Shivani_Patel Assignment #1 Neural Networks

July 4, 2021

[1]:
```python
import numpy as np
%matplotlib inline
import matplotlib.pyplot as plt

class Neural_Network(object):
    def __init__(self):
        #Define Parameters
        self.inputLayerSize = 2
        self.outputLayerSize=1
        self.hiddenLayerSize=3

        #Define Weights
        self.W1=np.random.rand(self.inputLayerSize,self.hiddenLayerSize)
        self.W2=np.random.rand(self.hiddenLayerSize,self.outputLayerSize)



    def forward(self,X):
        #Propagate inputs through network
        self.z2 = np.dot(X,self.W1)
        self.a2 = self.sigmoid(self.z2)
        self.z3 = np.dot(self.a2,self.W2)
        yHat = self.sigmoid(self.z3)
        return yHat

    def sigmoid(self, z):
        #Apply Sigmoid Activation Function
        return 1/(1+np.exp(-z))

    def sigmoidPrime(self,z):
        #Derivative of Sigmoid Function
        return np.exp(-z)/((1+np.exp(-z))**2)

    def costFunction(self, X, y):
        #Compute Cost Function with weights already stored in class
        self.yHat=self.forward(X)
        J=0.5*sum((y-self.yHat)**2)
```

```
        return J

    def costFunctionPrime(self, X, y):
        #Compute derivatives with respect to W1 and W2
        self.yHat=self.forward(X)
        delta3 = np.multiply(-(y-self.yHat),self.sigmoidPrime(self.z3))
        dJdW2=np.dot(self.a2.T,delta3)
        delta2=np.dot(delta3,self.W2.T)*self.sigmoidPrime(self.z2)
        dJdW1=np.dot(X.T,delta2)
        return dJdW1,dJdW2
```

[2]:
```
X=np.array(([3,5],[5,1],[10,1]),dtype=float)
y=np.array(([75],[80],[93]),dtype=float)
```

[3]:
```
X
```

[3]:
```
array([[ 3.,  5.],
       [ 5.,  1.],
       [10.,  1.]])
```

[4]:
```
y #answer
```

[4]:
```
array([[75.],
       [80.],
       [93.]])
```

[5]:
```
X=X/np.amax(X,axis=0)
y=y/100
```

[6]:
```
X,y
```

[6]:
```
(array([[0.3, 1. ],
        [0.5, 0.2],
        [1. , 0.2]]),
 array([[0.75],
        [0.8 ],
        [0.93]]))
```

[7]:
```
NN=Neural_Network()
```

[8]:
```
yH=NN.forward(X)
```

[9]:
```
yH
```

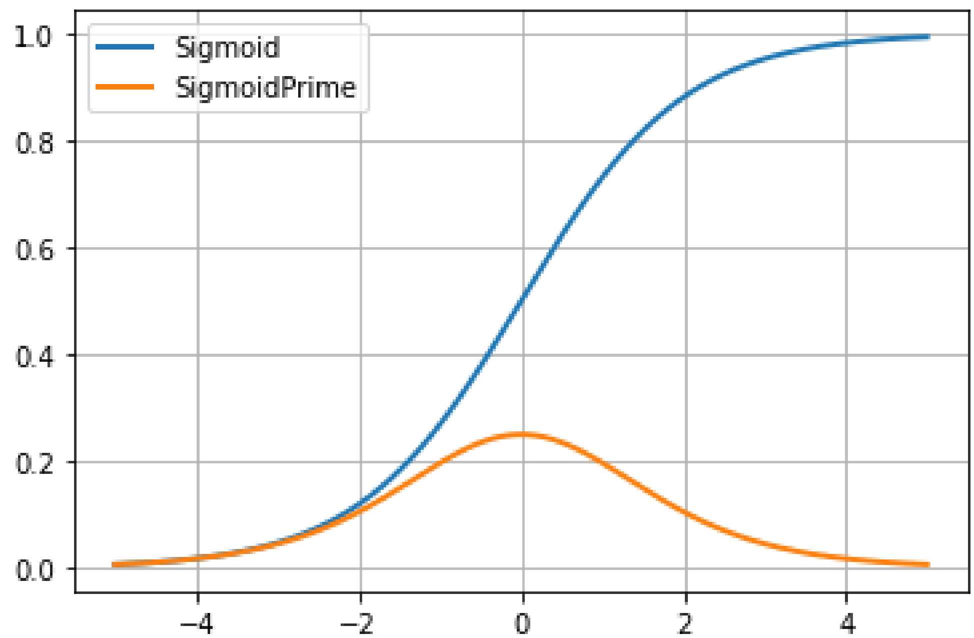
[9]:
```
array([[0.73101061],
       [0.7192052 ],
       [0.74626236]])
```

