EX10_190095C

May 18, 2022

0.0.1 Name - Bolonghe B.P.M

0.0.2 Index no - 190095C

0.0.3 Github repository - https://github.com/Pasindu-Manodara/Image-Processing-Home-Work-Exercise.git

Question 1

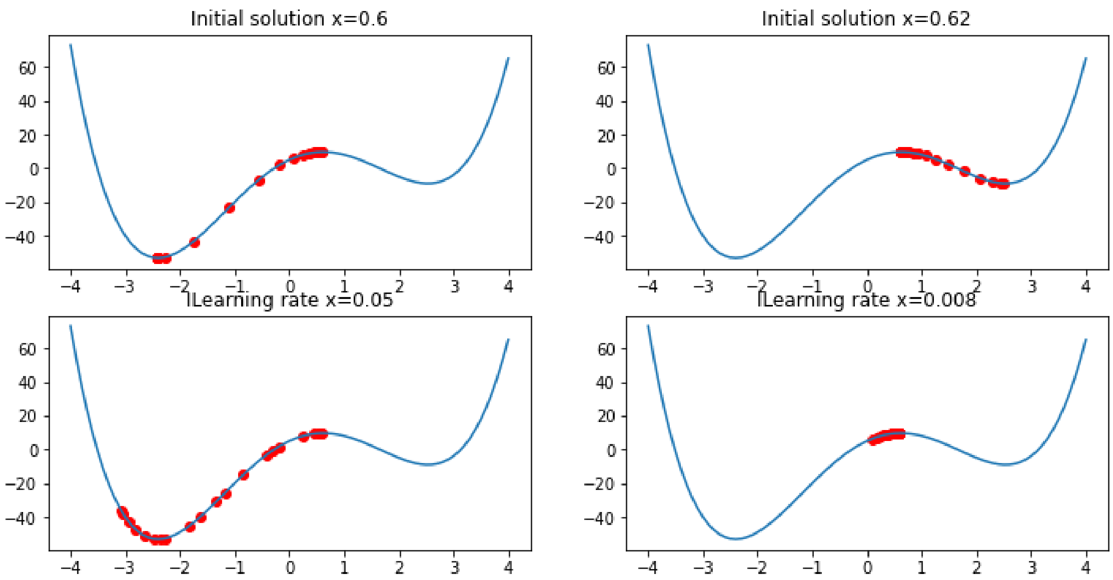
[ ]:

```
import numpy as np
import matplotlib.pyplot as plt

def f(x):
    w = np.array([1,-1,-12,15,5])
    M = np.size(w)-1
    return np.sum([x**i*w[M-i] for i in range(0,M+1)], axis=0)

def g(x):
    w = np.array([1,-1,-12,15,5])
    M = np.size(w)-1
    return np.sum([i*x**(i-1)*w[M-i] for i in range(0,M+1)], axis=0)

def minimum(x,alpha):
    # alpha = 0.02
    # x = 0.6
    x_hist = np.array(x)
    fx_hist = np.array(f(x))
    for i in range(20):
        x = x - alpha*g(x)
        x_hist= np.append(x_hist, x)
        fx_hist= np.append(fx_hist, f(x))

    print('x= ',x,'f(x) = ',f(x))
    return x_hist,fx_hist

#fig = plt.figure(figsize = (12,6))
fig,ax = plt.subplots(2,2,figsize=(12,6))
delta = 0.1
x_ = np.arange(-4,4+delta,delta)
ax[0,0].plot(x_,f(x_))
```

```
x_hist,fx_hist=minimum(0.6,0.02)
ax[0,0].scatter(x_hist,fx_hist, c='r')
ax[0,0].set_title("Initial solution x=0.6")

delta = 0.1
x_ = np.arange(-4,4+delta,delta)
ax[0,1].plot(x_,f(x_))
x_hist,fx_hist=minimum(0.62,0.02)
ax[0,1].scatter(x_hist,fx_hist, c='r')
ax[0,1].set_title("Initial solution x=0.62")

delta = 0.1
x_ = np.arange(-4,4+delta,delta)
ax[1,0].plot(x_,f(x_))
x_hist,fx_hist=minimum(0.6,0.05)
ax[1,0].scatter(x_hist,fx_hist, c='r')
ax[1,0].set_title("ILearning rate x=0.05")

delta = 0.1
x_ = np.arange(-4,4+delta,delta)
ax[1,1].plot(x_,f(x_))
x_hist,fx_hist=minimum(0.6,0.008)
ax[1,1].scatter(x_hist,fx_hist, c='r')
ax[1,1].set_title("ILearning rate x=0.008")
```

```
x=  -2.4003994283530288 f(x) =  -53.11840483760499
x=  2.5104174088324025 f(x) =  -9.073558171240812
x=  -0.29497479850285213 f(x) =  -0.43550699945570187
x=  0.09129371545369486 f(x) =  6.2686997952779855
```

```
[ ]: Text(0.5, 1.0, 'ILearning rate x=0.008')
```



