Neel Zadafiya (1115533)

Machine Learning - Home Assignment 1

Goal:

To learn how to use Perceptron for simple classification problem

Task 1:

(5 points) Repeat the computer experiment mentioned in the class, this time, however, positioning the two moons Figure to be on the edge of separability, that is, d=0. Determine the classification error rate produced by the algorithm over 2,000 test data points.

Answer: HalfMoon.py

```
################################################################################
#                                                                              #
#  File name : HalfMoon.py                                                     #
#  Version   : Python 3.8.3rc1 64bit                                           #
#  Author    : Neel Zadafiya                                                   #
#  StudentId : 1115533                                                         #
#  Purpose   : To implement perceptron using halfmoon dataset                  #
#                                                                              #
################################################################################

#Import Libraries
import random
import math
import matplotlib.pyplot as plt
import numpy as np

#Control variables
num_of_inputs = 2
epoches = 10

#Function to generate half moon
def halfmoon(rad,width,d,n_samp):

    data = list()

    #For upper half moon

    for i in range(int(n_samp/2)):

        theta = random.uniform(0, math.pi)

        x = random.uniform(rad - width / 2,rad + width /2) * math.cos(theta)
        y = random.uniform(rad - width / 2,rad + width /2) * math.sin(theta)

        data.append([x,y,1])

    #For lower half moon

    for i in range(int(n_samp/2)):

        theta = random.uniform(-math.pi,0)

        x = random.uniform(rad - width / 2,rad + width /2) * math.cos(theta) + rad
        y = random.uniform(rad - width / 2,rad + width /2) * math.sin(theta) - d
```

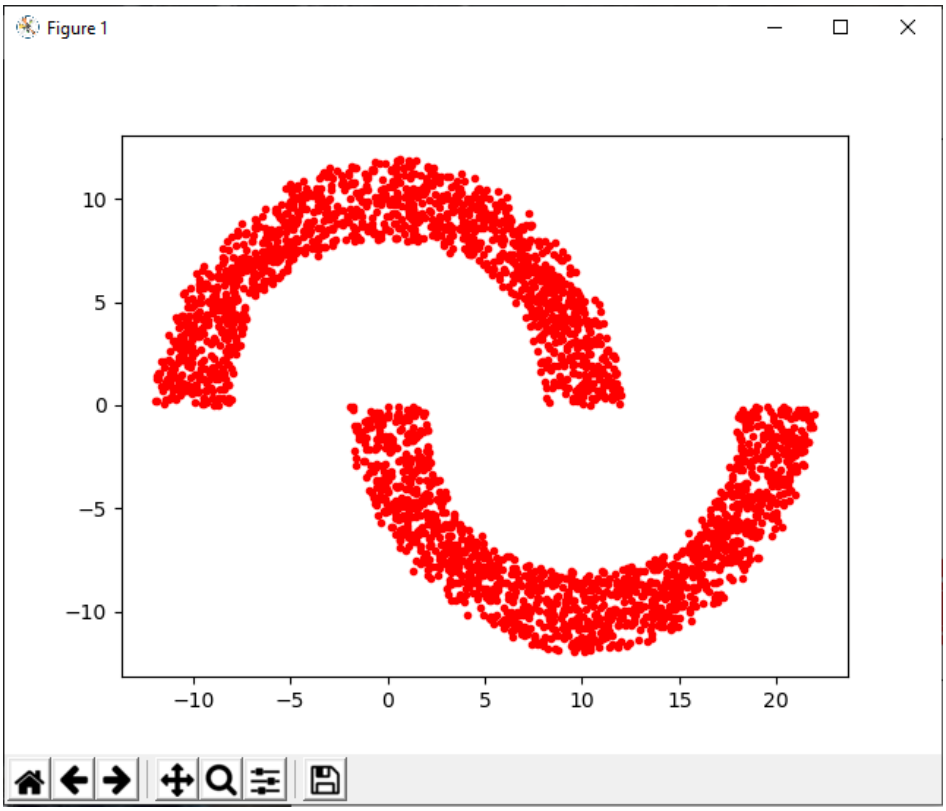
```
        data.append([x,y,-1])

    #Shuffle data
    random.shuffle(data)
    return data

#Activation function
def activation_function(x):

    if x >= 0:
        result = 1
    else:
        result = -1

    return result


#============================== Data Preprocess ================================


data = halfmoon(10,4,0,3000)

#Train test split

train_x = []
train_y = []
test_x =  []
test_y =  []

for i in data[:1000]:
    train_x.append(i[:-1])
    train_y.append(i[-1])

for i in data[1000:]:
    test_x.append(i[:-1])
    test_y.append(i[-1])


#================================== Training ===================================


#Weight vector and learning rate
weight_vector = np.zeros(num_of_inputs)
n = 0.1

#Train model
for e in range(epoches):

    for i in range(len(train_x)):

        #Construct input vector
        input_vector = []

        for k in range(num_of_inputs):
            input_vector.append(train_x[i][k])

        input_vector = np.array(input_vector)

        #Desired output
        d = train_y[i]

        #Generated output
```

```
        y = np.matmul(input_vector,weight_vector)
        y = activation_function(y)

        #Update weights
        weight_vector = weight_vector + n * (d - y) * input_vector


#================================== Testing ==================================


#Test model on training data

hit = 0
miss = 0

for i in range(len(train_x)):

    #Construct input vector
    input_vector = []

    for k in range(num_of_inputs):
        input_vector.append(train_x[i][k])

    input_vector = np.array(input_vector)

    #Desired output
    d = train_y[i]

    #Generated output
    y = np.matmul(input_vector,weight_vector)
    y = activation_function(y)

    #Compare the desired output with generated output
    if y == d:
        hit = hit + 1
    else:
        miss = miss + 1

#Print results
print("Training accuracy :" + str(hit/(hit+miss)))

#Test model on testing data

hit = 0
miss = 0

for i in range(len(test_x)):

    #Construct input vector
    input_vector = []

    for k in range(num_of_inputs):
        input_vector.append(test_x[i][k])

    input_vector = np.array(input_vector)

    #Desired output
    d = test_y[i]

    #Generated output
    y = np.matmul(input_vector,weight_vector)
    y = activation_function(y)
```

```
    #Compare the desired output with generated output
    if y == d:
        hit = hit + 1
    else:
        miss = miss + 1

#Print results
print("Testing accuracy  :" + str(hit/(hit+miss)))
print("Error rate        :" + str(miss/(hit+miss)))

#Plot data points
x = list()
y = list()

for i in data:
    x.append(i[0])
    y.append(i[1])

plt.plot(x,y,'r.')
plt.show()
```

