ASSIGNMENT - 9

ANIKEIT SETHI (190001003)

```
import numpy as np
from sklearn.utils import shuffle
import matplotlib.pyplot as plt
```

```
class All_Model:

    def activation_sigmoid(self,x):
        return 1/(1+np.exp(-x))

    def sigmoid_differentiation(self,x):
        return x*(1.0 - x)

    def
__init__(self,no_Inputs,no_hiden,no_out,learning_rate=0.001,epochs=1000,t=0.5)
:
        self.no_Inputs = no_Inputs
        self.no_hiden = no_hiden
        self.no_out = no_out
        self.learning_rate = learning_rate
        self.epochs = epochs
        self.threshold = t

        Layer = [self.no_Inputs] + self.no_hiden + [self.no_out]
        self.weights = []
        for i in range(len(Layer)-1):
            w = np.random.randm(Layer[i],Layer[i+1])
            self.weights.append(w)

        self.bias = []
        for i in range(len(Layer)-1):
            b = np.random.randm(1,Layer[i+1])
            self.bias.append(b)

        self.activations = []
        for i in range(len(Layer)):
            self.activations.append(np.random.randm(1,Layer[i]))

        self.wderivatives = []
        for i in range(len(Layer)-1):
            self.wderivatives.append(np.random.randm(Layer[i],Layer[i+1]))

        self.bderivatives = []
        for i in range(len(Layer)-1):
            self.bderivatives.append(np.random.randm(1,Layer[i+1]))
```

```
    def forward(self,inputs):
        a = inputs
        self.activations[0] = a.reshape(1,a.shape[0])
        for i,w in enumerate(self.weights):
            z = np.dot(a,w) + self.bias[i]
            a = self.activation_sigmoid(z)
            self.activations[i+1] = a

        return a

    def backward_pass(self,error):
        for i in reversed(range(len(self.wderivatives))):
            a_next = self.activations[i+1]
            delta = error*self.sigmoid_differentiation(a_next)
            delta = delta.reshape(delta.shape[0],-1)
            a_curr = self.activations[i]
            a_curr = a_curr.reshape(a_curr.shape[1],-1)
            self.wderivatives[i] = np.dot(a_curr,delta)
            self.bderivatives[i] = delta
            error = np.dot(delta,self.weights[i].T)

        return error

    def updating(self):
        for i in range(len(self.weights)):
            self.weights[i] += self.learning_rate*self.wderivatives[i]
            self.bias[i] += self.learning_rate*self.bderivatives[i]

    def train(self,inputs,labels):
        for i in range(self.epochs):
            for j,(x,y) in enumerate(zip(inputs,labels)):
                output = self.forward(x)
                error = y - output
                temp = self.backward_pass(error)
                self.updating()
```

Question 1

```
train_inputs = np.random.randint(2,size=(20,7))
val_inputs = np.random.randint(2,size=(10,7))

train_outputs = []
val_outputs = []

for x in train_inputs:
    if np.sum(x,axis=0)<3:
        train_outputs.append(0)
```

```
    else:
        train_outputs.append(1)

for x in val_inputs:
    if np.sum(x,axis=0)<3:
        val_outputs.append(0)
    else:
        val_outputs.append(1)

train_outputs = np.array(train_outputs)
val_outputs = np.array(val_outputs)
```

```
print("--------------Backpropagation Learning Method for 7 Input Majority Problem----------------")
print("Training from the Random training data....")
inst = Model(7,[15],1)
inst.train(train_inputs,train_outputs)
thres = 0.5
tot,cor = 0,0

for (inp,lab) in zip(train_inputs,train_outputs):
    out = inst.forward(inp)
    out = (out>thres)*1
    tot+=1
    if out==lab:
        cor+=1
    accu=cor/tot
    print(accu)
print("The prediction accuracy in Training is: ")
print(accu*100, "%")
tot,cor = 0,0

for (inp,lab) in zip(val_inputs,val_outputs):
    out = inst.forward(inp)
    out = (out>thres)*1
    tot+=1
    if out==lab:
        cor+=1
    print(accu)
    print(cor/tot)
print("The prediction accuracy in Validaion is: ")
print(accu*100, "%")
print(inst.weights)
```