Discussion

According to above example, initial solution tells which minimum point gradient descent converges. And also learning rate tuning is very important, otherwise it will not give accurate minimum valus.

[ ]:
```
# finding a root close to x0
from scipy.optimize import fsolve
from scipy.optimize import minimize
x0=0.7
root = fsolve(g,x0) #gradient is zero ath this point
print(root)

#Using scipy to find minimum
minimum = minimize(f,x0)
print(minimum)
```

```
[0.61654501]
      fun: -9.083837308515939
 hess_inv: array([[0.02625738]])
      jac: array([-7.62939453e-06])
  message: 'Optimization terminated successfully.'
     nfev: 16
      nit: 3
     njev: 8
   status: 0
  success: True
        x: array([2.53385792])
```

Question 2

[ ]:

```
import numpy as np
import tensorflow as tf
from tensorflow import keras
import matplotlib . pyplot as plt
from tensorflow.keras.datasets import cifar10 , mnist

(x_train,y_train) ,(x_test,y_test) = cifar10.load_data( )
# ( x_train , y_train ) , ( x_test , y_te st ) = mnist . load_data ( )
print(" x_train => " , x_train.shape)

Ntr = x_train.shape[ 0]
Nte = x_test.shape[ 0]
Din = 3072 # CIFAR10
 # Din = 784 # MINIST
x_train = x_train [range(Ntr),:]
x_test = x_test [range(Nte),:]
y_train = y_train [range(Ntr) ]
y_test = y_test [range(Nte)]



K = len(np.unique(y_train))

y_train = tf.keras.utils.to_categorical(y_train,num_classes=K)
y_test= tf.keras.utils.to_categorical(y_test,num_classes=K)

x_train = np.reshape(x_train,(Ntr,Din))
x_test= np.reshape(x_test,(Nte,Din))
x_train=x_train.astype(np.float32)
x_test = x_test.astype(np.float32)

x_train /= 255.
x_test /=255.
```

```
x_train =>  (50000, 32, 32, 3)
```

[ ]:

```
# Utility function for diaplaying
def display(y_train, y_test, y_train_pred, y_test_pred, loss_history, w, showim␣
 ↪= True):
    plt.plot(loss_history)


     # For diapaying the weights matrix w as an image. 32*32*3 assumption is␣
 ↪there
    if showim:
        f, axarr = plt.subplots(2, 5)
        f.set_size_inches(16, 6)
        for i in range(10):
            img = w[:, i].reshape(32, 32, 3)# CIFAR10
            # img = w1[:, i].reshape(28, 28)# MNIST
            img = (img - np.amin(img))/(np.amax(img) - np.amin(img))
            axarr[i//5, i%5].imshow(img)
        plt.show()

    train_acc = np.mean(np.abs(np.argmax(y_train, axis=1) == np.
↪argmax(y_train_pred, axis=1)))
    print("train_acc = ", train_acc)

    test_acc = np.mean(np.abs(np.argmax(y_test, axis=1) == np.
↪argmax(y_test_pred, axis=1)))
    print("test_acc = ", test_acc)
```

