Project Part 3 : Classification Using Neural Networks and Deep Learning

Introduction

This project involves implementing Handwritten Digits Recognition Task in Part 1 of the Project, using a convolutional neural network. The dataset being used is the same MNSIT dataset from the part 1. In this part of the project, we are using 60000 samples for training (each digit with 600 samples) and 10000 samples for testing (each digit with 100 samples)

Furthermore, a couple of experiments were conducted to understand how the neural network behaves for the different parameters

Experiment 1 (baseline model)

- I**nput size** is size of the image which is **28 * 28.** The number of **epochs** used is **12**
- First hidden layer is **1st convolutional layer** with **6 feature maps**, **kernels** which are **3 * 3 in size**, and **stride is 1**
- First convolution layer is followed by a **max pooling layer** which is of **size 2 * 2** and **stride 1**
- **2nd convolution layer** has **16 feature maps** with **kernels of size 3 * 3** and **stride 1**
- 2nd convolutional layer is followed by a **max pooling layer** of **size 2 * 2** and **stride 1**
- Followed by max pooling layer, the layer is connected to the next hidden layer with **120 nodes** and **ReLu as activation function**
- The above layer is then connected to another fully connected layer with **84 nodes** and **ReLu activation function** followed by connecting to another softmax layer with **10 output nodes** corresponding to the 10 classes

After training on 6000 samples and testing on 10000 samples, the training error and testing error as a function of the number of epochs is plotted below in **Figure 1**

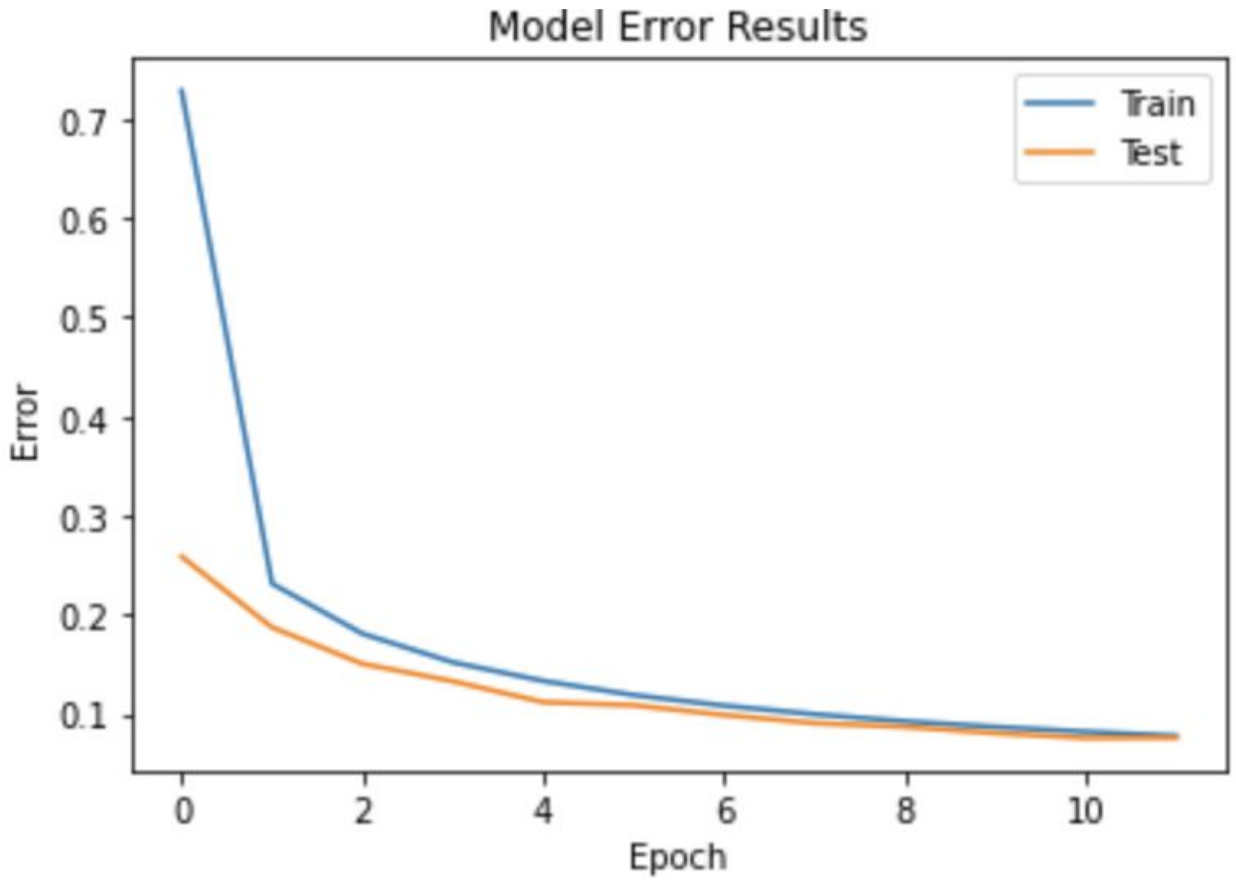

Figure 1 : Error rate of training and testing data vs the number of epochs for the baseline model

