Sami Emre Erdogan
Student ID: 2019280513

Deep Learning Homework 2

1.Record the training and testing accuracy, plot the training loss curve and training accuracy curve in the report.

Softmax for MNIST Classification

Training

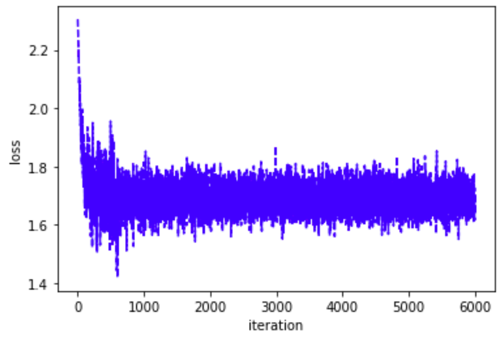
```
Epoch [9][10]	Batch [0][600]	Training Loss 1.6400	Accuracy 0.9200
Epoch [9][10]	Batch [100][600]	Training Loss 1.6175	Accuracy 0.7900
Epoch [9][10]	Batch [200][600]	Training Loss 1.6477	Accuracy 0.8600
Epoch [9][10]	Batch [300][600]	Training Loss 1.6287	Accuracy 0.8200
Epoch [9][10]	Batch [400][600]	Training Loss 1.6912	Accuracy 0.8000
Epoch [9][10]	Batch [500][600]	Training Loss 1.6639	Accuracy 0.8200
```

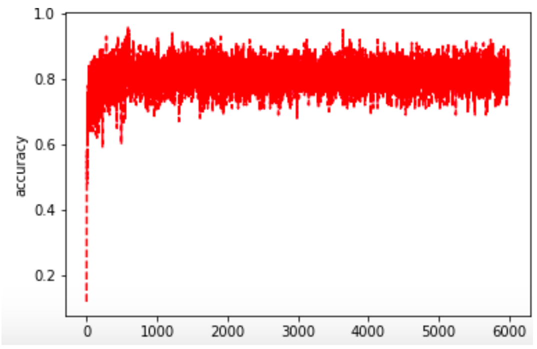
Testing

```
accuracy = correct * 1.0 / test_size
print('Test Accuracy: ', accuracy)
```

```
Test Accuracy:  0.8237
```

Plot





1. MLP for MNIST Classification

1.1 MLP with Euclidean Loss and Sigmoid Activation Function

Training

```
Epoch [19]	Average training loss 0.0925	Average training accuracy 0.9244
Epoch [19]	Average validation loss 0.0784	Average validation accuracy 0.9454
```

Testing

```
test(sigmoidMLP, criterion, data_test, batch_size, disp_freq)
```

```
Testing...
The test accuracy is 0.9296.
```

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1.2 MLP with Euclidean Loss and ReLU Activation Function

Training

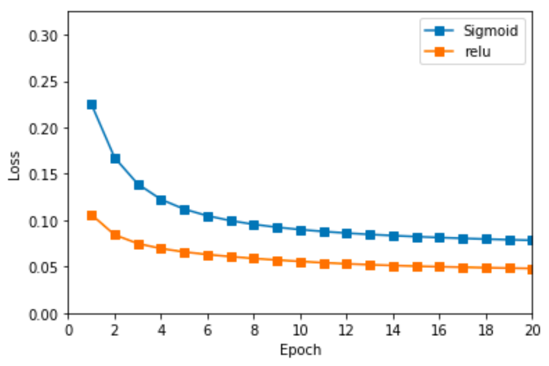
```
Epoch [19]        Average training loss 0.0509    Average training accuracy 0.9674
Epoch [19]        Average validation loss 0.0480  Average validation accuracy 0.9748
```

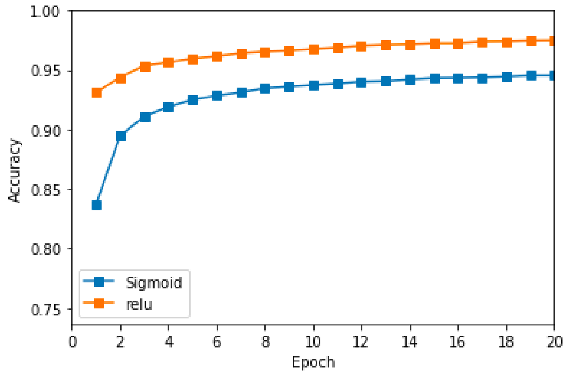
Testing

```
test(reluMLP, criterion, data_test, batch_size, disp_freq)
```

```
Testing...
The test accuracy is 0.9656.
```