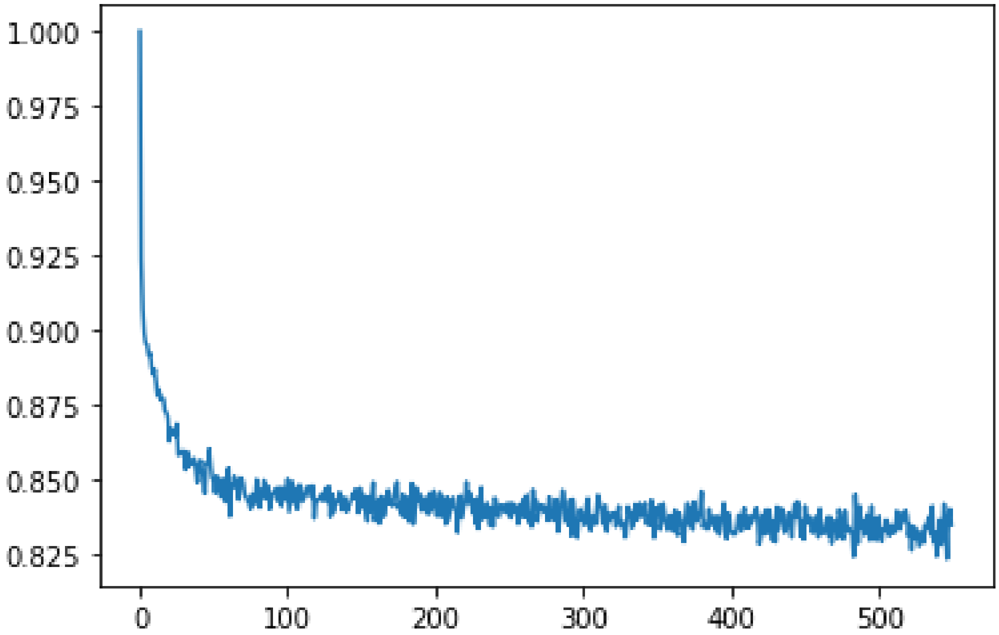
[ ]:

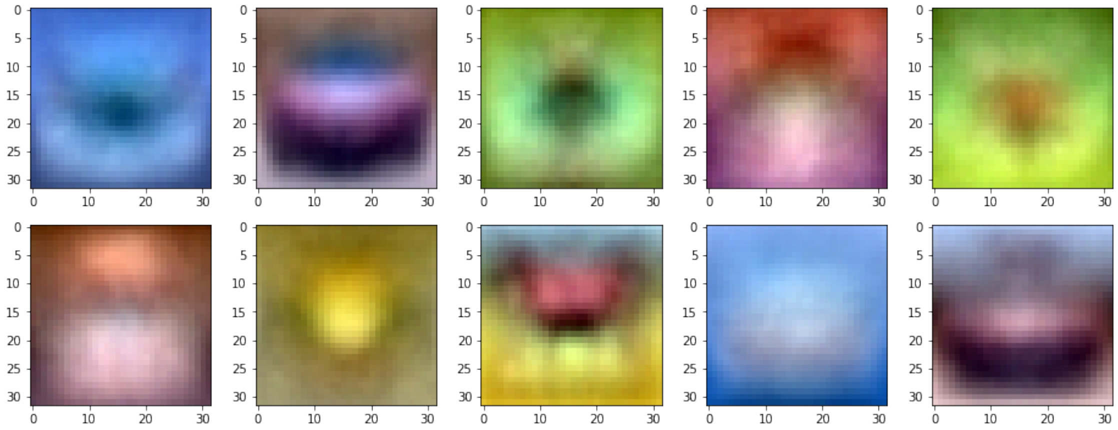
```
std =1e-5
w = std*np.random.randn(Din,K)
b = np.zeros(K)
lr = 1e-3
lr_decay=0.1
epochs =11
batch_size=1000
loss_history = []
rng = np.random.default_rng(seed=0)

for e in range(epochs):
    indices = np.arange(Ntr)
    rng.shuffle(indices)
    for batch in range(Ntr//batch_size):
        batch_indices = indices[batch*batch_size:(batch+1)*batch_size]
        x =x_train[batch_indices]#Extract a batch of 100
        y = y_train[batch_indices]

        #Forward pass
        y_pred = x@w+b
        loss=1./batch_size*np.square(y_pred-y).sum()
        loss_history.append(loss)

        #backward pass
        dy_pred =1./batch_size*2.0*(y_pred-y)
        dw = x.T @ dy_pred
        db = dy_pred.sum(axis=0)*1
        w=w-lr*dw
        b = b-lr*db

    if e % 5==0:
        print("Iteration %d / %d: loss %f"%(e,epochs,loss))
    if e % 10==0:
        lr *= lr_decay
```

```
Iteration 0 / 11: loss 0.850451
Iteration 5 / 11: loss 0.836759
Iteration 10 / 11: loss 0.834914
```

[ ]:

```
y_train_pred = x_train.dot(w)+b
y_test_pred = x_test.dot(w)+b
display(y_train,y_test,y_train_pred,y_test_pred,loss_history,w,showim=True)
```





```
train_acc =  0.3358
test_acc =  0.3354
```