Neural Networks **T.Raghu Bharadwaj**
Assignment 2 **18MCMT03**

Multi Layer Feedforward Network for Visual Hand Written Digit Recognition using MNIST dataset :

Back Error Propagation :

Input flows forward and the output is found out and the error at the output is being carried backward and calculated at each layer and then the weights are updated which in turn the error is calculated forward and then again the step is repeated backward and forward through which the final error and cost can be reduced to a great extent.

Libraries Used :

```
from sklearn.datasets import fetch_mldata
```
Fetching the data from MNIST database
```
import numpy as np
```
Numericals
```
from sklearn.metrics import confusion_matrix
```
Confusion matrix
```
from sklearn.metrics import classification_report
```
Classification report
```
from sklearn.model_selection import train_test_split
```
For splitting the data into training, testing, validation of the MNIST dataset
```
from sklearn.neighbors import KNeighborsClassifier
```
For 1-Nearest Neighbour Classification
```
import matplotlib
import matplotlib.pyplot as plt
```
For plotting the graph
```
import timeit
```
For calculating the time required for the program execution

Configuration of the PC :

Processor - Core i5 6th Gen
RAM - 12 GB

Total Cost in running the algorithm :

Final cost : 0.24034191688008916

Time needed to run the algorithm :

Time = -1907.308950973 (Around 33 mins)(Exceeded the limit of timeit() and returned a negative value. Shows the running time of the algorithm is very large.)

Confusion matrix :

```
[       [ 953    0   10    2    1   11   13    1    8    6]
        [   0 1104    9    1    1    3    3    6    4    7]
         [  4    5  938   21    6    1   10   30    8    3]
        [   3    4   12  927    1   43    0   10   30   11]
        [   0    0    6    0  915    6    9    6    4   23]
        [   7    1    1   18    2  777   13    1   28   10]
        [   6    3   15    1    9   12  899    0   10    2]
        [   4    1   12   16    5    5    0  949    8   28]
        [   2   16   24   16    9   29   11    2  862   13]
        [   1    1    5    8   33    5    0   23   12  906]       ]
```

Classification report :

	precision	recall	f1-score	support
0	0.97	0.95	0.96	1005
1	0.97	0.97	0.97	1138
2	0.91	0.91	0.91	1026
3	0.92	0.89	0.90	1041
4	0.93	0.94	0.94	969
5	0.87	0.91	0.89	858
6	0.94	0.94	0.94	957
7	0.92	0.92	0.92	1028
8	0.89	0.88	0.88	984
9	0.90	0.91	0.90	994

micro avg	0.92	0.92	0.92	10000
macro avg	0.92	0.92	0.92	10000
weighted avg	0.92	0.92	0.92	10000

Using 1 - Nearest Neighbour :

Memory Error.

Using deskewing :

Memory Error.

Citations :

Multilayer Perceptron - Jonathan Weisberg

1 - Nearest Neighbour - pyimagesearch