[10]:
```
y
```

[10]:
```
array([[0.75],
       [0.8 ],
       [0.93]])
```

[11]:
```
testValues=np.arange(-5,5,0.01)
plt.plot(testValues,NN.sigmoid(testValues),linewidth=2)
plt.plot(testValues, NN.sigmoidPrime(testValues),linewidth=2)
plt.grid(1)
plt.legend(['Sigmoid','SigmoidPrime'])
#u=NN.sigmoidPrime(testValues)
```

[11]:
```
<matplotlib.legend.Legend at 0x7fd1f9f8bdc0>
```



[12]:
```
NN=Neural_Network()
```

[13]:
```
cost1=NN.costFunction(X,y)
```

[14]:
```
dJdW1,dJdW2=NN.costFunctionPrime(X,y)
```

[15]:
```
dJdW1
```

[15]:
```
array([[-0.00440161, -0.00265527, -0.01439573],
       [-0.00148308, -0.00091192, -0.00481558]])
```

[16]:
```
dJdW2
```

[16]:
```
array([[-0.04906394],
       [-0.04421233],
       [-0.04153439]])
```

[17]:
```
scalar= 30
NN.W1 = NN.W1+scalar*dJdW1
NN.W2 = NN.W2+scalar*dJdW2
cost2 = NN.costFunction(X,y)
print (cost1,cost2)
```

```
[0.03109995] [0.62784011]
```

[18]:
```
scalar=3
NN.W1 = NN.W1-scalar*dJdW1
NN.W2 = NN.W2-scalar*dJdW2
cost3 = NN.costFunction(X,y)
print (cost2,cost3)
```

