

Machine Learning Project Report

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Abstract

In this project, I design 3 different neural networks on TensorFlow using Fashion MNIST dataset to classify the type of a cloth/accessory. The Fashion MNIST data. The dataset contains images of various images of clothing and accessories—such as shirts, bags, shoes, and other fashion items. The problem is an image classification problem, which can be solved by properly designed neural networks.

1 Introduction

My focus in this project is to gain experience by designing my first neural network on the Fashion MNIST dataset. The problem is famously known image classification problem. In this project, I designed 3 different neural network by using TensorFlow framework. The goal was to classify images of some clothing and accessories. In this report, I mostly analyze the relationship between number of epochs and accuracy of the model. The comparison is made for both training accuracy and testing accuracy.

2 Problem and Dataset Information

I have used the data from Fashion MNIST repository by Zalando Research. This new dataset contains images of various articles of clothing and accessories—such as shirts, bags, shoes, and other fashion items.

The examples in the dataset are 28x28 grayscale images with 10 different labels. These labels are;

- T-shirts

- Trousers
- Pullovers
- Dresses
- Coats
- Sandals
- Shirts
- Sneakers
- Bags
- Ankle boots

- Training set is consist of 55000 images. (85%)
- Tests set is consist of 10000 images. (15%)

I have used 3 different neural networks to classify images. For optimization, Adam Optimizer is used to minimize the cost, making use of TensorFlow framework.

3 Neural Network Designs and Optimizations Algorithms

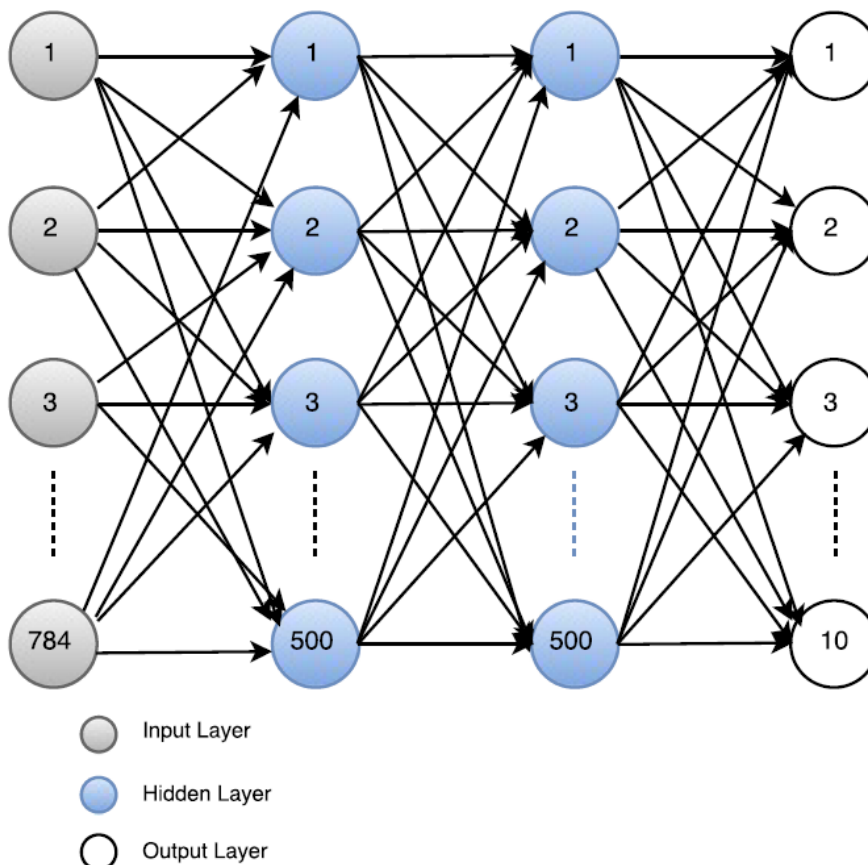
In this section, I discuss which optimization algorithm I used to minimize de loss and the designs of the 3 neural network I designed.

3.1 Adam Optimization Algorithm

I used Adam Optimizer to minimize the loss function since it achieves good results fast. That is one of the reasons that Adam Optimizer is one of the most popular one in the field of deep learning. Adam Optimization algorithm is some variation of stochastic gradient descent, which we have not covered yet but with Prof. Şensoy's suggestion, I used as the optimization engine in my neural networks.

