CIS 666 Artificial Intelligence

ASSIGNMENT 2

Submitted By

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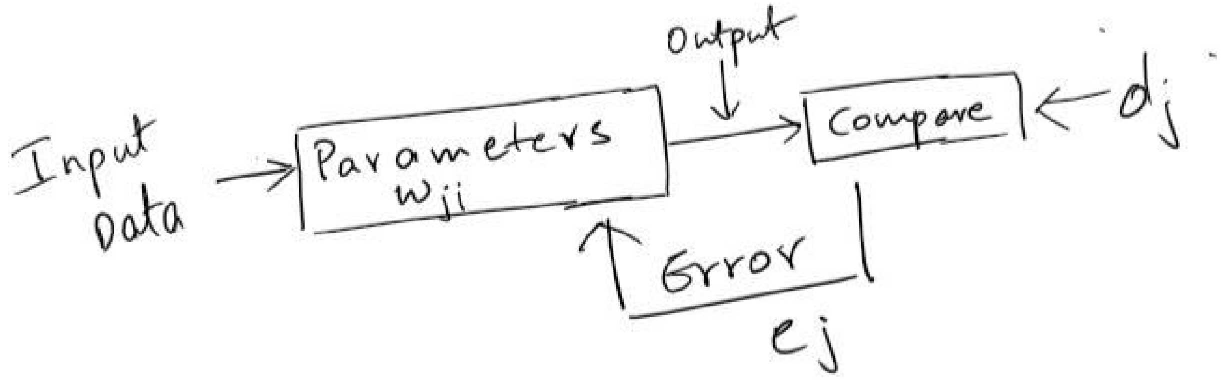
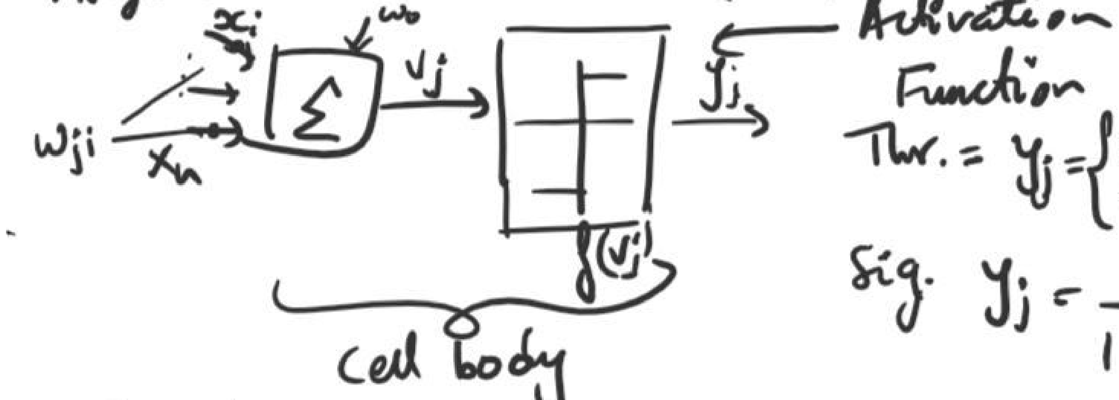


Steps:

1. Apply the input Xi
2. Compute output Yj
3. Compute error Ej
4. If ej>=E, modify wji => Ej = Dj - Yj if ej = 0, stop
5. Wji(t +1) = Wji(t) + change in (Wji(t))
6. Repeat steps 2 - 5 for all parameters
7. Repeat steps 2 - 6 till the error < = E(~0)

Artificial Neural Network (ANN)



Thr. = $y_j = \begin{cases} >1 \\ <0 \end{cases}$

Sig. $y_j = \frac{1}{1-e^{-v_j}}$

input $\Rightarrow x_i \cdot x_1, \ldots, x_N$

$$v_j = \sum_{i=1}^{N} x_j w_{ji} + w_0$$

$$y_j = f(v_j)$$

The Perceptron is inspired by the information processing of a single neural cell called a neuron. In a similar way, the Perceptron receives input signals from examples of training data that we weight and combined in a linear equation called the activation. The activation is then transformed into an output value or prediction using a transfer function, such as the step transfer function. In this way, the Perceptron is a classification algorithm for problems with two classes (0 and 1) where a linear equation (like or hyperplane) can be used to separate the two classes.