Plot





2. MLP with Softmax Cross-Entropy Loss

2.1 MLP with Softmax Cross-Entropy Loss and Sigmoid Activation Function

Training

```
Epoch [19]        Average training loss 1.8726    Average training accuracy 0.6926
Epoch [19]        Average validation loss 1.8559  Average validation accuracy 0.7236
```

Testing

```
test(sigmoidMLP, criterion, data_test, batch_size, disp_freq)
```

```
Testing...
The test accuracy is 0.7050.
```

2.2 MLP with Softmax Cross-Entropy Loss and ReLU Activation Function

Training

```
Epoch [19]        Average training loss 0.8175    Average training accuracy 0.8584
Epoch [19]        Average validation loss 0.7464  Average validation accuracy 0.8984
```

Testing

```
test(reluMLP, criterion, data_test, batch_size, disp_freq)
```

```
Testing...
The test accuracy is 0.8710.
```

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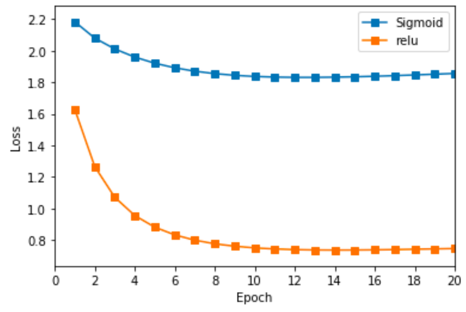
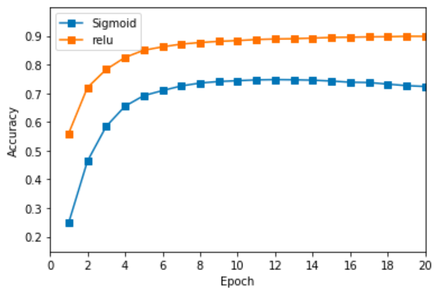
Plot





<u>Two-hidden-layer MLP</u>
<u>Softmax Cross-Entropy Loss and ReLU/ReLU Activation Function</u>

Training

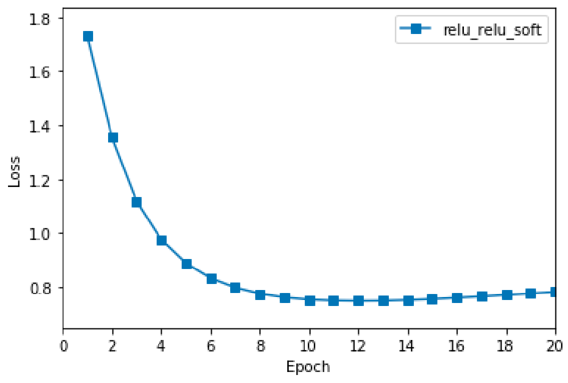
```
Epoch [19]      Average training loss 0.8431   Average training accuracy 0.8558
Epoch [19]      Average validation loss 0.7814 Average validation accuracy 0.8880
```

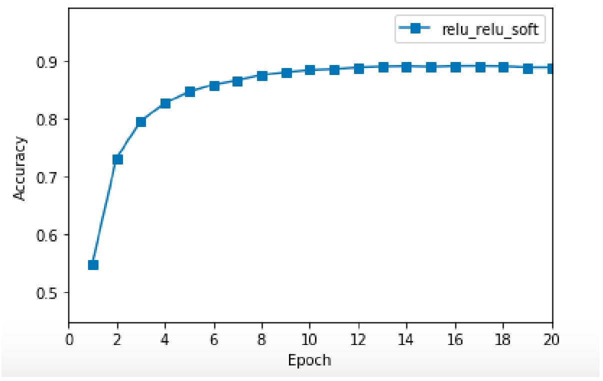
Testing

```
test(relu_relu_soft_MLP, criterion, data_test, batch_size, disp_freq)
```

```
Testing...
The test accuracy is 0.8643.
```

Plot





2. The given hyerparameters maybe performed not very well. You can modify the hyerparameters
by your own, and observe how does these hyerparameters affect the classification performance. Write down your observation and record these new results in the report.

