

Throughout the semester taking MA 325 as a course I have grown to learn a lot of important concepts that are not only theoretical in nature but also can be applied to real life situations. Thus, the name of the class Applied Mathematics. The class taught me to take what I learn like calculus and look at it for more than just a graph on paper, rather it taught me how to apply what we have learned in math to real world concepts. Through five different modules I did not only learn how to use concepts of math like calculus and probability in real life situations but also learned how to think critically on how to solve a problem that exists in the real world not just on paper. In addition to application skills I also learned theoretical concepts of how complex mathematical concepts are applied in everyday life like voting, GPS systems, stock markets, and image manipulation.

The class started with module 1 that revolved around reviewing the concepts of calculus needed for the rest of the class. It helped me understand some underlying concepts that I hadn't seen since calculus classes years ago. The main concept of the module involved understanding modern GPS systems and how a receiver is placed compared to satellites in space. The module also covered proper math topics such as regression both linear and non-linear which was needed to understand how the GPS systems work. We use GPS systems in our lives everyday now with going places especially when trying to find new places or when driving. It is hard to imagine life without since we are so reliant on it as it also provides more efficiency than physical maps. However, even though we are heavily reliant on it, hardly any of us know how the system works. This module helped me understand the underlying math of how satellite positioning works and where the receiver needs to be. The regression methods allowed me to calculate a complex system of equations to solve the location of the receiver given a set of satellites. Using regression with calculus, I was able to understand how positioning along with messages work when we use the GPS. How the message goes from a device which can be a receiver to satellites that position the device on the map and find the optimal location. The actual math and details are much more complicated with finding paths, however, this module gave me an insight into how the math we learn on a fundamental level can be used to apply such grand concepts. Using calculus and regression that we have been learning since high school can be used to learn about advanced topics such as global positioning systems and how to navigate. The GPS is one of the biggest inventions in recent history with saving not only time but allowing humans to explore easily without getting lost. At the heart of it there is little math that we learn throughout our lives but fail to understand. This module helped me apply basic mathematical concepts to advanced real world applications.

The second module was about understanding symmetry within geometric objects that we can understand from ordinary differential equations. The module started with understanding differential equations and how simple solutions can be solved. These techniques involved separation of variables and substitution. The module then followed with transformation of planes leading into how symmetries work in ordinary differential equations of simple and higher order. This module was more important for understanding how symmetries work for differential equations which is a concept that would be helpful in higher order mathematics classes. I do not intend to take higher order classes since I was almost done with my mathematics minor, however, understanding the proper differential equations and how they can be symmetrical is an interesting topic that can help us dive deeper into what makes a differential equation and how solutions came about. Since I have taken two classes of differential equations, I was familiar with techniques shown in the module but I had little understanding of the theoretical aspect of symmetry that helps drive solutions. It showed me why such solutions work and what math is involved in creating these solutions. If I have higher order classes for differential equations, I will use tools I learned from this module to understand the theory more in detail.

The third module involved learning about and deriving the Black Scholes Formula using calculus and probability. This formula was useful in understanding the theoretical price of European-style options, more specifically call or put options on the stocks. The idea of the formula was to get investors an estimate of the fair value of an option contract, based on several factors such as current price, strike price, time of expiration, risk free interest rate, and volatility of the stock. All this information, when plugged into the equation, gave a price that helped us determine whether or not to buy the option. This formula is very important when applied in real life since it allows us to predict whether to buy a stock or not depending on how it behaves. This removes guesswork to some degree which can be ideal when trading. For example, it can help us solve problems like whether or not to purchase NVIDIA stock in three months depending on what the option should cost and expected future behaviour. This module was quite interesting and helped me understand more about how stock markets work and how we can remove guesswork just a little bit. From a personal perspective, I want to learn trading and invest in the stock market, however, I want to be safe with money and not guess what I should buy. I was not aware until this module on how to predict prices based on a mathematical model that can help us make a choice with some level of trust. Going forward I will use this model in my trading journey to see if I can predict stock prices and how a stock will behave after some time. This will allow me to get better at trading and hopefully make some

money. Using concepts of calculus and probability, we derived this formula that is used everyday in real life by many traders. The module helped me take concepts of something I am very familiar with and apply it to real life by giving me a chance to predict call options.

The fourth module involved understanding geometry and gerrymandering. More specifically, the module involved using probability, combinatorics, geometry, and different aspects of mathematics to understand current issues in voting. The main concept involved was gerrymandering, the partition of areas for political convenience. I knew the concept of gerrymandering before the module and how the issue existed in the current political government. However, I was unaware of the mathematics combined with geometry that drive the idea of what gerrymandering is all about. For instance, I was unaware there were metrics that are used to determine how gerrymandering is determined and what can be counted as worse than others. The Polsby–Popper score and Minimal Convex Polygon score are examples of scores that help determine what area can be considered gerrymandering. Using this and other concepts of how voting issues work, I learned about problems in how our current system is set up and what we can do to solve it. The issue with gerrymandering is big and a lot of people know this but only a few know the underlying math which allows them to see the issue more in depth. I will take the knowledge from this module and apply it to understand more about geometric shapes and what metrics are used to classify them. I will use my knowledge in pursuit of understanding future problems with voting systems when it comes to land boundaries.

The last module dealt with images and how we can manipulate them using tools like matlab. The math of how geometric shapes work when transformations are applied was used to images to see differences after manipulation. For example, I learned to generate a series of histograms to display the image with multiple levels (2, 4, 8). I also learned image adjustments, thresholding, geometric transformations, metrics, edge detection, and segmentation. Using Matlab, I was able to put these concepts into practice with image manipulation and how we can generate numerous pictures with different configurations to see the differences. This is one of the most important skills that is seen in the real world. Pictures are now universal with everyone wanting to take pictures and wanting to edit them to look great. Using a tool like matlab and important skills I learned in this module, I can manipulate pictures with proper use of transformations and skills of how geometric shapes behave. In the future, I would like to apply these skills anywhere where I need to work with pictures, whether it is to generate different transformations of pictures,

whether it is to combine multiple images to make one, or even find our more detail about a picture.

Over the course of this class I have learned numerous concepts that allow me to understand how mathematics works in the real world. A lot of concepts we learn in college are normally only used since most exams create unrealistic scenarios. However, this class allowed me to use what I have learned, especially topics in calculus and probability to apply it to the real world. I was able to apply them in understanding Global Positioning Systems with how the satellites and receivers work. I also learned about symmetry with ordinary differential equations along with understanding how to predict prices for the stock market using the Black Scholes Formula. Lastly, I also learned more about gerrymandering and issues with our voting system and finishing with learning about image manipulation using Matlab. I will utilize these concepts in the future as needs arise since this class allowed me to use math I have learned and apply it to real world important situations.