It is closely related to linear regression and logistic regression that make predictions in a similar way (e.g. a weighted sum of inputs).

The weights of the Perceptron algorithm must be estimated from your training data using stochastic gradient descent.

- **Learning Rate**: Used to limit the amount each weight is corrected each time it is updated.
- **Epochs**: The number of times to run through the training data while updating the weight.

These, along with the training data will be the arguments to the function.

There are 3 loops we need to perform in the function:

1. Loop over each epoch.
2. Loop over each row in the training data for an epoch.
3. Loop over each weight and update it for a row in an epoch.

As you can see, we update each weight for each row in the training data, each epoch.

Design a fully connected network structure of 784 input nodes and 10 output nodes. The input to the single layer network architecture will be a set of binary pixels representing a 28×28 image of handwritten digits. The output should indicate which of the digits (0,....,9) is in the input image.

```
  weights = np.random.uniform(0,1,(10,784))
```

Random weights are initialised based on the size of the input that is 28*28

1) Input data

```
f = gzip.open('mnist.pkl.gz', 'rb')
train_set, valid_set, test_set = p.load(f,encoding='iso-8859-1')
f.close()
```

This is used to load the input into train_set and

#Task 1: Repeat this experiment for different learning rate parameters
#(at least 3 experiments. Start with a large value and gradually decrease to a small value).

```
  for nr in range(0,10):
          for i in range(0,50000):
          x = images[i]
          t = targets[i]
          z = np.dot(weights[nr],x)
          output = activation(z)
          if nr == t:
          target = 1
          else:
          target = 0
          adjust = np.multiply((target - output) * learningRate[e], x)
```

2. Output is generated using the activation function

```
def activation(x):
          if x > 0:
               return 1
          return 0
```

3. Compute the error

```
          temp += 0.5*(target - output)*(target - output)
```

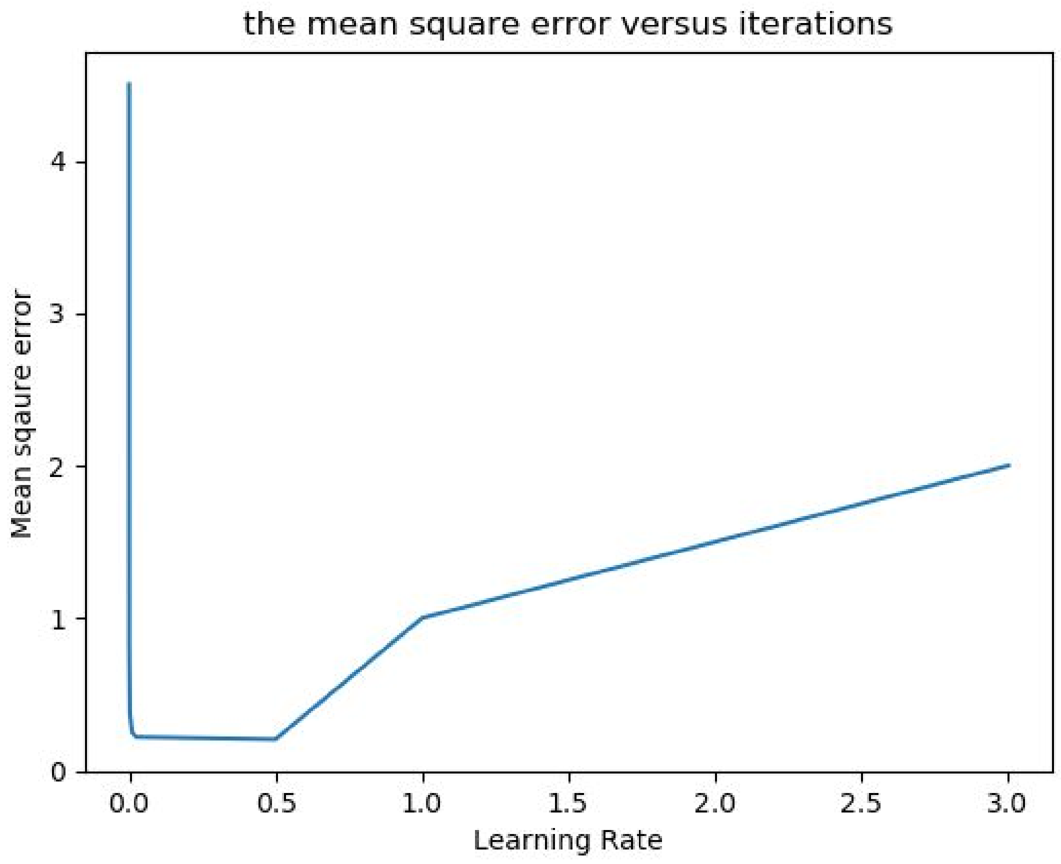
#target is desired output dj and output is yj applying 0.5(dj - yj)^2

