18KU1A05D2.

Assignment - 3

Let consider a sample dataset have one i/p (X_i^2) & one o/p (Y_i^2), & number of samples 4. Develop a simple linear regression model using Stochastic Gradient Descent Optimizer.

Sample (i)	X_i^2	Y_i^2
1	0.2	3.4
2	0.4	3.8
3	0.6	4.2
4	0.8	4.6

* → i) Do manual calculations for 2 iterations with 1st two samples.

Stochastic Gradient Descent Algorithm:

Step1: $m=1$, $c=-1$, $\eta=0.1$, epochs $=2$, $n_s=2$

Step2: iter $=1$

Step3: sample $=1$ $(i=1)$

Step4: $E=\frac{1}{2}(y_i-mx_i-c)^2$

$i=1$. $\frac{\partial E}{\partial m}=-(y_i-mx_i-c)x_i=-(y_1-mx_1-c)x_1$

$=-(3.4-(1)(0.2)-1)\,0.2$

$=-0.44$

$\frac{\partial E}{\partial c}=-(y_i-mx_i-c)=-(y_1-mx_1-c)$

$=-2.2$

Step5: $\Delta m=-\eta.\frac{\partial E}{\partial m}=-(0.1)(-0.44)$

$=-0.044$

$\Delta c = -\eta . \frac{\partial E}{\partial c} = -(0.1)(-2.2) = -0.22$

<u>Step 6:</u> $m = m + \Delta m = 1 - 0.044 = 0.956$ //

$c = c + \Delta c = 1 - 0.22 = 0.78$ //

<u>Step 7:</u> Sample $= 1 + 1 = 2$ $(i = 2)$

<u>Step 8:</u> if (sample $\overset{2 > 2}{> n_s}$) no,

else goto step 4.

<u>Step 4:</u> $\frac{\partial E}{\partial m} = -(y_i - m x_i - c) x_i$

$= -(y_2 - m x_2 - c) x_2$

$= -(3.8 - (0.956 \times 0.4) - 0.78)(0.4)$

$= -1.05504$ //

$\frac{\partial E}{\partial c} = -(y_i - m x_i - c)$

$= -(3.8 - (0.956 \times 0.4) - 0.78)$

$= -2.6376$ //

<u>Step 5:</u> $\Delta m = -\eta . \frac{\partial E}{\partial m} = -(-0.1)(-1.05504) = -0.105504$ //

$\Delta c = -\eta . \frac{\partial E}{\partial c} = -(-0.1)(-2.6376) = -0.26376$ //

<u>Step 6:</u> $m = m + \Delta m, = 0.956 - 0.105504 = 0.8504$ //

$c = c + \Delta c = 0.78 - 0.26376 = 0.51624$ //

<u>Step 7:</u> Sample $= 2 + 1 = 3$ $(i = 3)$

Step8: if (sample > n_s) yes ⇒ goto step 9. $3>2$

Step9: if (iter > epochs) no $2>2$

else goto step 3.

Step3: sample = 1 (i = 1)

Step4: $\frac{\partial E}{\partial m} = -(y_i - mx_i - c)x_i$

$= -(3.4 - (0.8504)(0.2) - 0.51624)(0.2)$

$= -0.5427321$ //

$\frac{\partial E}{\partial c} = -(y_i - mx_i - c)$

$= -(3.4 - (0.8504)(0.2) - 0.51624)$

$= -2.7136$ //

Step5: $\Delta m = -\eta \cdot \frac{\partial E}{\partial m} = -(-0.1)(-0.5427) = -0.0542732$ //

$\Delta c = -\eta \cdot \frac{\partial E}{\partial c} = -(-0.1)(-2.7136) = -0.27136$ //

Step6: $m = m + \Delta m = 0.9576 - 0.05427 = 0.79622$ //

$c = c + \Delta c = \cancel{0.9637} - 0.27136 = 0.24488$ //

0.51624

Step7: sample = 1+1 = 2. (i = 2)

Step8: if (sample > n_s) no $2>2$

else goto step 4.

Step4: $\frac{\partial E}{\partial m} = -(y_i - mx_i - c)x_i$

$= -(3.8 - (0.79622 \times 0.4) - 0.24488)(0.4)$

$= -1.29468$ //

$$\frac{\partial E}{\partial c} = -(y_i - mx_i - c) = -(3.8 - (0.79622)(0.4) - 0.244888)$$

$$= -3.236$$

Step 5: $\Delta m = -\eta \cdot \frac{\partial E}{\partial m} = -(-0.1)(-1.29) = -0.129$

$\Delta c = -\eta \cdot \frac{\partial E}{\partial c} = -(-0.1)(-3.236) = -0.323$

Step 6: $m = m + \Delta m = 0.79622 + (-0.129) = 0.66$

$c = c + \Delta c = 0.24488 - 0.323 = -0.079$

Step 7: Sample = 2+1 = 3.

Step 8: if (sample > n_s) $3 > 2$ yes goto step 9.

Step 9: iter = 2+1 = 3

Step 10: if (iter > epochs) $3 > 2$ yes $\Rightarrow$ goto step 11.

Step 11: print(m, c) $\boxed{m = 0.66}$, $\boxed{c = -0.079}$