Parameter	Observation
Test Error/Test Loss	**0.07589517453350127**
Test Accuracy	**0.9750999808311462**

Experiment 2 (kernel size is 5 * 5)

- I**nput size** is size of the image which is **28 * 28.** The number of **epochs** used is **12**
- First hidden layer is **1st convolutional layer** with **6 feature maps**, **kernels** which are **5 * 5 in size**, and **stride is 1**
- First convolution layer is followed by a **max pooling layer** which is of **size 2 * 2** and **stride 1**

- **2nd convolution layer** has **16 feature maps** with **kernels of size 5 * 5** and **stride 1**
- 2nd convolutional layer is followed by a **max pooling layer** of **size 2 * 2** and **stride 1**
- Followed by max pooling layer, the layer is connected to the next hidden layer with **120 nodes** and **ReLu as activation function**
- The above layer is then connected to another fully connected layer with **84 nodes** and **ReLu activation function** followed by connecting to another softmax layer with **10 output nodes** corresponding to the 10 classes

After training on 6000 samples and testing on 10000 samples, the training error and testing error as a function of the number of epochs is plotted below in **Figure 2**

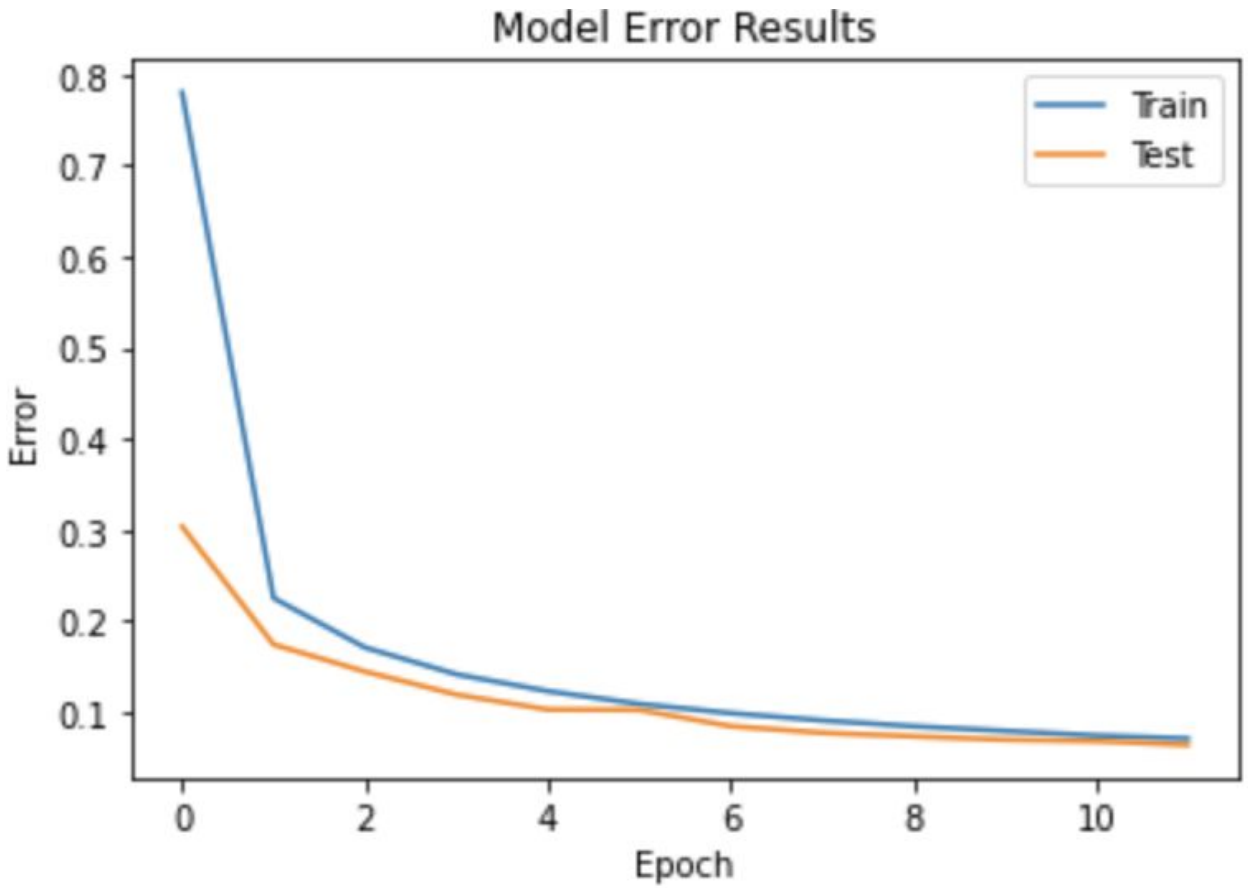

Figure 2 : Error rate of training and testing data vs the number of epochs for 5 * 5 kernel