$$E_j = \frac{1}{2}\left[d_j - y_j\right]^2$$

This the individual error and together makes it mean squared error which is marked against learning rate.

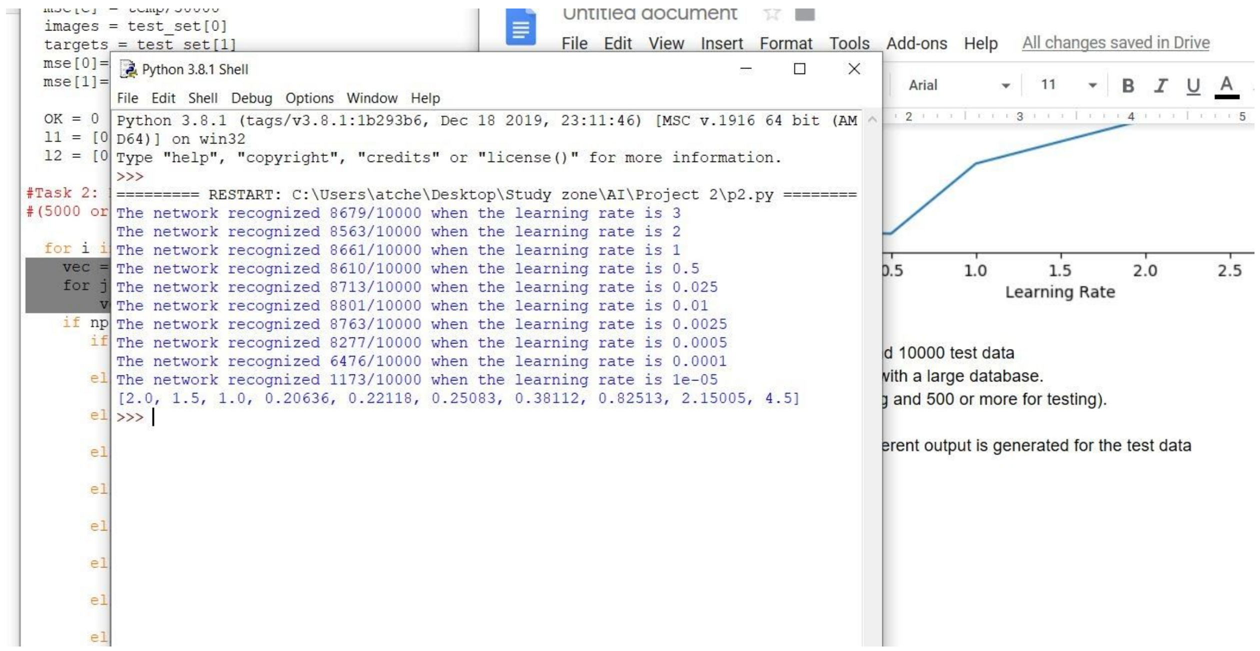
I used 10 different learning rate to better understand the scenario.

```
  learningRate = [3,2,1,0.5,0.025,0.01,0.0025,0.0005,0.0001,0.00001]
```



4.I used 50000 training and 10000 test data
#Task 2: Repeat Task #1 with a large database.
#(5000 or more for training and 500 or more for testing).

