Assignment 05

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Let us consider a sample dataset have one input (X_i^a) & one output (Y_i^a) & number of samples 4. Develop a Simple Linear regression model using MBGD
(Mini Batch Gradient Descent)

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 2 iterations with batch size 2.

Batch1

X	Y
0.2	3.4
0.8	4.6

Batch2

X	Y
0.4	3.8
0.6	4.2

Step1 : [X, Y], $m=1$, $c=-1$, $\eta=0.1$, epoch=100,
$bs=2$

Step2 : Split Training data based on bs
no. of batches $= nb = \frac{ns}{bs} = \frac{4}{2} = 2$

Step3 : iter=1

Step4 : batch=1

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step5: $E = \frac{1}{2bs} \sum_{i=1}^{bs} (y_i - mx_i - c)^2$

Gradient Calculation w.r.to model parameters

$$\frac{\partial E}{\partial m} = \frac{-1}{bs} \sum_{i=1}^{bs} (y_i - mx_i - c)(x_i)$$

$$= \frac{-1}{2}\left[(y_1 - mx_1 - c)(x_1) + (y_2 - mx_2 - c)(x_2)\right]$$

$$= \frac{-1}{2}\left[(3.4 - (1)(0.2) + 1)(0.2) + (4.6 - 0.8 + 1)(0.8)\right]$$

$$= \frac{-1}{2}\left[0.84 + 3.84\right] = \underline{-2.34}$$

$$\frac{\partial E}{\partial c} = \frac{-1}{bs} \sum_{i=1}^{bs} (y_i - mx_i - c)$$

$$= \frac{-1}{bs} \sum_{i=1}^{2} (y_i - mx_i - c)$$

$$= \frac{-1}{2}\left[(3.4 - 0.2 + 1) + (4.6 - 0.8 + 1)\right]$$

$$= \frac{-1}{2}\left[4.2 + 4.8\right] = \underline{-4.5}$$

step6: $\Delta m = -\eta \frac{\partial E}{\partial m}$ ~~step~~ 1

$$= -0.1(-2.34) = \underline{0.234}$$

$$\Delta c = -\eta \frac{\partial E}{\partial c}$$

$$= -0.1(-4.5) = \underline{0.45}$$

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step7 $m = m + \Delta m$
$= 1 + 0.234$
$\underline{m = 1.234}$

$c = c + \Delta c$
$= -1 + 0.45$
$\underline{c = -0.55}$

step8 batch= batch+1 = 1+1 = 2

step9 if(batch > nb)
2 > 2 ✗
goto step5.

~~step~~ batch = batch+1
= 1+1 = 2

step5 $E = \frac{1}{2bs} \sum_{i=1}^{bs} (y_i - mx_i - c)^2$

$$\frac{\partial E}{\partial m} = \frac{-1}{bs}\Big[\big(3.8 - (1.23 * 0.4) + 0.55\big)(0.4) + \big(4.2 - (1.23 * 0.6) + 0.55\big)(0.6)\Big]$$

$$= \frac{-1}{2}\left[1.543 + 2.407\right] \cancel{0.1}$$

$$\frac{\partial E}{\partial m} = -1.975$$

$$\frac{\partial E}{\partial c} = \frac{-1}{2}\Big[\big(3.8 - (1.23 * 0.4) + 0.55\big) + \big(4.2 - (1.23 * 0.6) + 0.55\big)\Big]$$

$$= \frac{-1}{2}\left[3.85 + 4.012\right]$$

$$\frac{\partial E}{\partial c} = -3.93$$

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step 6

$\Delta m = -\eta \frac{\partial E}{\partial m}$

$= (-0.1)(-1.975)$

$\Delta m = 0.197$

$\Delta c = -\eta \frac{\partial E}{\partial c}$

$= -0.1(-3.93)$

$\Delta c = 0.393$

step 7

$m = m + \Delta m$

$= 1.23 + 0.197$

$m = 1.427$

$c = c + \Delta c$

$c = -0.55 + 0.393$

$c = -0.157$

step 8 batch = 2+1 = 3

step 9 if(batch > nb)

3 > 2 ✓

go to next step

step 10 iter = iter + 1 = 2

step 11 if(iter > epochs)

2 > 2 ✗

goto step 4

step 4

batch = 1

step 5

Gradients Calc

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5

$$\frac{\partial E}{\partial m} = \frac{-1}{bs} \sum_{i=1}^{bs} (y_i - mx_i - c)(x_i)$$

$$= \frac{-1}{2}\left[(3.4 - (1.42 * 0.2) + 0.157)(0.2) + (4.8 - (0.8 * 1.42) + 0.157)(0.8)\right]$$

$$= \frac{-1}{2}\left[(3.27)(0.2) + (3.82)(0.8)\right]$$

$$= \frac{-1}{2}\left[0.654 + 3.056\right]$$

$$\frac{\partial E}{\partial m} = -1.85$$

$$\frac{\partial E}{\partial c} = \frac{-1}{2}\left[3.27 + 3.82\right] = -3.54$$

step6

$$\Delta m = -\eta \frac{\partial E}{\partial m}$$

$$= -(0.1)(-1.85)$$

$$\Delta m = 0.185$$

$$\Delta c = -\eta \frac{\partial E}{\partial c}$$

$$= -(0.1)(-3.54)$$

$$\Delta c = 0.354$$

step7

$$m = m + \Delta m$$

$$= 1.42 + 0.185$$

$$m = 1.605$$

$$c = c + \Delta c$$

$$= -0.157 + 0.354$$

$$c = 0.197$$

step8 batch $= 1 + 1 = 2$

step9 if (batch > nb)

$2 > 2$ ✗

go to step 5

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step5: $\frac{\partial E}{\partial m} = \frac{-1}{bs} \sum_{i=1}^{b} (y_i - mx_i - c)(x_i)$.

$$= \frac{-1}{(2)}\Big[[3.8-(1.6*0.4)-0.197](0.4) + [4.2-(1.6*0.6)-0.197](0.6)\Big]$$

$$= \frac{-1}{2}\left[(2.96)(0.4)+(3.04)(0.6)\right]$$

$$= \frac{-1}{2}\left[1.184 + 1.825\right]$$

$$= \frac{-1}{2}(3.009) = \underline{-1.504}$$

$$\frac{\partial E}{\partial c} = -\frac{1}{2}\left[2.96+3.04\right] = -3.0$$

step6:

$\Delta m = \cancel{1.004} -\eta \frac{\partial E}{\partial m}$

$= -0.1(-1.504)$

$= 0.150$

$\Delta c = -\eta \frac{\partial E}{\partial c}$

$= -0.1(-3)$

$= 0.3$

step7

$m = m + \Delta m$

$= 1.605 + 0.150$

$\boxed{m = 1.75}$

$c = c + \Delta c$

$= 0.197 + 0.3$

$\boxed{c = 0.49}$

step8: batch = 2+1 = 3

step9. if (batch > nb)

3 > 2 ✓

goto next step

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step10: iter = iter+1

= 2+1 = 3

step11: if (iter > epochs)

3 > 2 ✓

go to next step

step12: print m, c

$$\left.\begin{array}{l} m = 1.75 \\ c = 0.49 \end{array}\right\}$$ ∴ iterations = 2 (batchsize = 2)