Differential Equations and their Applications

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Abstract

In this paper I will describe what I have learned and experienced in my Differential Equations course taught by PhD. William Edward Hahn during the spring of 2022. Artificial intelligence is the future of mankind and the future of every industry on the planet. Learning how differential equations and matrix multiplication apply to neural networks we learned their basic construction and how they learn. We learned how to use current applications and technologies used in the industry.

1 Artificial Intelligence

From the very beginning of computers, artificial intelligence has been envisioned as the future of humanity. Although we have yet to achieve the science fiction visions of A.I., we have taken huge leaps in the past ten years. It was not too long ago when determining between a cat and a dog, or a car and a truck would have been beyond the scope of artificial intelligence. At the core of artificial intelligence is matrix multiplication and vector math and differential equations. When neural networks view data such as images it classifies that image as a matrix with values assigned to each cell.

Neural networks generally follow certain structure or steps when analyzing data. We begin with images which are classified and valued as a matrix, or a 2-D vector. The next step involves a process called convolution. Inspired by natural biology it follows the structure and workings of neurons inside animal brains. While not a simple process, convolution is the dot product and multiplication of the input image (2-D matrix) with certain feature maps, or bias filters, that have been created to acquire different data on each cell inside the image matrix. Afterwards an activation function such as ReLu is used to

remove negative values and the whole process can repeated multiple times. Other functions such as hyperbolic tangent and sigmoid function exist as well. Pooling is then done to condense the matrix and reduce the computations and space required. Finally the data is sent to the fully connected layer already flattened and process called soft activation function which uses probabilities in order for the network to makes a decision on the data.

Using this exact process the class created a basic convolutional neural network to experiment with our own set of data. We learned how to classify and use the data we gathered to have the neural network perform an image classify.

2 Tools and Technologies

While learning about artificial intelligence and neural networks this course, we also learned about some of the tools and technologies associated with the field. The programming code we used with our neural networks was python programming language. Before this year I have never coded or learned about programming so it was a lot to take in at first, but Python programming language is very intuitive and easy to learn how to start using. With the professors help and internet searches I was able to quickly follow along. The code was written on and ran on Google Colab, which allows anybody to write and execute arbitrary python code through the browser, and is especially well suited to machine learning, data analysis and education. Both are completely free and can be used on any browser. To write our reports we learned to use Overleaf, a collaborative cloud-based LaTeX editor used for writing, editing and publishing scientific documents that is easy to use. After creating reports and projects we used GitHub to post and publish our work.

3 Applications and Implications

Artificial Intelligence has infinite applications and implications for our world and the future generations to come. Finding a way to apply artificial should be the goal of every company and corporation. In this course we were challenged to think of ways to bring A.I. into different aspects of life. While creating my report on the use of A.I. I chose sports, mainly boxing and fencing, as my main interest in the implementation of artificial intelligence. In the "Two-minute Paper" titled "This AI Learned Boxing. . . With Serious

Knockout Power" (Gleave, et al. 2020), we can see this learning framework learning to box and fence through millions of learning steps and processes. Through the use of convolution the network was able to learn how to box and fence respectively. The network was fed 90 seconds of motion capture data and left to learn on its own which resulted in complex movements and tactics. The idea of using this same framework and applying it to other sports is the future of sports and something I am very interested in. I believe the application of A.I. in sports is analogous to the Moneyball era in baseball when advanced statistics led to improved performance and projections which culminated in the Oakland Athletics winning the world series and also being one of the best teams in Major League Baseball. This advantage was exploited for years until the rest of the league caught up and had their own advanced statistic department.

4 Individual Project

In this section I will describe my experience constructing my CNN (convoluted neural network) for my class project. There are many different neural networks that have been made and while creating our neural network we decided to use "Alexnet" as our base architecture and structure. "Alexnet" is is the name of a convolutional neural network (CNN) architecture, designed by Alex Krizhevsky in collaboration with Ilya Sutskever and Geoffrey Hinton. It is used as an a type of image-net that can be fed image data and can learn to differentiate between them. With Alexnet as our base we then collected images of data in order to test, train, and judge our A.I.'s performance. I collected 50 images of pickup trucks as well as 50 images of cars to train the image-net to decide which type of automobile it was presented. The code we used was written in python programming language and was run on Google Colab. The steps taken in the neural network were convolution, relu, maxpool and linear function to learn and eventually test on the data presented. After 30 epochs, or training runs, the network was able to judge correctly 75 percent of the time. Although not the ideal success rate, it still shows the power of A.I. learning and possibilities using image-net based neural networks. If more data (images) were added, the success in predicting the category would only increase. I envision using this type of CNN in transportation departments, law enforcement, or even among private companies. This basic type of CNN was easy to use and has many uses practical uses for

just about every industry.

5 Conclusion

This class has opened the world of artificial intelligence and offered me insight into how it can be applied in many industries today and the future. Artificial intelligence has always interested me from movies to books to video games, but before this class I had never learned much about it. I never expected to learn so much about neural networks but it was one of the most interesting classes I have ever taken. While hardly an expert, I do feel that I at least understand the framework of what current artificial intelligence networks are and how they can be easily applied to image data sets. We are currently in the time of applying artificial intelligence to every industry for the first time and the possibilities are endless and exciting. I hope to bring my knowledge of CNN's and differential equations with me on my career and apply it to really set myself apart. I would tell everyone to invest the time to learn about artificial intelligence and even think about how it can be applied to your job or industry, you won't regret it.