For each learning rate different output is generated for the test data



```
  images = test_set[0]
  targets = test_set[1]
  mse[0]=
  mse[1]=

  OK = 0
  l1 = [0
  l2 = [0

#Task 2:
#(5000 or

  for i i
    vec =
    for j
      v
    if np
      if
      el
```

```
Python 3.8.1 (tags/v3.8.1:1b293b6, Dec 18 2019, 23:11:46) [MSC v.1916 64 bit (AM
D64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
========= RESTART: C:\Users\atche\Desktop\Study zone\AI\Project 2\p2.py ========
The network recognized 8679/10000 when the learning rate is 3
The network recognized 8563/10000 when the learning rate is 2
The network recognized 8661/10000 when the learning rate is 1
The network recognized 8610/10000 when the learning rate is 0.5
The network recognized 8713/10000 when the learning rate is 0.025
The network recognized 8801/10000 when the learning rate is 0.01
The network recognized 8763/10000 when the learning rate is 0.0025
The network recognized 8277/10000 when the learning rate is 0.0005
The network recognized 6476/10000 when the learning rate is 0.0001
The network recognized 1173/10000 when the learning rate is 1e-05
[2.0, 1.5, 1.0, 0.20636, 0.22118, 0.25083, 0.38112, 0.82513, 2.15005, 4.5]
>>>
```

d 10000 test data
with a large database.
g and 500 or more for testing).