Output: -

```
--------------Backpropagation Learning Method for 7 Input Majority Problem----
------------
Training from the Random training data....
1.0
1.0
1.0
0.75
0.8
0.8333333333333334
0.8571428571428571
0.875
0.8888888888888888
0.9
0.8181818181818182
0.8333333333333334
0.8461538461538461
0.8571428571428571
0.8
0.8125
0.8235294117647058
0.8333333333333334
0.7894736842105263
0.8
The Prediction accuracy in Training is:
80.0 %
0.8
1.0
0.8
0.5
0.8
0.6666666666666666
0.8
0.75
```

```
0.8
0.8
0.8
0.8333333333333334
0.8
0.8571428571428571
0.8
0.75
0.8
0.7777777777777778
0.8
0.8
The prediction accuracy in Validation is:
80.0 %
[array([[-0.06660227,  0.72155564,  0.37586231, -0.10741246, -1.65382569,
         0.66761229,  0.61488964, -0.91539825,  2.2211288 ,  0.46855515,
        -0.9924254 , -0.05937517,  0.95093172, -0.02435977, -0.26611339],
       [-1.90473897, -1.76578526, -0.52214779,  0.8498715 ,  1.79969922,
        -0.58866771,  0.41823551, -0.2699563 ,  0.04119393,  0.41387243,
         1.26056125, -1.59770543, -0.03210174, -0.21123512, -1.29265612],
       [ 0.91111313,  0.84204261, -0.06905433, -1.64214804,  0.78951244,
        -1.36183371,  0.71314258, -0.44207665, -0.64954111, -1.24881859,
         0.6386992 ,  0.1099403 , -0.76354102, -0.0633258 , -0.99162939],
       [-1.44383373, -0.76480796,  0.52142164, -0.85515827,  0.74708105,
        -0.49247987,  1.10841211,  0.32475989,  1.77209451, -0.6966146 ,
        -0.23551413,  0.59285101,  0.00282316, -0.17800279,  1.64508227],
       [ 2.57453219, -0.70034219, -0.01589378,  0.45038571,  0.05168163,
        -1.87891889,  1.60205303,  0.29604735, -0.18557684,  0.66751935,
         0.12019122, -1.06343832,  0.40951304, -1.25101041, -1.47741853],
       [-0.03249059, -0.23313102,  1.10673468, -0.65099544,  0.01931627,
         0.95506936, -1.36133367,  1.72888577,  0.14936569,  0.97763711,
         0.03928996, -0.41628484, -0.4712511 , -0.52963986, -2.7769816 ],
       [-0.17475631, -2.28847415, -1.32673761,  0.51544357, -0.58200755,
```

```
         0.16616807,  1.57696166, -0.39750736, -0.70316049,  0.70540364,
         0.80265609,  0.4074295 , -1.5220078 ,  0.80331609, -0.50037943]]),
array([[-0.16615796],
       [-0.89001294],
       [ 0.80624529],
       [-1.77810643],
       [-0.05722135],
       [ 0.27033676],
       [ 1.73266401],
       [-0.06863087],
       [-0.29580756],
       [ 0.43558615],
       [ 0.39324364],
       [-0.0418154 ],
       [ 0.65957816],
       [ 0.65975825],
       [-0.03343952]])]
```

```
# Question 2
```

```
parent_inputs = []
parent_outputs = []

for i in range(1,100):
    temp = [int(j) for j in bin(i)[2:]]
    repr = []
    for j in range(7-len(temp)):
        repr = [0] + repr
    repr = repr+list(temp)
    parent_inputs.append(np.array(repr))
    parent_outputs.append([round(1/(i+1),3)])

parent_inputs,parent_outputs =
shuffle(parent_inputs,parent_outputs,random_state=0)

train_inputs = np.array(parent_inputs[:80])
train_outputs = np.array(parent_outputs[:80])

val_inputs = np.array(parent_inputs[80:])
```

```
val_outputs = np.array(parent_outputs[80:])
```

