CAP 5619 - Deep and Reinforcement Learning

Homework 1 Hua Huang

In this homework, the example of mnist_mlp.py from Keras tutorial is used. It is slightly modified in solving problem 2.

1 Problem 1

(1) It's a MLP network, in which there is 4 layers, namely input layer, 2 hidden layers, and output layer. The 2 hidden layers have Re-LU non-linear units, the output layer has softmax activation function. The input is a 784 dimension vector, two hidden layers are of dimension 512, output layer has 10 units. In total, there are $(784+1)\times 512+(512+1)\times 512+(512+1)\times 10 = 669706$ parameters.
(2)

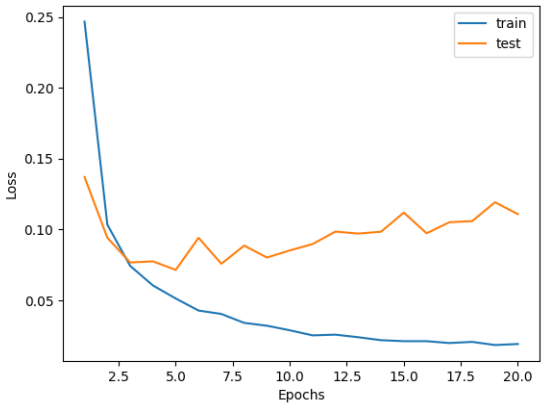

Figure 1: Loss

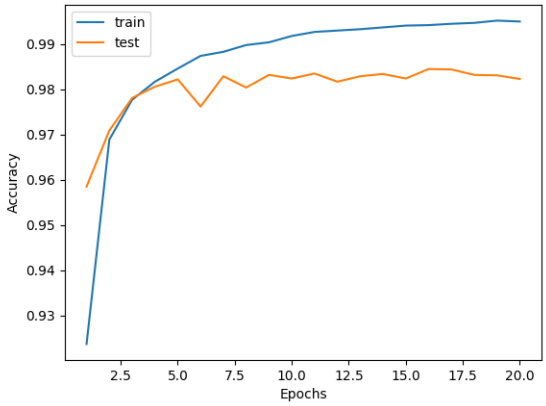

Figure 2: Accuracy

2 Problem 2

(1) Here in the training, the labels are changed to random numbers from $0 \sim 9$. Since the training is much slower then in problem 1, here epochs are increased to 200.

(2) One of the biggest difference is the randomized lables in training dramat-

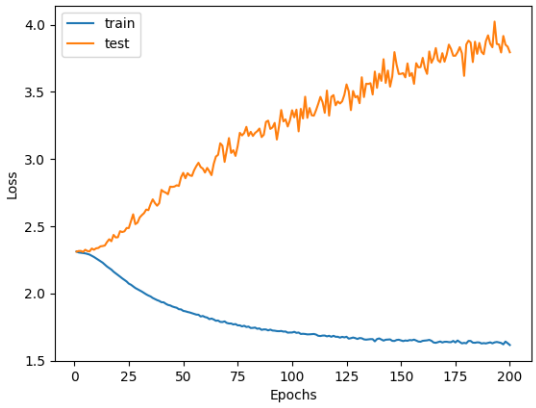

Figure 3: Loss

ically slower the trainning process. Interestingly, it's reasonable to speculate

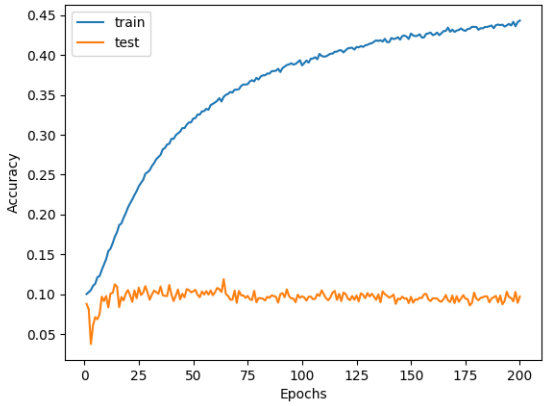

Figure 4: Accuracy

if we increase the total epochs further, say 1000 epochs, we might still get a near-perfect training accuracy. Just as expected, the test accuracy is just the probalbility of being the actual labels when random number is picked uniformly from $0 \sim 9$, namely 0.1. This leads to a significantly increased gap between the training and test accuracy.
The difference may be introduced by the fact that deep neural network is so powerful in representation, that it can "remeber" the training data (here is the pixels in training data) if we train the training data long enough. This "remeber" is not learning, namely it will not be able to generalize to data it never seen before, so it will not be able to predict the test data, eventually we see a huge gap in the accuracy of traing data and test data.

3 Problem 3

The paper indicates the difficulty in explaning the generalization capability of deep network. If we want to improve the generalization capability, namely reduce the gap between training accuracy and test accuracy, regularization may or may not work. In this test, dropout is added but it failed to reduce the gap.
Thanks to this assignment, now I can understand why **early stop** will help reduce over-training and improve generalization. Deep neural network is so

powerful it can easily memorize the trianing data, and this memorizing is not learning, it will not be able to predict the data it never seen.