erent output is generated for the test data

Python 3.8.1 Shell
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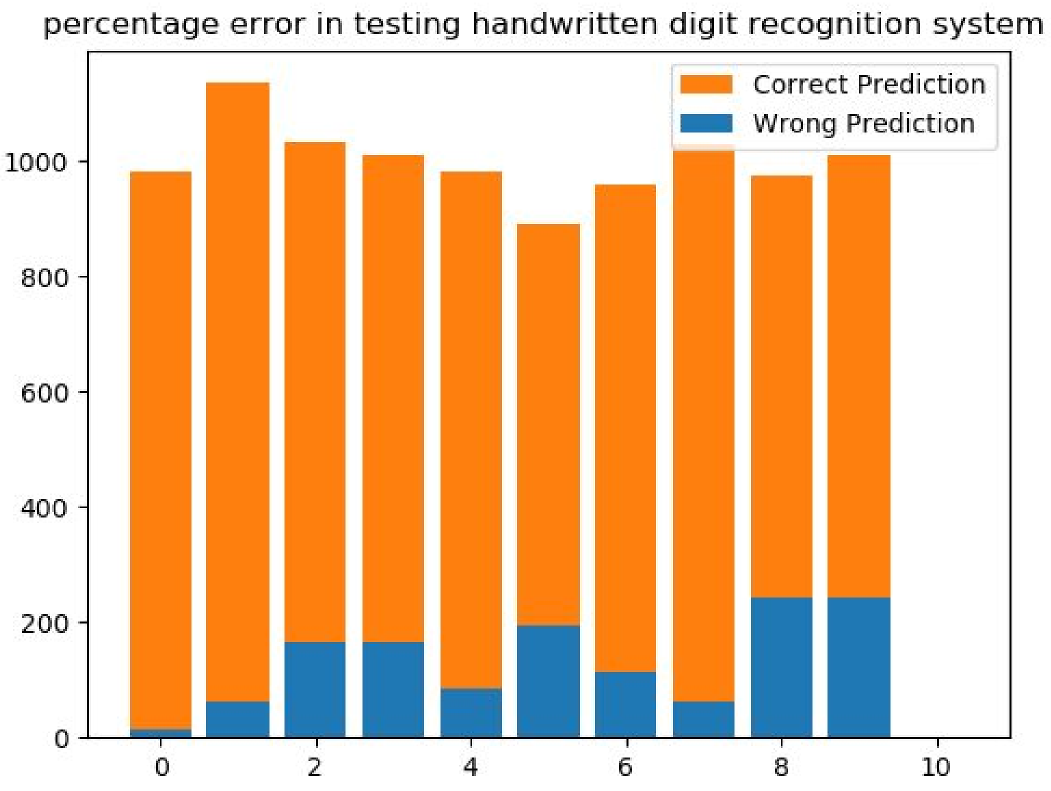
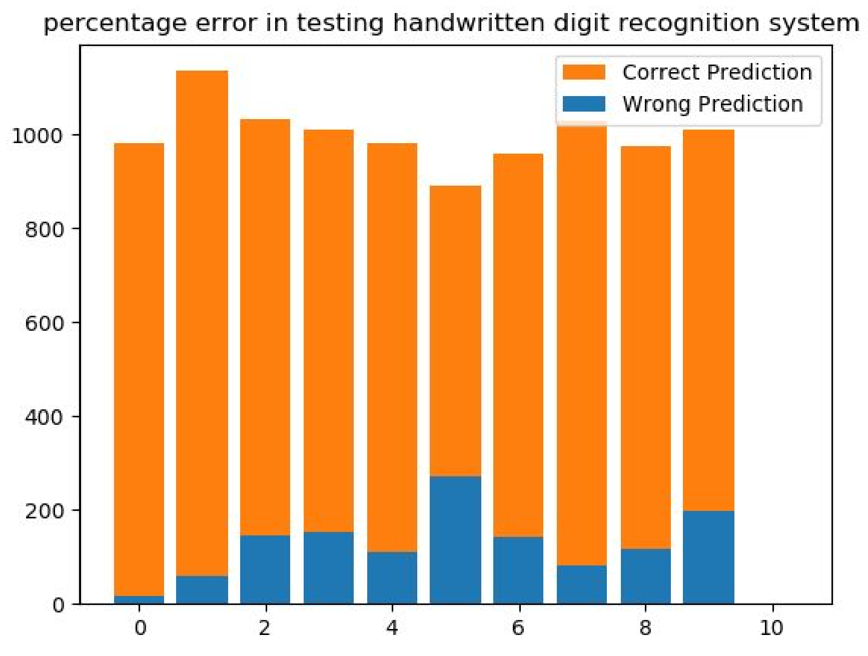
11
0.5
1.0
1.5
2.0
2.5
Learning Rate

Plot the percentage error in testing your handwritten digit recognition system as a bar chart.