3.2 Neural Network with Two Hidden Layer

In my first design, I built a simple multi-layer neural network with just two hidden layer. It is a 3 layer feedforward neural network with 500 neurons in each hidden layer. The hidden layer computes a function which is then passed into a ReLU activation function. You can see the architecture of first neural network below:

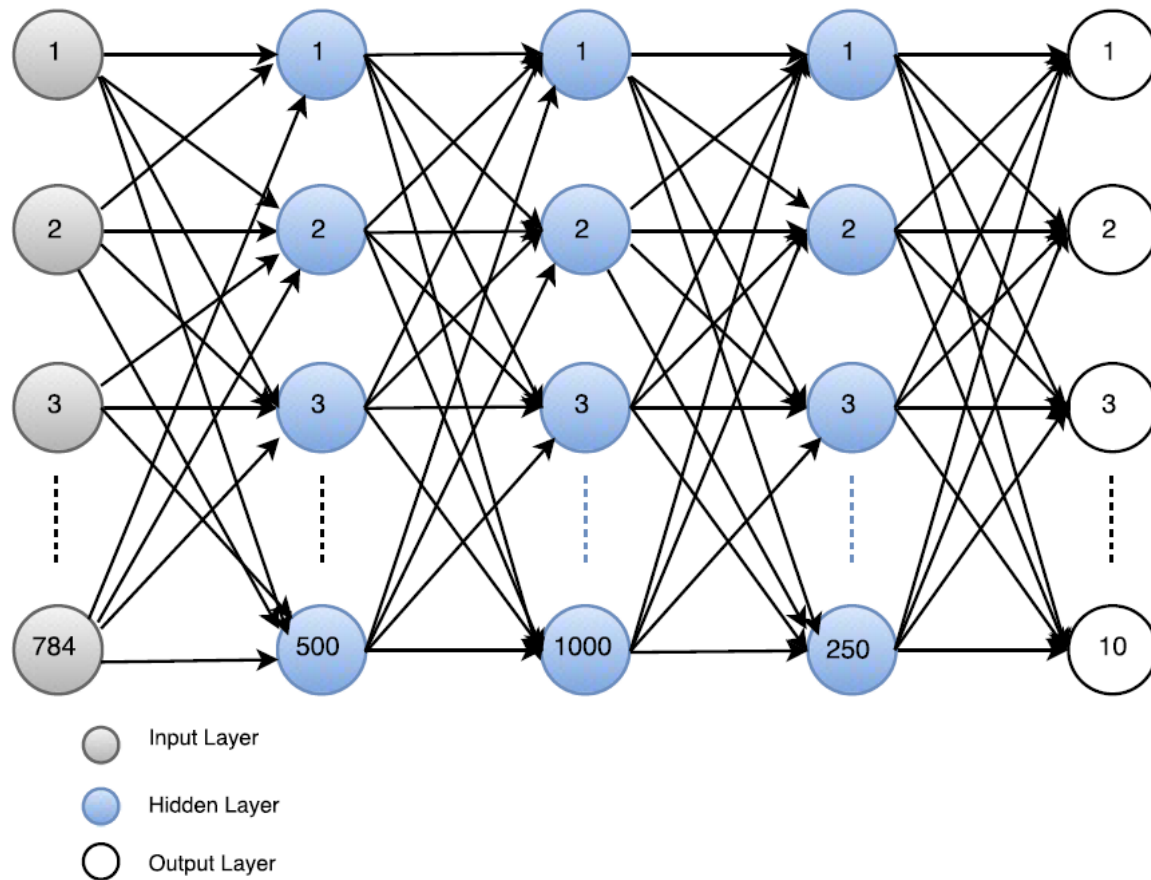


As you can see, the architecture is consist of one input layer, two hidden layer and 1 output layer. The input layer takes input signals (values) and passes them to the next layer without any operations on the values. In our network data have $28 \times 28 = 784$ input values. As I mentioned before, the hidden layers have 500 neurons in each.

3.3 Neural Network with Three Hidden Layers

The second neural network I have designed is a multi-layered neural network which is consist of 3 hidden layers. As the first one, the input and output layers are $28 \times 28 = 784$ and 10 respectively. However, in this case, there are three hidden layers

in between which have 500, 1000 and 250 neurons in each. You can see the architecture of second neural network below:



3.4 Convolutional Neural Network Design

For the third neural network, I designed a convolutional neural network. It has 2 convolutional and 1 full connected layers. While the first convolutional layer is (5,5,16), the second convolutional layer is (5,5,32). After the two convolutional layers are passed, there is one fully connected layer with 500 neurons.

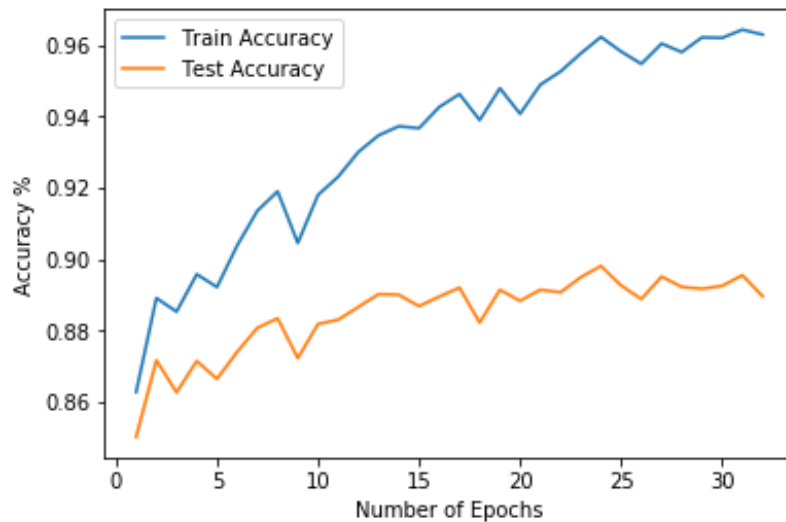
4 Results

In this section, I observe the relationship between accuracy and number of epochs, for both training and testing datasets.

For all of the neural network designs, number of epochs are 32, and the batch sizes are 55. Adam Optimizer is used in both networks and also for activation functions, ReLU function is preferred.

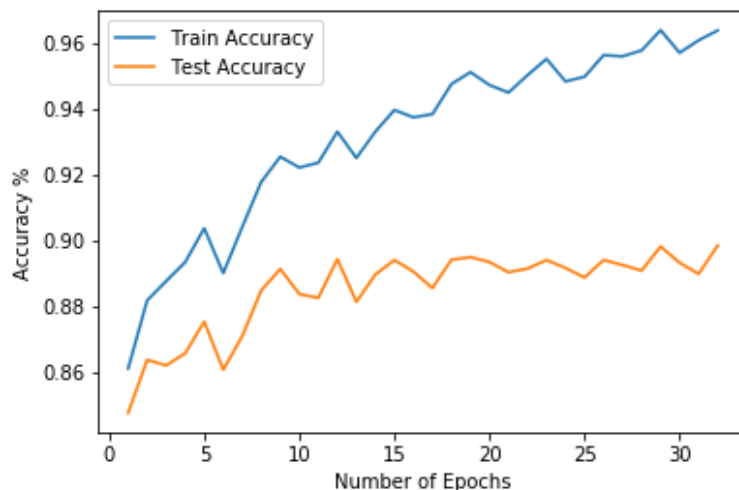
Neural Network 1:

The graph below shows the relationship between accuracy and number of epochs, for the first neural network.

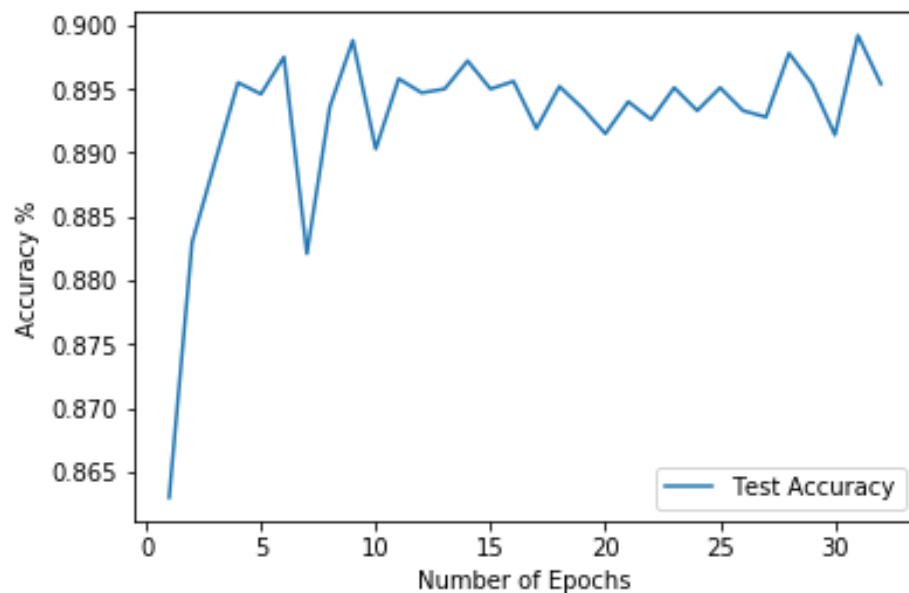


Neural Network 2:

As you can see from the graph, the accuracy of training is increased with a higher rate than training accuracy. Although I tried a lot to increase the test accuracy higher than 90%, the test accuracy was mostly at 89.50-89.85%.



Neural Network 3:



For the convolutional neural network design, I was not able to construct the plot for Training accuracy vs. number of epochs. I tried to do it, but it always gives me the same error, which is “ResourceExhaustedError”. I couldn’t fully figure out why I am taking this error. But I am predicting that with the complexity of convolutional network I design, my PC is not able to find the accuracy of training set.

As you can see from the graph, at the first 7-8 epoch, the training accuracy is increasing sharply. But after the 8th epoch, some fluctuations begin.

5 Conclusion

As conclusion, for each neural networks I have designed, the test set accuracy is not so much different from each other. Since the convolutional neural network is much sophisticated than the other two, it gets the 89.8% range quicker than the others. But at the end, all of the neural networks I designed are not able to pass 90%.

As this is the first deep learning project I have done in my life and it is the first project of our “Introduction to Deep Learning” course, I think I did not do a bad job. This project helps me to implement and practice my knowledge about deep learning. Designing different types of neural networks and analyzing the performance of these networks help me to understand which parameters are affecting the performance measures like accuracy and loss. By making these kind of project, I hope to get better at this field.

References:

<https://github.com/zalandoresearch/fashion-mnist>