Assignment 5: Manual Calculations:

- Mini Batch Gradient Descent:

x	y
0.2	3.4
0.4	3.8
0.6	4.2
0.8	4.6

step 1: Read dataset [x, y], $\eta = 0.1$, $m = 1$, $c = -1$, epochs = 2, batch_size = 2

step 2: splitting data into batches.

batch 1

0.2	3.4
0.8	4.6

batch 2

0.4	3.8
0.6	4.2

step 3: iter = 1

step 4: batch = 1

step 5: calculate gradient descents

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

(0.2)

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

$$= -\frac{1}{2}\left[(4.2)(0.2) + (4.8)(0.8)\right] = -\frac{1}{2}\left[4.68\right]$$

$$= -2.34$$

$$\frac{\partial E}{\partial c} = -\frac{1}{2}\left[4.2 + 4.8\right] = -9.0/2 = -4.5$$

step 6: $\Delta m = -\eta \frac{\partial E}{\partial m} = 0.234$, $\Delta c = 0.45$

step 7: $m = m + \Delta m \Rightarrow 1 + 0.234 = 1.234$

$c = c + \Delta c = -1 + 0.45 = -0.55$

Step 8: batch = batch + 1 = 1 + 1 = 2

Step 10: if batch > no-of batches ⇒ 2 > 2 → false

∴ go to step 5

Step 11: $\frac{\partial E}{\partial m} = -\frac{1}{n_b} \sum_{i=1}^{n_b} (y_i - mx_i - c) x_i$

$= -\frac{1}{2} \left[(3.8 - (1.234 \times 0.4) + 0.55)(0.4) + (4.2 - (1.234 \times 0.6) + 0.55)(0.6) \right]$

$= -\frac{1}{2} \times \left[(3.8564)(0.4) + (4.00961(0.6) \right]$

$= -1.97416$

$\frac{\partial E}{\partial c} = -\frac{1}{2} \left[3.8564 + 4.0096 \right] = -3.933$

Step 12: $\Delta m = -\eta \frac{\partial E}{\partial m} = 0.197416$

$\Delta c = -\eta \frac{\partial E}{\partial c} = 0.3933$

Step 13: $m = 1.234 + 0.197416 = 1.4314$

$c = -0.55 + 0.3933 = -0.1567$

Step 14: batch = batch + 1 = 2 + 1 = 3

Step 15: if batch > n_b ⇒ 3 > 2

goto step 16

Step 16: iter = iter + 1 = 1 + 1 = 2

step 17: if iter > epoch ⇒ 2 > 2 ⇒ false

⇒ goto step 4

step 18: batch = 1

step 19: $\frac{\partial E}{\partial m} = -\frac{1}{2} \times \left[(3.4 - (1.4314)(0.2) + 0.1567)(0.2) + (4.6 - (1.4314)(0.8) + 0.1567)(0.8) \right]$

$= -\frac{1}{2} \times \left[(3.27042)(0.2) + (3.61158)(0.8) \right]$

$= -\frac{1}{2} \times \left[0.65408 + 2.88926 \right] = -1.77167$

$\frac{\partial E}{\partial c} = -\frac{1}{2} \left[3.27042 + 3.61158 \right] = -3.441$

step 20: $\Delta m = -\eta \frac{\partial E}{\partial m} = 0.177167$

$\Delta c = -\eta \frac{\partial E}{\partial c} = 0.3441$

step 21: $m = m + \Delta m = \overset{1.4314}{3.27042} + 0.177167 = 1.60856$

$c = c + \Delta c = 0 - 0.1567 + 0.3441 = 0.1874$

step 22: batch = batch + 1 = 1 + 1 = 2

step 23: if batch > n_b = 2 > 2 ⇒ false

go to step 5

step 24: $\frac{\partial E}{\partial m} = -\frac{1}{2} \left[(3.8 - (1.60856)(0.4) - 0.1874)(0.4) + (4.2 - (1.60856)(0.6) - 0.1874)(0.6) \right]$

$$= -\frac{1}{2}\left[(2.96917)(0.4) + (3.047464)(0.6)\right]$$

$$= -\frac{1}{2}\left[1.187668 + 1.828478\right] = -1.50807$$

$$\frac{\partial E}{\partial c} = -\frac{1}{2}\left[6.01663\right] = -3.00831$$

Step 25: $\Delta m = 0.150807, \Delta c = 0.300831$

Step 26: $m = 1.60856 + 0.150807 = 1.759067$

$c = 0.1874 + 0.300831 = 0.488231$

Step 27: batch = 2+1 = 3

Step 28: if batch > n_b = 3 > 2 ⇒ goto step 29

Step 29: iter = iter + 1 = 2+1 = 3

Step 30: if iter > epoch ⇒ 3 > 2 ⇒ goto step 31

Step 31: Print(m, c)

⇒ 1.759067, 0.488231

Step 32: Mean Square error

$$= \frac{(3.4 - 0.84004) + (3.8 - 1.19185) + (4.2 - 1.54367) + (4.6 - 1.89548)}{4}$$

mse = 2.63224