Parameter	Observation
Test Error/Test Loss	**0.06377932123444043**
Test Accuracy	**0.9797000288963318**

Experiment 3 (Feature maps in 1st convolutional layer as 10 and in 2nd convolutional layer as 20)

- I**nput size** is size of the image which is **28 * 28.** The number of **epochs** used is **12**
- First hidden layer is 1st **convolutional layer** with **10 feature maps**, **kernels** which are **3 * 3 in size**, and **stride is 1**
- First convolution layer is followed by a **max pooling layer** which is of **size 2 * 2** and **stride 1**
- **2nd convolution layer** has **20 feature maps** with **kernels of size 3 * 3** and **stride 1**
- 2nd convolutional layer is followed by a **max pooling layer** of **size 2 * 2** and **stride 1**
- Followed by max pooling layer, the layer is connected to the next hidden layer with **120 nodes** and **ReLu as activation function**
- The above layer is then connected to another fully connected layer with **84 nodes** and **ReLu activation function** followed by connecting to another softmax layer with **10 output nodes** corresponding to the 10 classes

After training on 6000 samples and testing on 10000 samples, the training error and testing error as a function of the number of epochs is plotted below in **Figure 3**

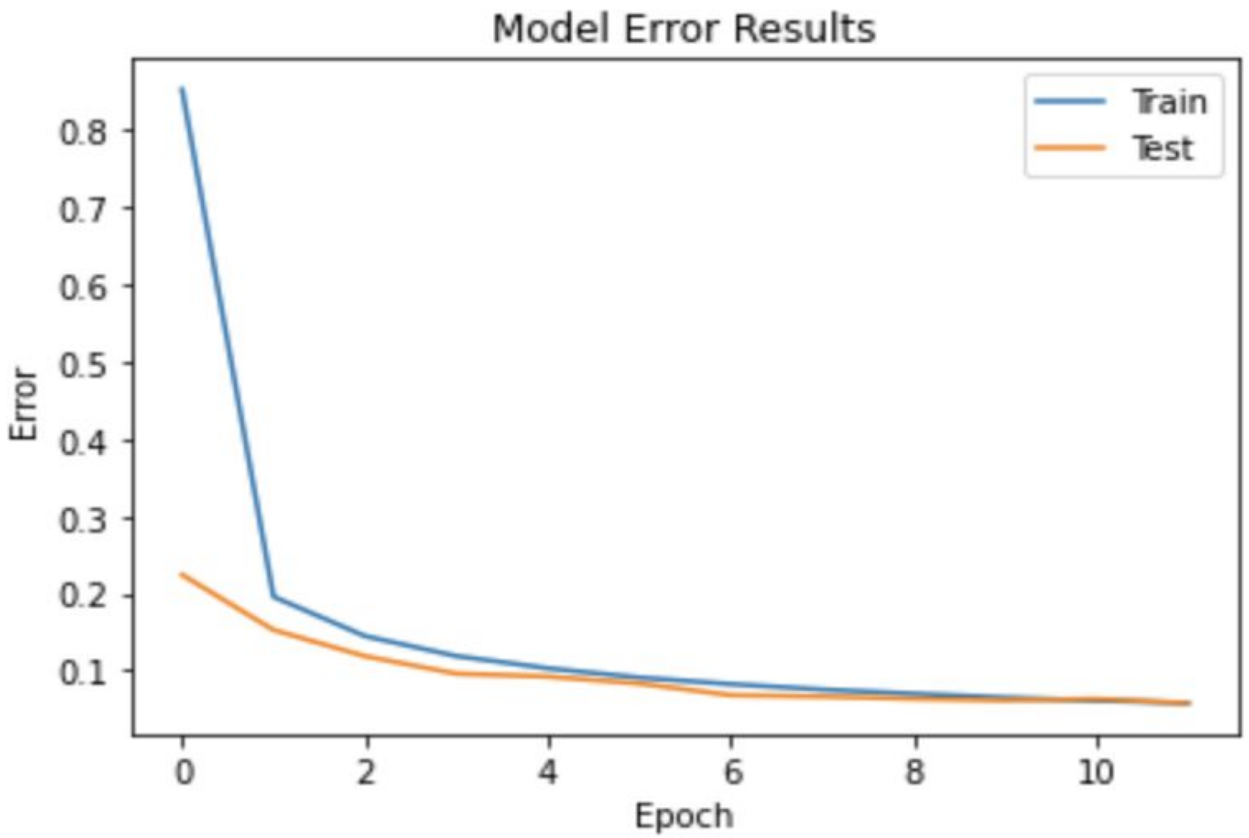

Figure 3 : Error rate of training and testing data vs the number of epochs where the number of feature maps is 10 in 1st convolutional layer and the number of feature maps is 20 in the 2nd convolutional layer

Parameter	Observation
Test Error/Test Loss	**0.057911215771175924**
Test Accuracy	**0.9811999797821045**

Overall Observations

Upon increasing the kernel size and the number of feature maps, it is observed that the **test error/test loss reduces** and the **test accuracy increases**, as compared to the the baseline model