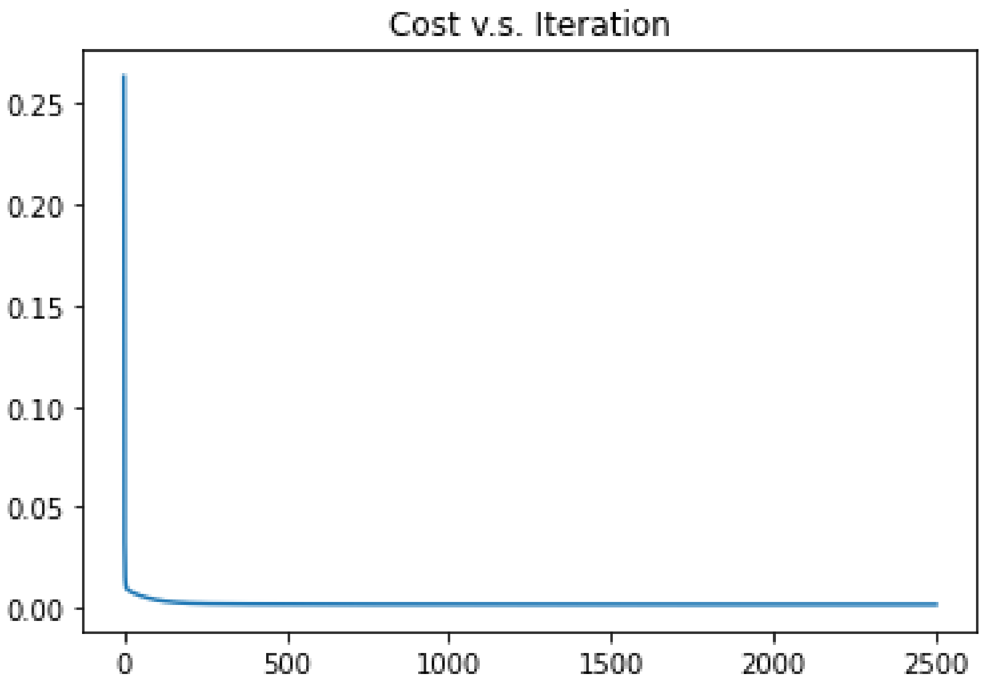
```
[0.62784011] [0.56092123]
```

[19]:
```
n= 2500
array=[]
x=np.arange(0,n)

for i in range(n):
    dJdW1, dJdW2 = NN.costFunctionPrime(X,y)
    NN.W1 = NN.W1 - scalar*dJdW1
    NN.W2 = NN.W2 - scalar*dJdW2
    cost = NN.costFunction(X, y)
    array.append(cost)
print(cost)
```

```
[0.00178209]
```

[20]:
```
plt.plot(x,array)
plt.title('Cost v.s. Iteration')
```

[20]:
```
Text(0.5, 1.0, 'Cost v.s. Iteration')
```



[21]:
```
y
```

[21]:
```
array([[0.75],
       [0.8 ],
       [0.93]])
```

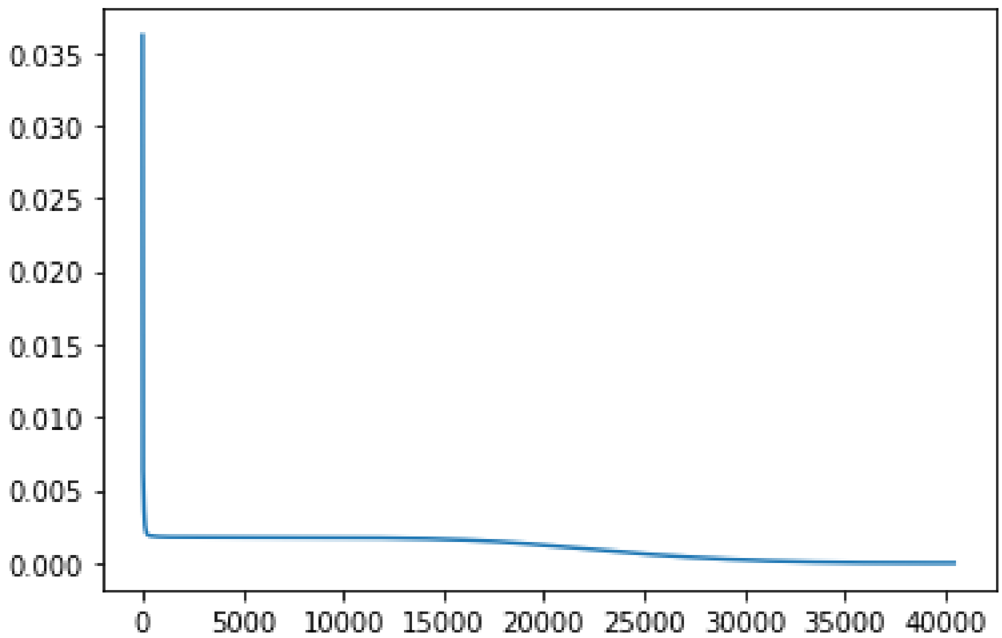
[22]:
```
scalar=15
stats = []

NN=Neural_Network()
cost=NN.costFunction(X,y)

while (cost > 0.000001):
    dJdW1,dJdW2=NN.costFunctionPrime(X,y)
    NN.W1 = NN.W1-scalar*dJdW1
    NN.W2 = NN.W2-scalar*dJdW2
    cost = NN.costFunction(X,y)
    stats.append(cost)

    if (scalar > 4):
        scalar -= 1

yHat = NN.forward(X)
```

```
yHat
```

[22]:
```
array([[0.7496793 ],
       [0.80094003],
       [0.92899356]])
```

[23]:
```
plt.plot(stats)
```

[23]:
```
[<matplotlib.lines.Line2D at 0x7fd1f1a9dc40>]
```



[24]:
```
# This neural network minimizes the cost to 0.000001 using batch gradient␣
↪descent.
# The learning rate is designedto get smaller as it makes progress towards the␣
↪target value.
# This approach helps to filter out local minimums and focus on the global␣
↪minimum.
```