Recognition of Handwritten Numerical Digits By Neural Networks Algorithms

HANDE CEREN GÜLER

Supervisor
Dr. MÜCAHİT K. ÜNER
Electrical and Electronics Engineering Department, Hacettepe University

Introduction

- In this project, the neural network created for the recognition of handwritten numbers, the parameters that affect the learning of the neural network and how changing these parameters affect learning, and which values should be given to which parameter in order to get the best result were examined.

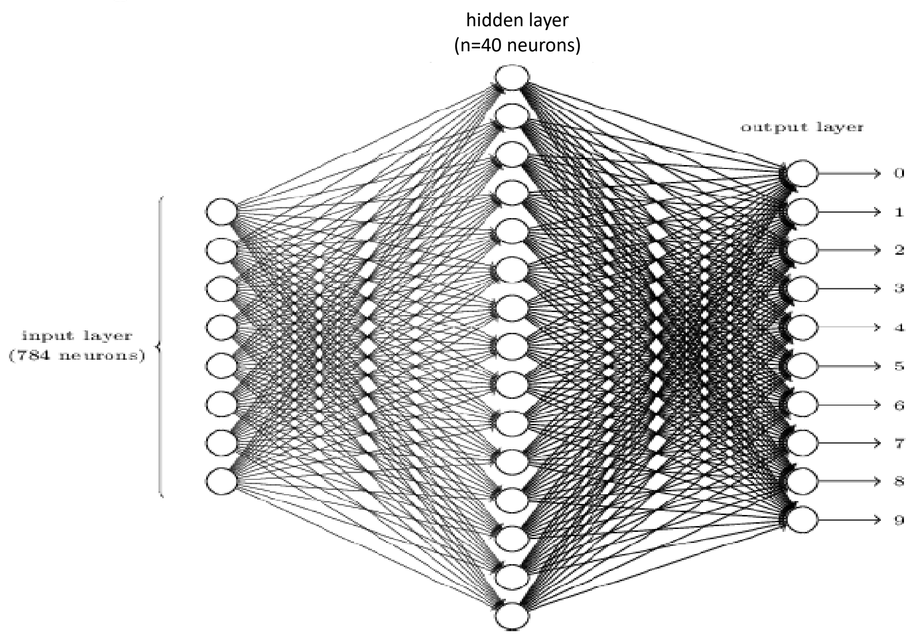

Figure 1. Three Layer Neural Network[1]

Specifications and Design Requirements

- Neural network method was used in this project. In the created network, **sigmoid neuron**, which is an important artificial neuron type, and a standard learning algorithm known as **Stochastic Gradient Descent** were used.
- The input layer of the network contains neurons that encode the values of the input pixels (28 * 28 = 784 neurons). The second layer of the network is a hidden layer (n neurons). The output layer of the network contains 10 neurons. Output neurons are numbered from 0 to 9.
- **Input Data:** The MNIST dataset was used in this project (60,000 data=50,000 trains and 10,000 test data).
- **Input parameters:** The biases and weights of the network are randomly initialized using a Gaussian distribution with a mean of 0 and a variance of 1. The neural network was trained using mini-batch stochastic gradient descent(SGD). Within the scope of the project, various changes were made on the data used for training and testing, and this new data sets were also used for analyses of system performance.

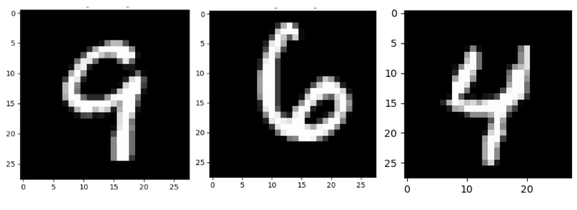

Figure 2. Input Data Sample From MNIST

$$\sigma(z)=\frac{1}{1+\exp\left(\underbrace{\sum_j w_j x_j - b}_{z}\right)}$$

Figure 3. Sigmoid Function with Input,Weight,Bias[1]

Solution Methodology

- The following changes have been made on the network, which parameter effects on learning:
  1.Changing 'Learning Coefficient' Value (Optimum 3 obtained)
  2.Changing Number of Neurons at Hidden Layer (Optimum 40 obtained)
  3.Changing Mini-Batch Size (Optimum 32 obtained)
  4.Adding Gaussian Noise to Training and Test Data
  5.Dark Patches Applied on Training and Test Data
  6.Rotating Training and Test Data

Application Areas

- Handwritten numerals recognition using a neural network can be used in processing information containing handwritten digits such as recognizing address numbers on packages and letters and telephone numbers.