My hyperparameters performed reasonably well so I didn’t have the need to change it.

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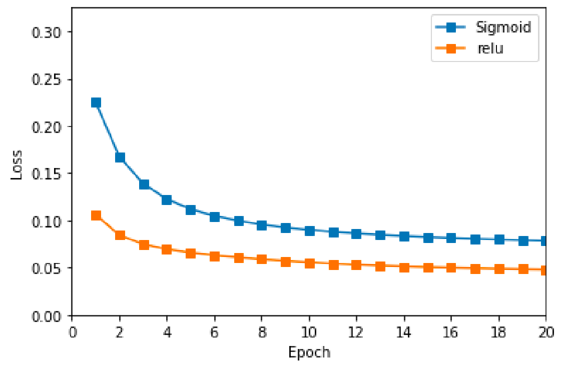
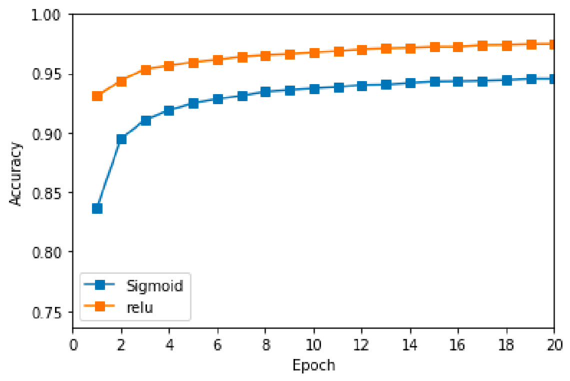
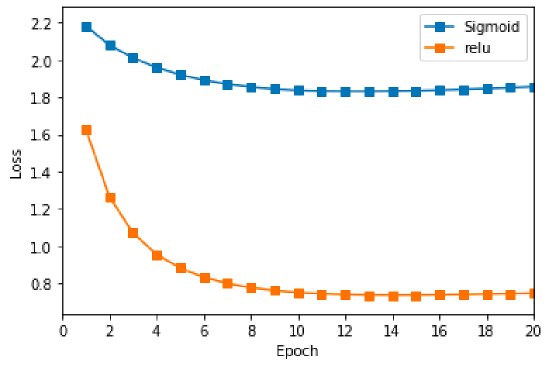
3.Compare the difference of results when using Sigmoid and ReLU as activation function (you can discuss the difference from the aspects of training time, convergence and accuracy).

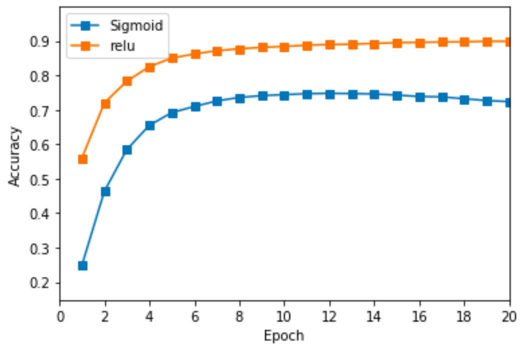
__Euclidean Loss__





__Softmax Cross-Entropy Loss__





3.As you can see from above Relu performed better in both Euclidean and Softmax Cross Entropy Loss than Sigmoid.

4.Compare the difference of results when using EuclideanLoss and SoftmaxCrossEntropy-Loss as loss function
4.The highest accuracy rate 0.9656 was achieved by using MLP wıth Euclidean Loss and Relu Activation function. The lowest was 0.7050 with Softmax Cross-Entropy Loss and Sigmoid Activation Function. When we compare the results between Euclidean and Softmax Cross Entropy we can see that Euclidean performed better with both Sigmoid and Relu.

5.Construct a MLP with two hidden layers (choose the number of hidden units by your own), using any activation function and loss function. Also, compare the difference of results between one-layer structure and two layers structure.

I chose to compute the MLP two hidden layers with Softmax Cross-Entropy Loss and ReLU/ReLU Activation Function. As a result, it performed better than our worst result but at the end it wasn't the best but overall it performed really well and maybe if I had played with the hyperparameters or tried a different two hidden layer it would have performed better.