How to Build a Vector Space
A Video Explanation by Henry Jugan

Abstract

The purpose of this project is to animate a video lecture that explains the basics of linear algebra. The project will utilize the manim, numpy, and matlibplot python libraries. The video will begin by defining a vector, describe the concepts of vector addition and multiplication, and then wrap up by showing how these concepts can be used to create a coordinate system.

The video also goes on to give brief explanations of the dot product and cross product. There are intuitive video animations for both operations. After this I give some insight into fun applications of linear algebra. My goal is to create an aesthetically appealing, educational, and engaging animation.

Tools/Resources

The primary tools will be the aforementioned python libraries: manim, numpy, and matlibplot. I referenced each library's documentation website extensively throughout the duration of this project. The non-coding resources will be "Introduction to Linear Algebra" by Gilbert Strang, lecture notes from Dr. Pretel at Santa Barbara City College, lecture notes from the Python DECAL, and the 3blue1brown youtube channel. 3blue1brown's channel has multiple tutorials on how to use manim. I will be using Adobe Premier Pro as my software of choice to edit the video. I want to give a special thanks to Dr. Pretel from SBCC. Not only did I use his lecture notes extensively while working on this project, but I also believe that his class is what cemented my passion for the subject in the first place.

Methods

I began this project by animating all of the necessary scenes for the video. I used an outline from a Dr. Pretel lecture to construct the flow of the video. It also helped me think about which topics seemed most important to cover. After animating all of the scenes, I edited them together in Adobe Premiere Pro. After this, I wrote a script to narrate over the animations. I used the software to record my script and piece the video together.

Analysis

A majority of this project's analysis happened during the coding phase. I had to refer to each python library's documentation extensively. Since I was learning manim from scratch I had to learn the syntax. In addition to this, I taught myself all of the python concepts required to use it (objects, classes, methods, etc.). The library's documentation is still being created, since it is a fan documented project, so I also had to parse complicated code examples in order to understand specific animation sequences/techniques.

There was additional analysis done on the lesson front. I went over all of the concepts that I covered in the video so that I could give pithy and insightful commentary.

Results

The fruits of my labor have been manifested in a fun video animation. Unfortunately it is slightly longer than the maximum 3 minutes, but I hope that will be okay when presenting. Considering I only had 3 minutes to teach the basics of linear algebra, I think I did a pretty damn good job of packing it into one video. The animations are relatively clean, and the video flows pretty well. There are some animations that I don't think turned out super well, but manim is a very difficult library to use. Not only is the syntax non-intuitive, but the puzzle of trying to animate the concepts you visualize is a very difficult one. It's not like

you can just draw on the screen. You have to take the images in your head, and then try to draw them with python!!! It's not easy. I'm really happy with the way the project turned out.