Type A Project: LeNet-5 Based on Numpy

ECE 579
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Introduction

This project is a type A project. I manually implement a LeNet-5 convolutional NN using Numpy (no automatic gradient).

Data

The dataset is the MNIST dataset

Model Description

To implement this model, firstly, I implement all the layers in Numpy, including the convolutional layer, fully connected layer, ReLu activation layer, and softmax layer. Every layer is written in a class type and every class has both forward() and backward() functions. (Detail in the “layer.py” file)

Then I implement the LeNet-5 model based on layers I wrote before. The LeNet5 is also written in a class type, and it has the initialization function to generate all layers I need for this model. And the forward() function has the sequence of all the layers’ forward() function for the forward process. Also, the backward() function has the sequence of all the layers’ backward() function for the backward process.

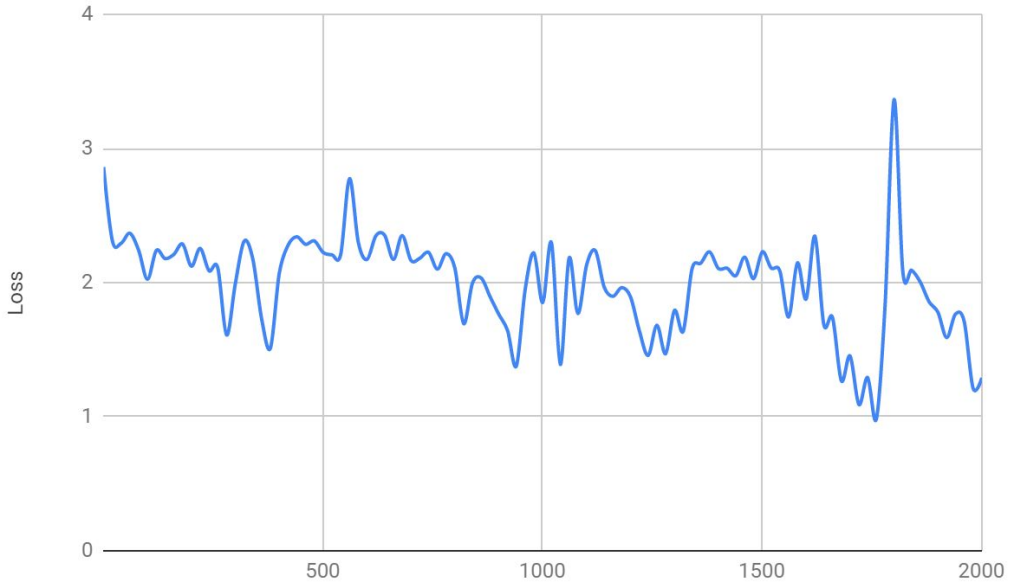
Experimental Procedure

The experiment is basically loading the data from the MNIST and putting them inside the model.

Results

Because of the performance restriction of Numpy and my laptop, this neural network based on Numpy runs very slowly, and it's impossible for me to finish even one epoch. (it's estimated to take 10,000 seconds)
So I run the training program for some time. The detailed results are in the ”Result.txt” file.
I finish training 2000 data and record the loss. The trend of loss shows that this model does work, the overall trend of the loss does decrease, while it may be unstable because of the restricted number of training data.

Here is the graph of the trend of how the loss changes in this 2000 times of training.



Conclusion

The LeNet-5 can be implemented just based on Numpy, but the performance is really bad. And LeNet-5 is kind of unnecessary for the MNIST dataset

Reference

1. Build Lenet from Scratch - Gary
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2. Convolutional Neural Network implemenation from scratch in python numpy - vaibhavnaggar
   https://github.com/vaibhavnaagar/cnn
3. lenet-5-mnist-from-scratch-numpy - toxtli
   https://github.com/toxtli/lenet-5-mnist-from-scratch-numpy