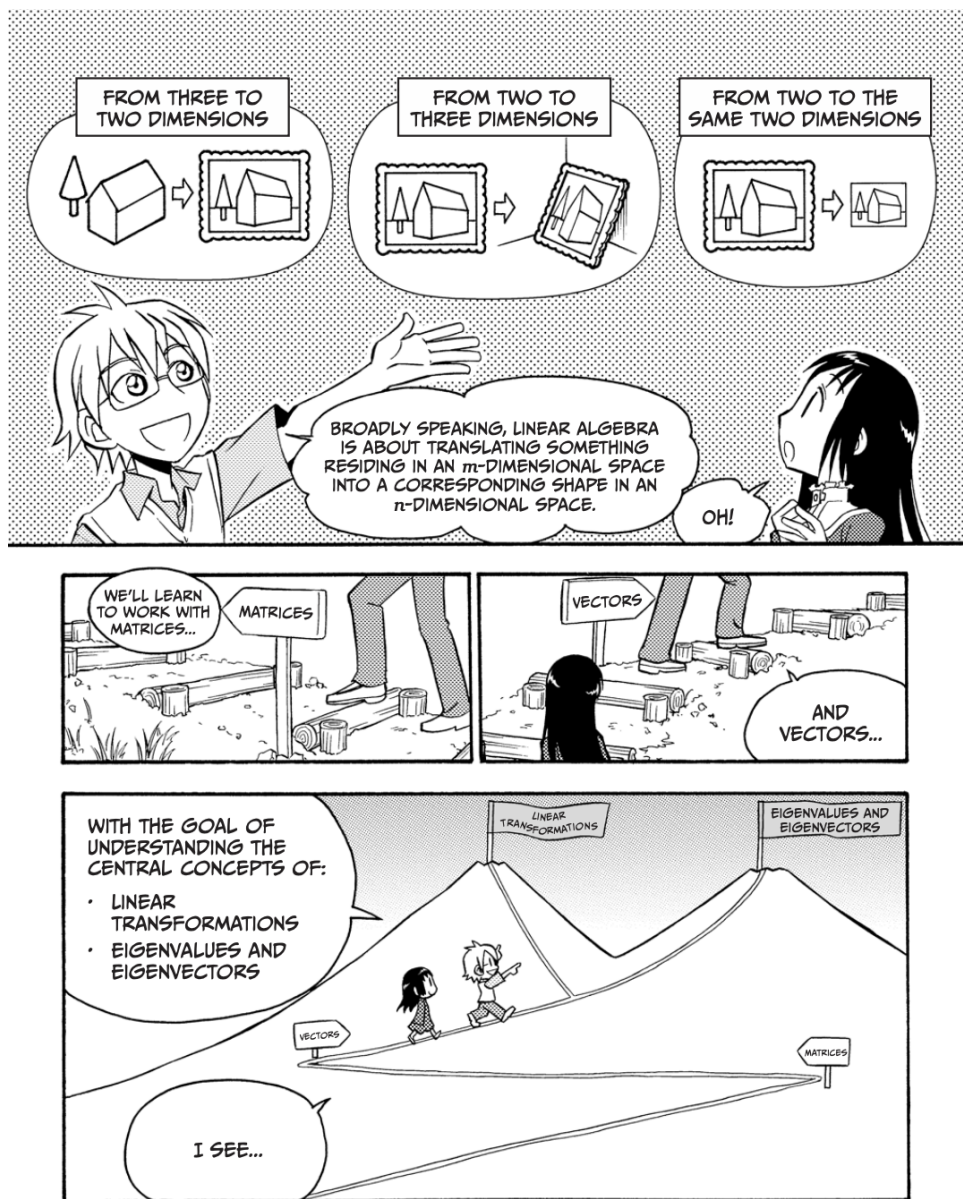
## Learning Objectives

Our goal is to create an environment in which we all feel comfortable contributing our ideas as we explore the land of linear algebra. We will work towards this by asking questions and collaborating to figure out ways to answer them. As a result, we will practice mathematical thinking and gain experience talking about math with others.

**Note.** A bonus takeaway is an appreciation for math and/or that not all math is calculus.

## Seminar Outline

In a nutshell, we hope to cover the topics our protagonist Reiji mentions below.



Here is a tentative week-to-week schedule. It's more important to me that *you and everyone else* understand the material instead of rushing through it. So it's alright if we don't reach the destination, the journey is equally important. :)

### Week 1. What is Linear Algebra?

Introductions, ice breakers, and community agreements.

Overview of linear algebra with some history

Discussion on the fundamentals: numbers, implications, set theory, and functions

- Week 2. **Fundamentals (cont.) and Intro to Matrices**  
 Before – review fundamentals and read matrix calculations  
 Mini-lecture on matrix arithmetic and cool matrices  
 Practice problems
- Week 3. **More Matrices**  
 Before – continue working on practice problems  
 Students present problems  
 Discussion on area of a parallelogram and “determinants”
- Week 4. **Vectors and Degrees of Freedom**  
 Before – think about how you might define dimension  
 Mini-lecture on vectors and dimension + related ideas needed for this  
 Group work on exploring these concepts
- Week 5. **Interesting Functions**  
 Review vectors and dimension of a space  
 Group activity on vector transformation  
 Summarizing these ideas into a definition of “linear transformation”
- Week 6. **Linear Transformations**  
 Mini-lecture on two spaces associated to a linear transformation and a dimension formula relating them  
 Group discussion and practice problems
- Week 7. **Interesting Numbers and Vectors Associated to a Matrix**  
 Before – read page 211–218  
 Group exploration on interesting numbers and vectors  
 Summarizing these ideas into a definition of “eigenvalues” and “eigenvectors”
- Week 8. **Google’s Search Engine**  
 Before – review eigenvalues and eigenvectors  
 Group activity on ranking web pages to show on a Google search!
- Week 9. **TBD**  
 I’m thinking we can use this day as a cushion to review some concepts, happy to talk as a group for what we want to do this week. The one thing for sure is we will celebrate what you have learned this quarter!

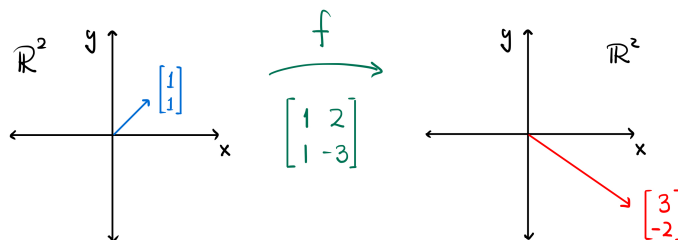


Figure 1: A depiction of vectors (the blue and red arrows), a matrix (the green array of numbers), and a linear transformation  $f$  and how it transforms vectors in  $\mathbb{R}^2$ .