Assignment - 09 :-

Let consider a sample dataset have one i/p (x_i^a) & one o/p (y_i^a) & number of samples 4. Develop a simple linear regression model using momentum optimizer.

sample (i)	x_i^a	y_i^a
1	0.2	3.4
2	0.4	3.8
3	0.6	4.2
4	0.8	4.6

- Do manual calculations for two iterations with first 2 samples

sol:-

sample (i)	x_i^a	y_i^a
1	0.2	3.4
2	0.4	3.8

Applying momentum optimizer + stochastic gradient optimizer (SGD)

step1:- $[x, y]$, $m=1$, $c=1$, $\eta=0.1$, epochs $= 2$, $ns=2$

$\gamma = 0.9$, $V_m = V_c = 0$.

step2:- iter = 1

step3:- sample = 1

step4:- $\frac{\partial E}{\partial m} = -(y_i - mx_i - c)(x_i)$

$= -[3.4 - (1)(0.2) - 1](0.2)$

$$\boxed{\frac{\partial E}{\partial m} = -0.44}$$

$$\frac{\partial E}{\partial c} = -(y_i - mx_i - c) = -[3.4 - (1)(0.2) - 1]$$

$$\boxed{\frac{\partial E}{\partial c} = -2.2}$$

$\left(\because g_m = \frac{\partial E}{\partial m}, \quad g_c = \frac{\partial E}{\partial c}\right)$

step 5:- $V_m = \gamma V_m - \eta g_m$

$= (0.9)(0) - (0.1)(-0.44)$

$= 0 - (0.1)(-0.44)$

$$\boxed{V_m = 0.044}$$

$V_c = \gamma V_c - \eta g_c$

$= (0.9)(0) - (0.1)(-2.2)$

$= 0 + 0.22$

$$\boxed{V_c = +0.22}$$

step 6:- $m = m + V_m$

$= 1 + 0.044$

$$\boxed{m = 1.044}$$

$c = c + V_c$

$= 1 + 0.22$

$$\boxed{c = 1.22}$$

step 7:- sample = sample + 1 = 1 + 1 = 2

step 8:- if (sample > ns)

$2 > 2$ ×

False: go to step 4

step 4:- $\frac{\partial E}{\partial m} = -x_i(y_i - mx_i - c)$

$= -(0.4)[3.8 - (1.044)(0.4) - 1.22]$

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$$\boxed{\frac{\partial E}{\partial m} = -0.86496}$$

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

$$= -\left[3.8 - (1.044)(0.4) - (1.22)\right]$$

$$\boxed{\frac{\partial E}{\partial c} = -2.1624}$$

step5:- $V_m = \gamma V_m - \eta \frac{\partial E}{\partial m}$

$$= (0.9)(0.044) - (0.1)(-0.86496)$$

$$\boxed{V_m = 0.126096}$$

$$V_c = \gamma V_c - \eta \frac{\partial E}{\partial c}$$

$$= (0.9)(0.22) - (0.1)(-2.1624)$$

$$\boxed{V_c = 0.41424}$$

step6:- $m = m + V_m$

$$= 1.044 + 0.126096$$

$$\boxed{m = 1.170096}$$

$$c = c + V_c$$

$$= 1.22 + 0.41424$$

$$\boxed{c = 1.63424}$$

step7:- sample = sample + 1

= 2+1 = 3

step8:- if (sample > ns)

3 > 2 ✓

True: go to next step

step 9 :- iter = iter + 1

= 1 + 1

= 2

step10 :- if (iter > epochs)

2 > 2 ✗

False : go to step 3.

step3 :- sample = 1

step4 :- $\frac{\partial E}{\partial m} = -x_i(y_i - mx_i - c)$

$= -(0.2)[3.4 - (1.170096)(0.2) - 1.63424]$

$= -0.2(1.5317408)$

$\boxed{\frac{\partial E}{\partial m} = -0.30634816}$

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

$= -[3.4 - (1.170096)(0.2) - 1.63424]$

$\boxed{\frac{\partial E}{\partial c} = -1.5317408}$

steps :- $V_m = \gamma V_m - \eta \frac{\partial E}{\partial m}$

$= \cancel{(0.9)(0.41424)}$

$= (0.9)(0.126096) - (0.1)(-0.30634816)$

$\boxed{V_m = 0.144121216}$

$V_c = \gamma V_c - \eta \frac{\partial E}{\partial c}$

$= (0.9)(1.63424) - (0.1)[-1.5317408]$

$\boxed{V_c = 1.62399008}$

step6:- $m = m + V_m$

$= 1.170096 + 0.144121216$

$m = 1.314217216$

$c = c + V_c$

$= 1.63424 + 1.62399008$

$\boxed{C = 3.25823008}$

step7:- Sample = sample + 1

$= 1 + 1$

$= 2$

step8:- if (sample > ns)

$2 > 2$.

False: go to step4.

step4:- $\frac{dE}{dm} = -(y_i - m x_i - c)(x_i)$

$= -[[3.8 - (1.314217216)(0.4) - 3.25823008](0.4)$

$\frac{dE}{dm} = -(0.0160830336)(0.4)$

$= -0.0064332134 4$

$\frac{dE}{dc} = -(y_i - m x_i - c)$

$\frac{dE}{dc} = -0.0160830336.$

step5:- $V_m = \gamma V_m - \eta \frac{dE}{dm}$

$= (0.9)(0.144121216) - (0.1)(-0.0064332134 4)$

$V_m = \cancel{0.129065773}3) = 0.1303524157$

$\boxed{V_m = 0.1303524157}$

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$V_c = \gamma V_c - \eta \frac{dE}{dc}$

$= (0.9)(1.62399008) - (0.1)(-0.0160830336)$

$\boxed{V_c = 1.463199375}$

step6:- $m = m + V_m$

$= 1.314217216 + 0.130352415 7$

$\boxed{m = 1.444569632}$

$c = c + V_c$

$= 3.25823008 + 1.463199375$

$\boxed{C = 4.721429455}$

step7:- sample = sample + 1

= 2+1

= 3

step8:- if (sample > ns)

3 > 2

True: go to next step

step9:- iter = iter + 1

= 2+1

= 3

step10:- if (iter > epochs)

3 > 2 ✓

True: go to next step

step11:- print m & c values.

$m = 1.444569632$, $c = 4.721429455$