percentage error in testing handwritten digit recognition system
Correct Prediction
Wrong Prediction
0
200
400
600
800
1000
0
2
4
6
8
10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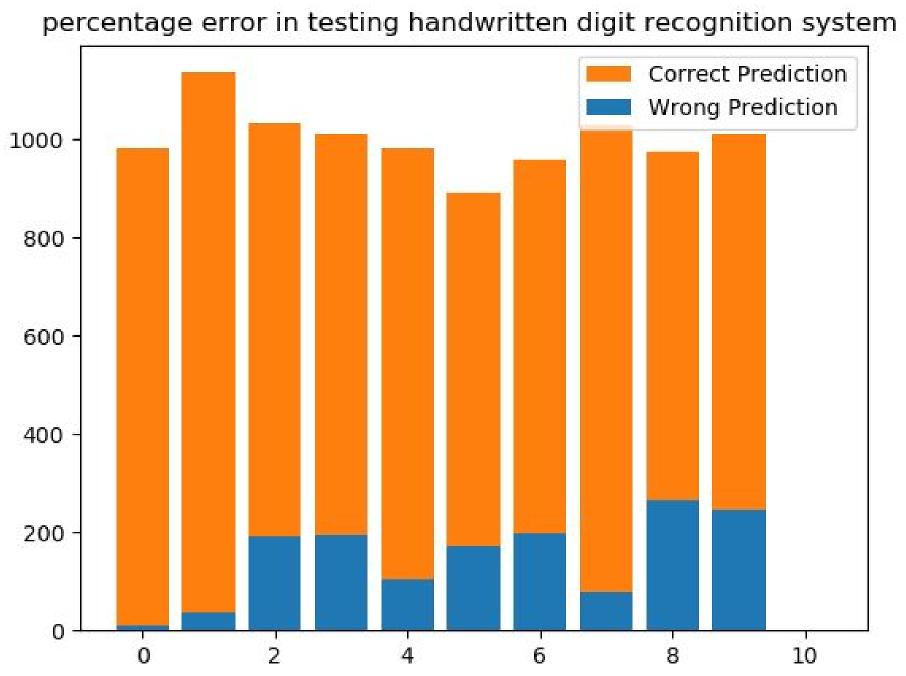
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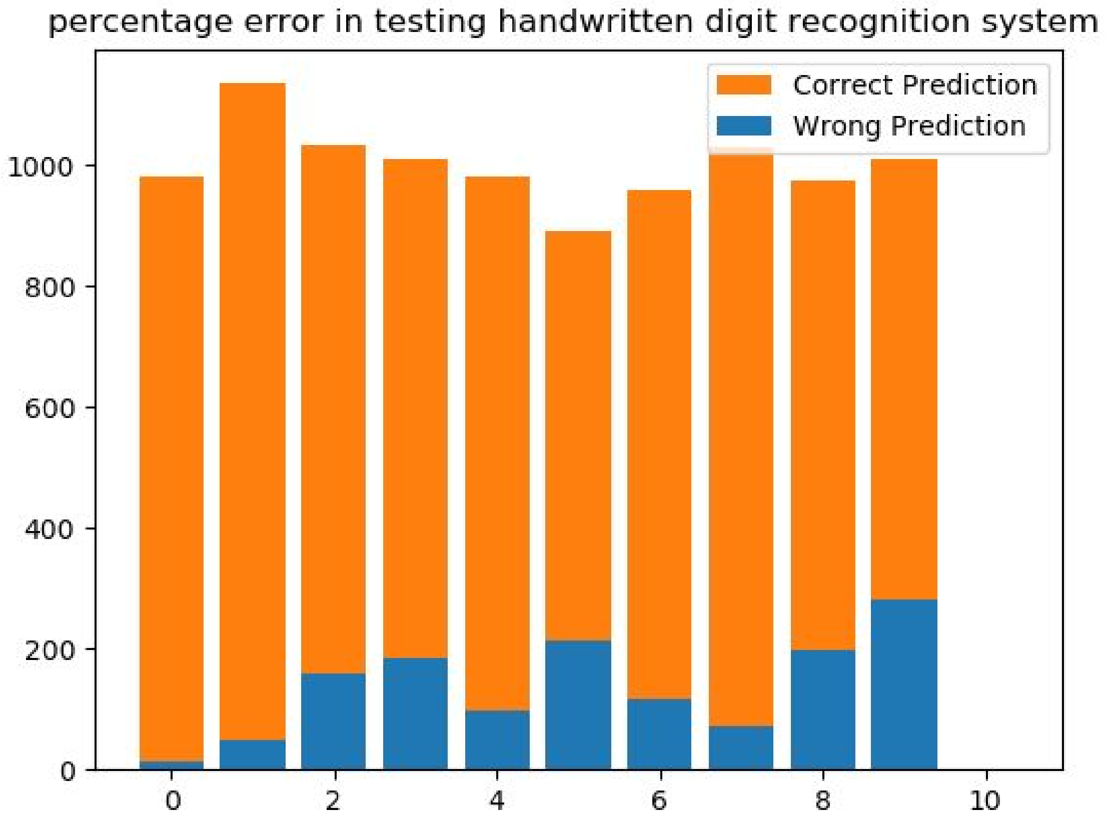
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