Assignment -13 :-

Let consider a sample dataset have one input (x_i^9) and one output (Y_i^9) and number of samples 4. Develop a simple linear regression model using ADAGRAD Optimizer.

sample (i)	x_i^9	Y_i^9
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 samples.

sol:- step1:- [x, y], epochs = 2, m = 1, c = 1, $G_m = G_c = 0$,

$\eta = 0.1$, $\varepsilon = 10^{-8}$.

step2:- iter = 1

step3:- sample = 1

step4:- $g_m = -[y_i - mx_i - c)(x_i)$

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

$g_m = -0.44$

$g_c = -(y_i - mx_i - c)$

$= -(3.4 - (1)(0.2) - 1) = -2.2$ $\quad g_c = -2.2$

step5:- $G_m = G_m + (g_m)^2$

$= 0 + (-0.44)^2 = -0.1936$ $\quad G_m = +0.1936$

$G_c = G_c + (g_c)^2 = 0 + (-2.2)^2 = 4.84$.

$G_c = 4.84$

step6:- $\Delta m = \frac{-\eta}{\sqrt{G_m + \varepsilon}} (g_m)$

$\Delta m = \frac{-0.1}{\sqrt{0.1936 + 10^{-8}}} (-0.44) = 0.0999$.

$\Delta m = 0.0999$

$\Delta c = \frac{-\eta}{\sqrt{G_c + \varepsilon}} (g_c) = \frac{-0.1}{\sqrt{4.84 + 10^{-8}}} (-2.2)$

$\Delta c = 0.0999$

step7:- $m = m + \Delta m$

$m = 1 + 0.0999 = 1.0999$ $\quad m = 1.0999$

$c = c + \Delta c = 1 + 0.0999 = 1.0999$ $\quad c = 1.0999$

step8:- sample = sample + 1

$= 1 + 1$

$= 2$

step9:- if (sample > no)

$2 > 2$

false:- goto step 4.

step4:- $g_m = -(y_i - mx_i - c)(x_i)$

$= -[3.8 - (1.0999)(0.4) - (1.0999)](0.4)$

$= -(3.8 - 0.43996 - 1.0999)(0.4)$

$g_c = -(y_i - mx_i - c)$

$g_m = -0.904$

$g_c = -(y_i - mx_i - c) = -(3.8 - (1.0999)(0.4) - (1.0999)$

$g_c = -2.26014$

step5:- $G_m = G_m + (g_m)^2$

$= 0.1936 + (-0.904)^2$

$G_m = 1.0108$

$G_c = G_c + (g_c)^2$

$= 4.84 + (-2.26014)^2$

$G_c = 9.948$

step6:- $\Delta m = \frac{-\eta}{\sqrt{G_m + \varepsilon}} (g_m)$

$= \frac{-0.1}{\sqrt{1.018 + 10^{-8}}} (-0.904)$

$\Delta m = 0.089$

$\Delta c = \frac{-\eta}{\sqrt{G_c + \varepsilon}} (g_c)$

$\Delta c = \frac{-0.1}{\sqrt{9.948 + 10^{-8}}} (-2.26014)$

$\Delta c = 0.07165$

step7:- $m = m + \Delta m$

$m = 1.0999 + 0.089$

$\boxed{m = 1.1889}$

$c = c + \Delta c$

$= 1.0999 + 0.07165$

$\boxed{c = 1.17155}$

step8:- sample = sample + 1

$= 2 + 1 = 3$

step9:- if (sample > ns)

$3 > 2$

True: go to step10.

step10:- iter = iter + 1

$= 1 + 1$

$= 2$

step11:- if (iter > epochs)

$2 > 2$

false: go to step3.

step3:- sample = 1

step4:- $g_m = -(y_i - mx_i - c)(x_i)$

$= -(3.4 - (1.1889)(0.2) - 1.17155)(0.2)$

$= -(3.4 - 0.2377 - 1.17155)(0.2)$

$\boxed{g_m = -0.398}$

step5:- $g_c = -(y_i - mx_i - c)$

$= -(3.4 - (1.1889)(0.2) - 1.17155)$

$= -(3.4 - 0.2377 - 1.17155)$

$\boxed{g_c = -1.99075}$

Step 5:- $G_m = G_m + (g_m)^2$

$= 1.0108 + (-0.398)^2$

$G_m = 1.1692$

$G_c = G_c + (g_c)^2$

$= 9.948 + (-1.99075)^2$

$G_c = 13.9110$

Step 6:-

$$\Delta m = \frac{-\eta}{\sqrt{G_m + \varepsilon}} (g_m)$$

$$= \frac{-0.1}{\sqrt{1.1692 + 10^{-8}}} (-0.398)$$

$\Delta m = 0.036$

$$\Delta c = \frac{-\eta}{\sqrt{G_c + \varepsilon}} (g_c)$$

$$= \frac{-0.1}{\sqrt{13.9118 + 10^{-8}}} (-1.9907)$$

$\Delta c = 0.0533$

Step 7:- $m = m + \Delta m$

$= 1.1889 + 0.036$

$m = 1.2249$

$c = c + \Delta c$

$= 1.17155 + 0.0533$

$c = 1.22485$

step8:- sample = sample + 1
= 1 + 1
= 2

step9:- if (sample > ns)
2 > 2
false : goto step 4.

step4:- $g_m = -(y_i - mx_i - c)(x_i)$
$= -(3.8 - (1.22249)(0.4) - 1.22485)(0.4)$
$= -(3.8 - 0.48996 - 1.22485)(0.4)$

$g_m = -0.8340$

$g_c = -(y_i - mx_i - c)$
$= -(3.8 - (1.22249)(0.4) - (1.22485))$

$g_c = -2.08519$

step5:- $G_m = G_m + (g_m)^2$
$= 1.1692 + (-0.8340)^2$
$G_m = 1.8647$
$G_c = G_c + (g_c)^2$
$= 13.9110 + (-2.08519)^2$
$G_c = 18.25901$

Step6:- $\Delta m = \frac{-\eta}{\sqrt{G_m + \varepsilon}} (g_m)$
$= \frac{-0.1}{\sqrt{(1.8647) + 10^{-8}}} (-0.8340)$

$\Delta m = 0.0610$

$$\Delta c = \frac{-\eta}{\sqrt{Gc + \varepsilon}} (gc)$$

$$= \frac{-0.1}{\sqrt{(18.259) + 10^{-8}}} (-2.085)$$

$$\boxed{\Delta c = 0.0487}$$

step7:- $m = m + \Delta m$

$= 1.2249 + 0.0610$

$$\boxed{m = 1.2859}$$

$c = c + \Delta c$

$= 1.22485 + 0.0487$

$$\boxed{c = 1.27355}$$

step8:- sample = sample + 1

$= 2 + 1$

$= 3$

step9:- if (sample > ns)

$3 > 2$

True: goto nextstep.

step10:- iter = iter + 1

$= 2 + 1$

$= 3$

step11:- if (iter > epochs)

$3 > 2$

True: goto nextstep.

step12:- print m & c values

m = 1.2859, c = 1.2735