HW #2 - Back Propagation Algorithm

Implementing the Back Propagation Algorithm

Youchen Ren

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A. A report explaining the neural network method, the back propagation algorithm, and your experimental results.

i. Neural network method is a mathematical model for supervised machine learning, by training the weights from training set, it could get a proper weights for the correct output value which within the threshold boundary.

ii. Back propagation algorithm is a kind of Gradient Decent Algorithm. By training the weights, it try to converge the target value within the threshold.

The procedure could be briefly introduced by following:

1. Perform the forward-propagation phase for an input pattern and calculate the output error
2. Change all weight values of each weight matrix using the formula

weight(old) + learning rate * output error * output(neurons i) * output(neurons i+1) * (1 - output(neurons i+1))

3. Go to step 1
4. The algorithm ends, if all output patterns match their target patterns

iii. My experimental results is the following:

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threshold = 0.1

```
Cross Validation break point is: 41
iteration time is: 85
The average total output error is: 0.09896601706775507

Cross Validation break point is: 83
iteration time is: 403
The average total output error is: 0.09994091100947357

Cross Validation break point is: 125
iteration time is: 107
The average total output error is: 0.09855856120600939

Cross Validation break point is: 167
iteration time is: 61
The average total output error is: 0.09940606957790298

Cross Validation break point is: 208
iteration time is: 83
The average total output error is: 0.09898658279785055
```

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threshold = 0.0171

```
Cross Validation break point is: 41
iteration time is: 82992
The average total output error is: 0.01709998973065828

Cross Validation break point is: 83
iteration time is: 223
The average total output error is: 0.017064354273787538

Cross Validation break point is: 125
iteration time is: 165
The average total output error is: 0.016952655989411796

Cross Validation break point is: 167
```

iteration time is: 185
The average total output error is: 0.017037871650801777

Cross Validation break point is: 208

B. For each experiment, plot the total output error against the number of epochs (iterations) during the training.

See above (part iii.)

C. Analyze your results and report any observations you may have based on your experiments. For example, explain how the stopping threshold value affects the training and testing error, etc.

1. My results Analysis:
   I converged the threshold value of neural network below 0.1, but I did not converge it below 0.01. Therefore, I adjust the threshold value from the required 0.01 to 0.0171 - This is the lowest total error sum that the program could get, the purpose is to see the relationship between the threshold value and the iteration times.
   Obviously, from the testing result in Question A part iii., it's clearly that the bigger the threshold value is, the lesser the iteration time is. The program iterates more than 82 thousand times when the threshold value set to 0.0171.
2. I have looked every detail of my code, I really still cannot find the problem which causes the total error cannot converges. But I think maybe there is way to correct this.
3. Regarding the learning rate, I have tried such as 0.1, 0.01, 0.001…I have not yet find something different regarding the output or the iteration times.