Output:

```
C:\Windows\System32\cmd.exe - python  HalfMoon.py

D:\Work\M_SC_LU_Term_4\Machine Learning\Assignment 1>python HalfMoon.py
Training accuracy :0.996
Testing accuracy  :0.993
Error rate        :0.007
```



Task 2:

(5 points) Download one of the UCI dataset, reuse your own perceptron codes to get the testing accuracy of the selected dataset.

Answer: UCI.py

```
################################################################################
#                                                                              #
#  File name : UCI.py                                                          #
#  Version   : Python 3.8.3rc1 64bit                                           #
#  Author    : Neel Zadafiya                                                   #
#  StudentId : 1115533                                                         #
#  Purpose   : To implement perceptron using UCI (Connectionist Bench) dataset #
#                                                                              #
################################################################################

#Dataset link:
http://archive.ics.uci.edu/ml/datasets/connectionist+bench+(sonar,+mines+vs.+rocks)
#The label associated with each record contains the letter "R" if the object is a rock
and "M" if it is a mine (metal cylinder).
#In the preprocessing part, M is converted to 1 and R is converted to -1

#Import Libraries
import random
import math
import matplotlib.pyplot as plt
import numpy as np
import csv

#Control variables
num_of_inputs = 60
epoches = 50

#Activation function
def activation_function(x):

    if x >= 0:
        result = 1
    else:
        result = -1

    return result

#============================== Data Preprocess ================================

results = []
data = []

#Read csv file to results
with open("sonar.all-data") as csvfile:
    reader = csv.reader(csvfile)
    for row in reader:
        results.append(row)

#Convert data to float
for i in results:
    temp = []
    for j in i[:-1]:
        temp.append(float(j))

    if i[-1] == 'R':
```

```
            temp.append(-1)
        else:
            temp.append(1)

        data.append(temp)

    #Shuffle data
    random.shuffle(data)

    #Train test split
    train_x = []
    train_y = []
    test_x =  []
    test_y =  []

    for i in data[:69]:
        train_x.append(i[:-1])
        train_y.append(i[-1])

    for i in data[69:]:
        test_x.append(i[:-1])
        test_y.append(i[-1])

    #================================== Training ==================================

    #Weight vector and learning rate
    weight_vector = np.zeros(num_of_inputs)
    n = 0.1

    #Train model
    for e in range(epoches):

        for i in range(len(train_x)):

            #Construct input vector
            input_vector = []

            for k in range(num_of_inputs):
                input_vector.append(train_x[i][k])

            input_vector = np.array(input_vector)

            #Desired output
            d = train_y[i]

            #Generated output
            y = np.matmul(input_vector,weight_vector)
            y = activation_function(y)

            #Update weights
            weight_vector = weight_vector + n * (d - y) * input_vector

    #================================== Testing ==================================

    #Test model on training data
    hit = 0
    miss = 0

    for i in range(len(train_x)):
        #Construct input vector
        input_vector = []

        for k in range(num_of_inputs):
```

```
            input_vector.append(train_x[i][k])

        input_vector = np.array(input_vector)

        #Desired output
        d = train_y[i]

        #Generated output
        y = np.matmul(input_vector,weight_vector)
        y = activation_function(y)

        #Compare the desired output with generated output
        if y == d:
            hit = hit + 1
        else:
            miss = miss + 1

#Print results
print("Training accuracy :" + str(hit/(hit+miss)))

#Test model on testing data

hit = 0
miss = 0

for i in range(len(test_x)):

        #Construct input vector
        input_vector = []

        for k in range(num_of_inputs):
            input_vector.append(test_x[i][k])

        input_vector = np.array(input_vector)

        #Desired output
        d = test_y[i]

        #Generated output
        y = np.matmul(input_vector,weight_vector)
        y = activation_function(y)

        #Compare the desired output with generated output
        if y == d:
            hit = hit + 1
        else:
            miss = miss + 1

#Print results
print("Testing accuracy  :" + str(hit/(hit+miss)))
print("Error rate        :" + str(miss/(hit+miss)))
```

Output: