Jimmy Wallace

Dr. Fossler-Lussier

CSE 5526

May 1, 2020

Lab 4 – Convolutional Neural Networks

Introduction:

In this lab, convolutional neural networks with varying architectures are examined as image classifiers on the Fashion MNIST data set. The Fashion MNIST data set contains 60,000 28x28 pixel grayscale images of different articles of clothing with corresponding labels such as dress, coat, sandals, and more. The goal of this lab is to construct three different convolutional neural networks and compare their performance on classifying the images provided within this data set. Each convolutional neural network varies in architecture to explore the effects of different architectures and their consequent performance results.

Procedure:

The first portion of this lab deals with constructing, training, and testing the base architecture convolutional neural network. The base architecture convolutional neural network serves as a control model to compare against alternate architectures. The base architecture model consists of five layers described in the lab write up. The first two layers serve as convolution and max pooling layers whereas the last three layers serve as fully connected linear layers with 10 outputs corresponding to each class label in the Fashion MNIST data set. To train the model, cross entropy loss is utilized as the loss function and batch processing is utilized to modify the model’s parameters.

The next portion of the lab deals with constructing, training, and testing the two variant architecture convolutional neural networks. For the first variant, the design of the model is based around extracting more features from each convolution, so each convolutional layer features a greater number of output channels. For the second variant, the design of the model places an emphasis on the fully connected linear layers after the initial convolutional layer and utilizes a greater number of parameters to increase the hypothesis space of the model. Aside from these distinguishing factors, the variant two architectures remain very similar to the base architecture model. To train the variant models, the same training process was utilized as the base architecture model.

The hyperparameters of each model are constant to ensure unbiased performance comparison. The learning rate each model uses is 0.01, each model trains for 10 epochs, and each model utilizes a batch size of 1000 images. After each model is trained and tested, the performance metrics of the test results are printed to the console and a graph containing the results is displayed.

Results:

At the end of each model’s training, the test set accuracy of the model’s performance on the Fashion MNIST data set is reported. As a reference, a base model multilayer perceptron with no convolutions is trained and tested first with its results reported to the screen.

Table : Multilayer Perceptron Image Classification Performance Results

A picture containing computer

Description automatically generated

Next, the base architecture convolutional neural network performance results are reported to the console.

Table : Base Architecture Convolutional Neural Network Image Classification Performance Results

A picture containing computer, keyboard

Description automatically generated

Next, the first variant architecture convolutional neural network performance results are reported to the console.

Table : Variant I Architecture Convolutional Neural Network Image Classification Performance Results

A picture containing computer

Description automatically generated

Lastly, the second variant architecture convolutional neural network performance results are printed to the console.

Table : Variant II Architecture Convolutional Neural Network Image Classification Performance Results

A picture containing computer

Description automatically generated

After all the models’ test results are reported, a graph is displayed containing the performance results of each model on the training set.

A close up of a map

Description automatically generated

Figure : Neural Network Image Classification Performance Results

Discussion:

As noted from Figure 1, the second variant architecture convolutional neural network had the greatest accuracy after ten epochs on the training set of Fashion MNIST images. It is also important to note that the multilayer perceptron model without any convolutional layers outperformed the remaining convolutional neural networks after training for ten epochs. It follows that the second variant architecture convolutional neural network contained the best training set accuracy because after the convolutional layers, there is a vast fully connected network of linear layers with a large hypothesis space. Furthermore, it similarly follows that the multilayer perceptron showed great image classification accuracy because it also contained a large network of linear layers with a great hypothesis space. Also, it seems that the multilayer perceptron trained with great accuracy but seemed to plateau quickly. I believe if each model was trained for a large of number epochs, greater than ten, the convolutional neural networks would continue to increase in training set accuracy as well as test set accuracy.

It was also interesting that the first variant architecture convolutional neural network which used a greater number of filters to achieve more feature detection abilities performed relatively poorly after training. I believe this is due to the use of a low learning rate, I believe a greater learning rate that was not held constant between models would enhance this model’s performance results.

Conclusion:

In this lab, three different convolutional neural networks were compared on their performance results of image classification on the Fashion MNIST data set. The effects of varying architectural designs on convolutional neural networks was explored and discussed. Also, this lab demonstrated successfully that convolution neural networks can achieve a high degree of training and testing accuracy when designed appropriately.