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Index No.: 190172K

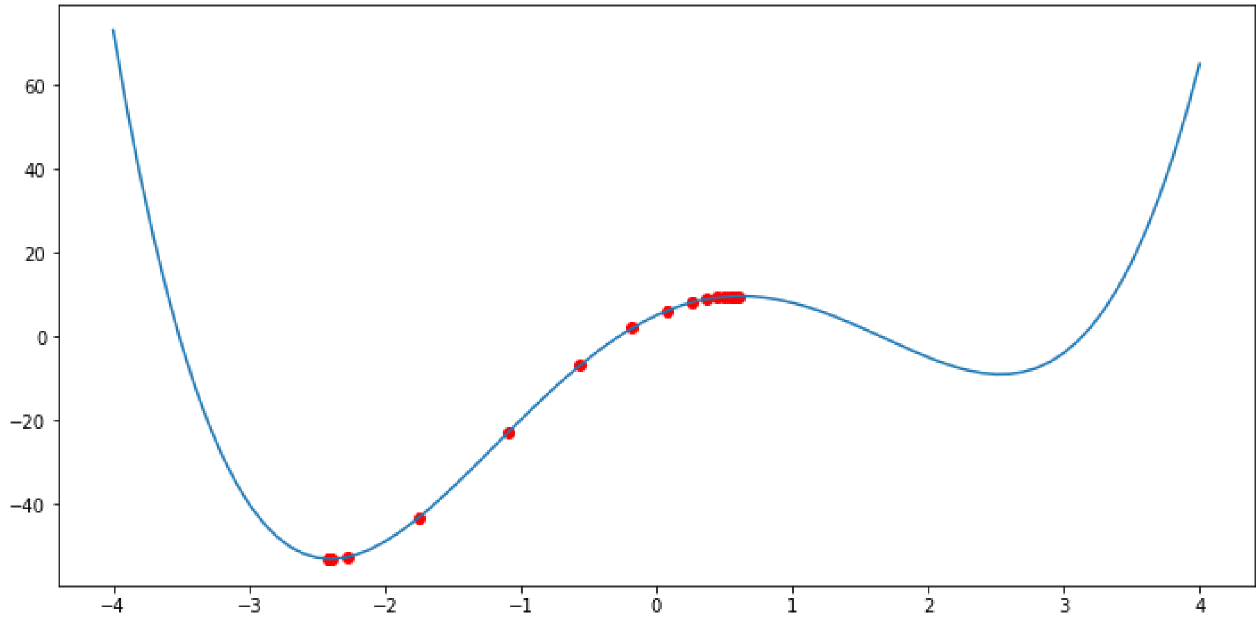
In [ ]:

```
import cv2
import numpy as np
import sympy
import matplotlib.pyplot as plt
import matplotlib.gridspec as gridspec
from plyfile import PlyData,PlyElement
%matplotlib inline
```

In [ ]:

```
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)

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))

fig = plt.figure(figsize = (12,6))
ax = plt.subplot(1,1,1)
delta = 0.1
x_ = np.arange(-4,4+delta,delta)
ax.plot(x_,f(x_))
ax.scatter(x_hist,fx_hist, c='r')
plt.show()
```

```
x =  -2.4003994283530288 f(x) = -53.11840483760499
```



In [ ]:

```
from scipy.optimize import fsolve
from scipy.optimize import minimize
x0 = 0.7
root = fsolve(g,x0)
print(root)
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])
```

In [ ]:

```
import tensorflow as tf
from tensorflow import keras
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_tes t ) = 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 ) ]
```

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

In [ ]:

```
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.
```

In [ ]:

```
def display(y_train, y_test, y_train_pred, y_test_pred, loss_history, w, showim = True)
    plt.plot(loss_history)
    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)
            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, ax
    print("train_acc = ", train_acc)

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

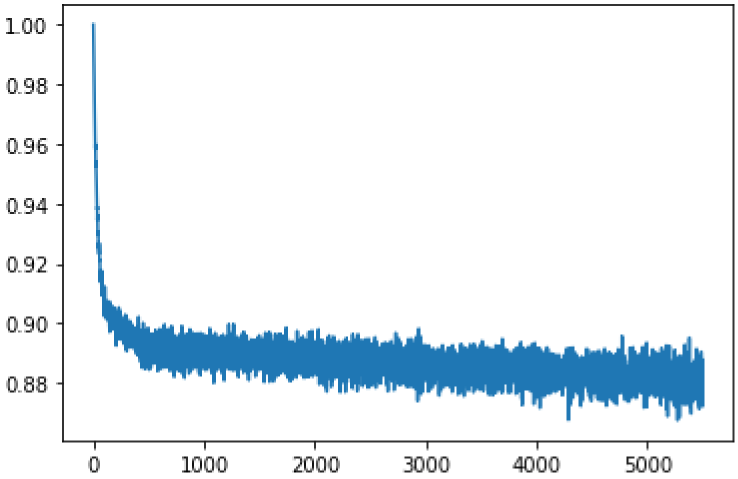
In [ ]:

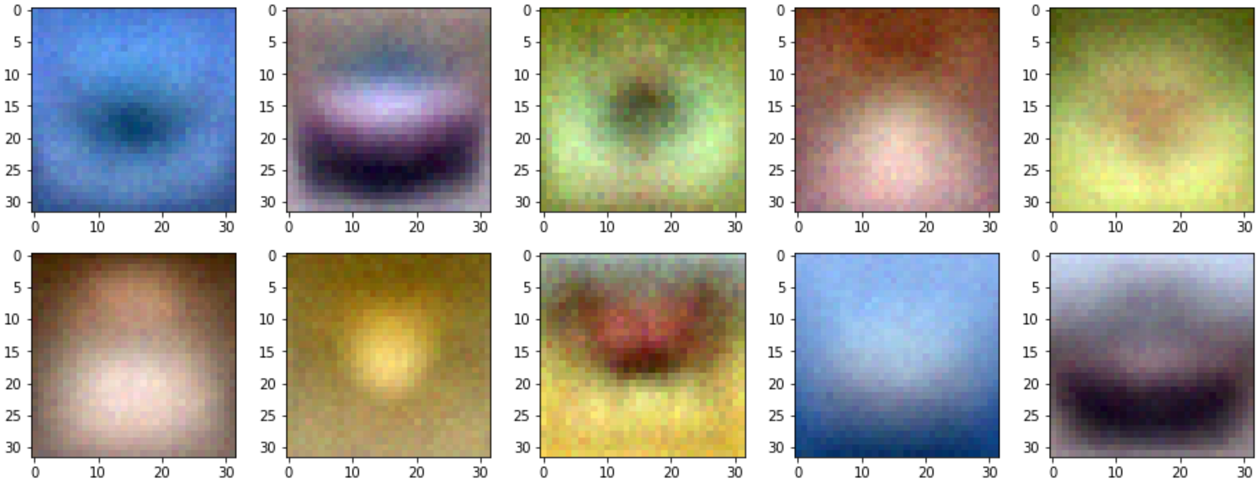
```
std = 1e-5
w = std*np.random.randn(Din, K)
b = np.zeros(K)
lr = 1e-5
lr_decay = 0.1
epochs = 11
batch_size = 100
loss_history = []
rng = np.random.default_rng(seed = 0)

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]
        y = y_train[batch_indices]

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

        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 0.892720
Iteration 5 / 11 : loss 0.887805
Iteration 10 / 11 : loss 0.876355
```

In [ ]:

```
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 =  0.24772
test_acc =  0.245
```