Results and Discussion

Examples of Distorted Images

1. Result of Adding Gaussian Noise to Training and Test Data

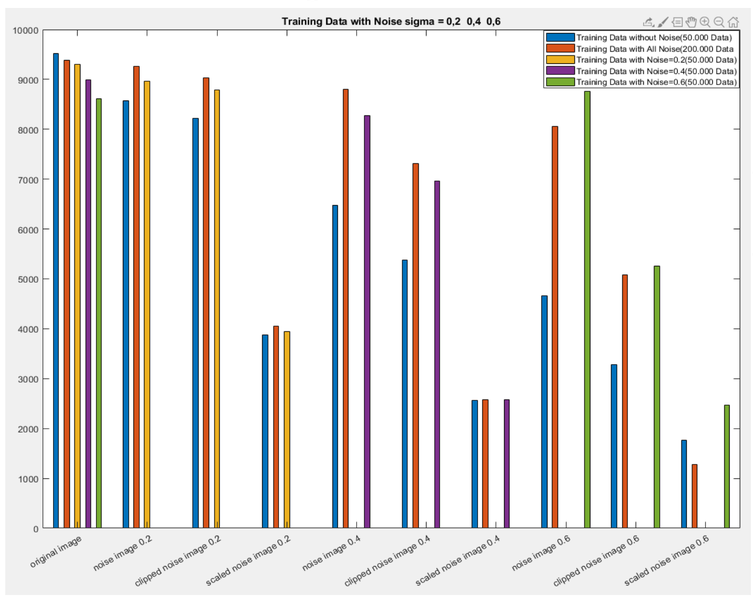

Figure 4. Adding Gaussian Noise to Training and Test Data

As the power (σ^2) of the added noise increases, the amount of distortion in the image increases and the learning rate decreases.

2. Result of Dark Patches Applied on Training and Test Data

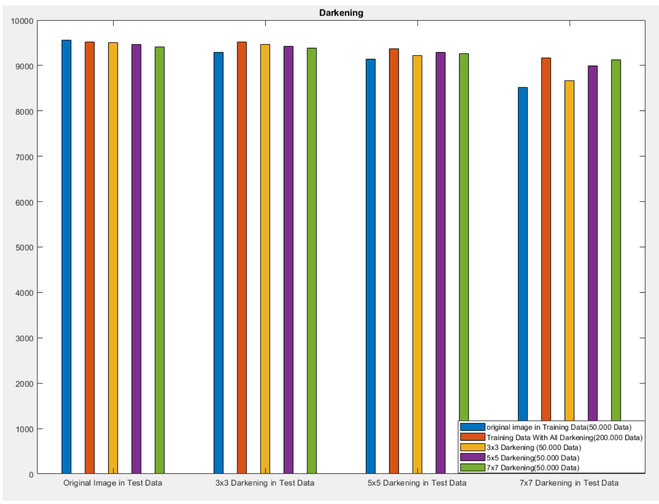

Figure 5. Darkening Training and Test Data

The darkening process did not cause much deterioration in the image, as the location of the darkening on the image was randomly determined and the major part of the image was black. For this reason, the learning rate has not decreased much.

3. Result of Rotating Training and Test Data

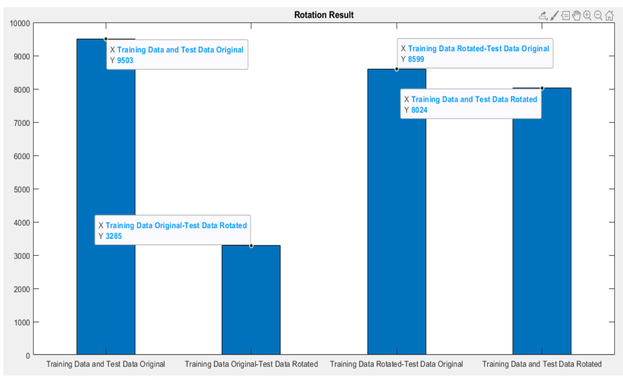

Figure 6. Rotating Training and Test Data

Rotations were applied to the images of training and test data in different orders.If there is rotated test data then rotated training data must be used in order to get better performance.

References

❖[1]http://neuralnetworksanddeeplearning.com/index.html

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