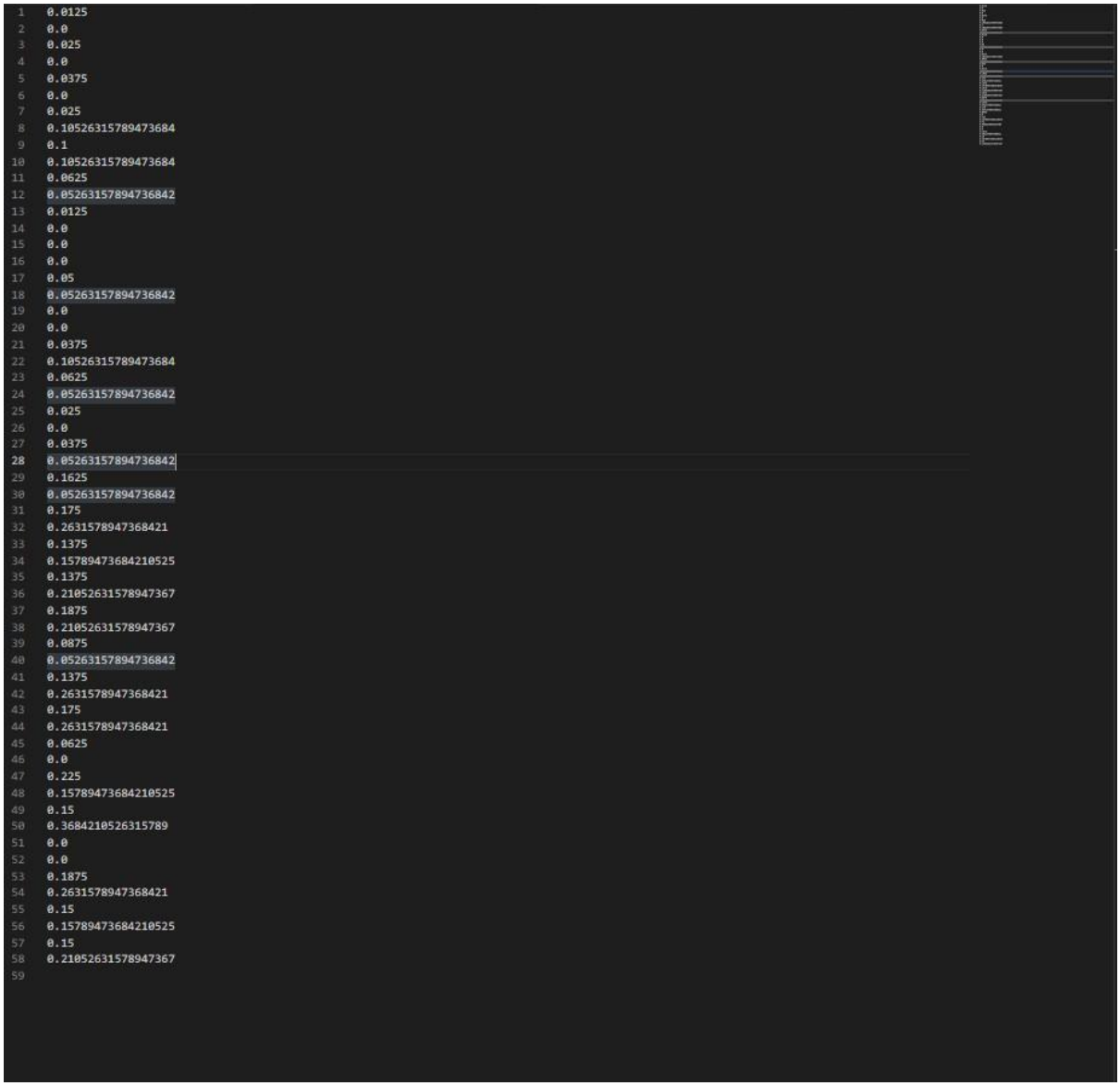
```
for hid in range(1,30):
    inst = Model(7,[hid],1)
    inst.train(train_inputs,train_outputs)

    tot,cor = 0,0

    for (inp,lab) in zip(train_inputs,train_outputs):
        out = inst.forward(inp)
        out[0][0] = round(out[0][0],2)
        lab = round(lab[0],2)
        tot+=1
        if out.item()==lab.item():
            cor+=1
    print(cor/tot)
    tot,cor = 0,0

    for (inp,lab) in zip(val_inputs,val_outputs):
        out = inst.forward(inp)
        out[0][0] = round(out[0][0],2)
        lab = round(lab[0],2)
        tot+=1
        if out.item()==lab.item():
            cor+=1
    print(cor/tot)
```

Output: -



Question 3

```
train_inputs =
np.loadtxt(open('train_data.csv'),delimiter=',',usecols=range(4),skiprows=(1))
train_outputs =
np.loadtxt(open('train_data.csv'),delimiter=',',usecols=(4),skiprows=(1),dtype
=str)
train_outputs = (train_outputs == 'versicolor')*1

train_inputs,train_outputs =
shuffle(train_inputs,train_outputs,random_state=0)
```

```
test_inputs =
np.loadtxt(open('test_data.csv'),delimiter=',',usecols=range(4),skiprows=(1))
test_outputs =
np.loadtxt(open('test_data.csv'),delimiter=',',usecols=(4),skiprows=(1),dtype=
str)
test_outputs = (test_outputs == 'versicolor')*1

test_inputs,test_outputs = shuffle(test_inputs,test_outputs,random_state=0)


inst = Model(4,[5],1)
inst.train(train_inputs,train_outputs)

thres = 0.5
tot,cor = 0,0
for (inp,lab) in zip(train_inputs,train_outputs):
    out = inst.forward(inp)
    out = (out>thres)*1
    tot+=1
    if out==lab:
        cor+=1
print(cor/tot)

tot,cor = 0,0

for (inp,lab) in zip(test_inputs,test_outputs):
    out = inst.forward(inp)
    out = (out>thres)*1
    tot+=1
    if out==lab:
        cor+=1
print(cor/tot)
```

Output: -