Observation Report on Training a Fully Connected Feedforward Neural Network (FCFNN) for Function Approximation

MD. NAZMUL HASAN

Department of Computer Science and Engineering

University of Rajshahi

Student ID: 2111176131

August 29, 2025

1 Introduction

In this experiment, we designed and trained a Fully Connected Feedforward Neural Network (FCFNN) to approximate the quadratic equation

$$f(x) = 5x^2 + 10x - 2.$$

2 Methodology

2.1 Data Preparation

The dataset was generated by computing values of $f(x)$ for randomly sampled integers x in the range $[0, 99]$, resulting in 10,000 samples. The dataset was split into:

- Training set: 70%

- Validation set: 10%

- Test set: 20%

2.2 Neural Network Architecture

The FCFNN architecture used in this experiment consists of:

- Input layer: 1 neuron (representing x),

- Hidden layers: 6 layers with ReLU activation functions and neurons in the order [8, 16, 64, 128, 32, 8],

- Output layer: 1 neuron (representing $\hat{f}(x)$, the predicted output).

2.3 Training

The network was trained using the Adam optimizer and Mean Squared Error (MSE) as the loss function. Training was conducted for 200 epochs with a batch size of 32. The training and validation losses were monitored to ensure convergence.

3 Results and Observations

The trained FCFNN was evaluated on the test set. Figure 1 shows a comparison between the original function $f(x)$ and the predicted function $\hat{f}(x)$.
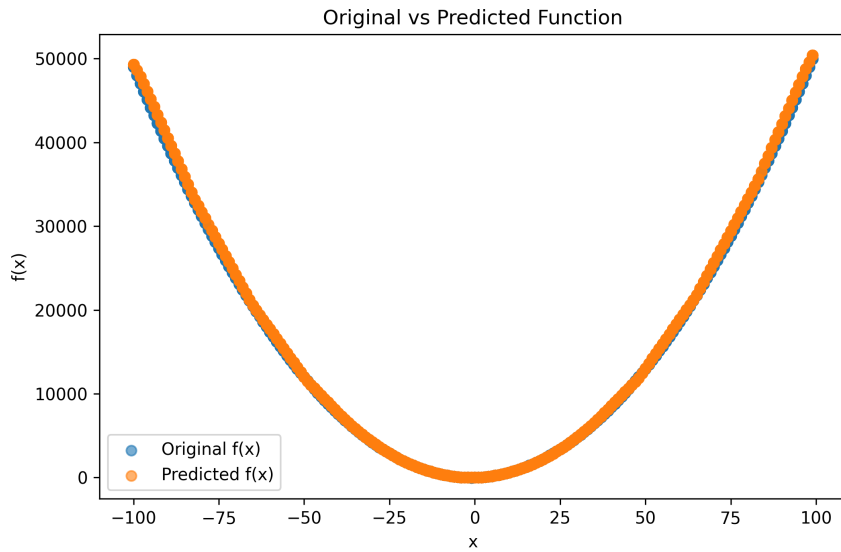

Figure 1: Comparison of original function $f(x)$ and predicted function $\hat{f}(x)$ by the FCFNN.

3.1 Performance Analysis

- The predicted function closely matches the original function, demonstrating the network's capability to approximate nonlinear mappings.

- The training loss decreased steadily over epochs, showing effective learning.

- Minor deviations were observed at extreme values of x, likely due to limited training samples in those regions.

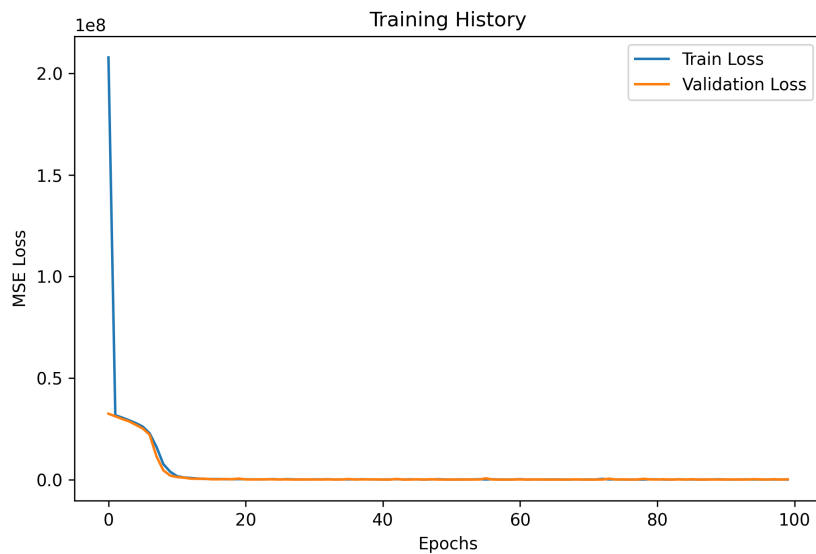Figure 2 shows the training and validation loss over epochs.

Figure 2: Training and validation loss over epochs for the FCFNN.

4 Conclusion

The experiment demonstrated that a Fully Connected Feedforward Neural Network (FCFNN) can effectively approximate a quadratic function such as

$$f(x) = 5x^2 + 10x - 2.$$

The network achieved good accuracy in predicting values, validating the theoretical ability of neural networks to approximate nonlinear continuous functions.

5 Resources

- GitHub Repository: Click here

- Google Colab: Click here