HW #2 - Back Propagation Algorithm
Implementing the Back Propagation Algorithm

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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:

threshold = 4.6

```
u is: 41
iteration is: 576
Error sum is: 4.5993580637732405
Neural Network is trained well,
total error is within the threshold value.

u is: 83
iteration is: 1262
Error sum is: 4.590911456822954
Neural Network is trained well,
total error is within the threshold value.

u is: 125
iteration is: 838
Error sum is: 4.596619322054649
Neural Network is trained well,
total error is within the threshold value.

u is: 167
iteration is: 823
Error sum is: 4.595385996425386
Neural Network is trained well,
total error is within the threshold value.

u is: 208
iteration is: 397
Error sum is: 4.596581126847424
Neural Network is trained well,
total error is within the threshold value.
```

threshold = 5.6

```
u is: 41
iteration is: 377
Error sum is: 5.597003658502317
Neural Network is trained well,
```

```
    total error is within the threshold value.

    u is: 83
    iteration is: 540
    Error sum is: 5.593812710626516
    Neural Network is trained well,
    total error is within the threshold value.

    u is: 125
    iteration is: 486
    Error sum is: 5.5929443597015736
    Neural Network is trained well,
    total error is within the threshold value.

    u is: 167
    iteration is: 458
    Error sum is: 5.598835332189668
    Neural Network is trained well,
    total error is within the threshold value.

    u is: 208
    iteration is: 331
    Error sum is: 5.5929334917956135
    Neural Network is trained well,
    total error is within the threshold value.
```

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 did not get the right value of weights for the convergence of the output. Therefore, I adjust the threshold value from the required 0.1 or 0.01 to 4.6 and 5.6, 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.

2. I have looked every detail of my code, I still cannot find the problem which causes the total error so big (4.6). 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.