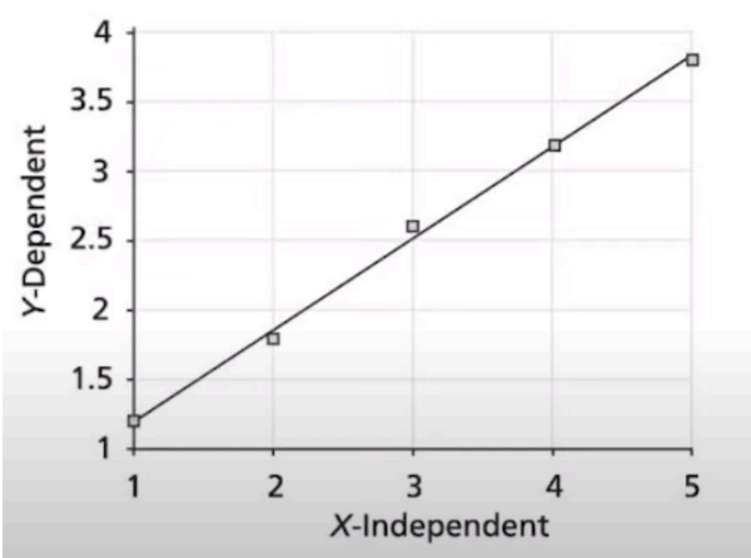
1. Apply linear regression techniques to predict the 7th and 12th week sales.

x_i (Week)	y_j (Sales in Thousands)
1	1.2
2	1.8
3	2.6
4	3.2
5	3.8

Solution:
Step 1 : First we have to plot a graph of independent variables against dependent variables. The goal of linear regression is to find a straight line which will fit into this dataset completely.



Linear regression equation is given by

y=c + m*x

c=intercept , m = coefficient of independent variable

Loss Function

The loss is the error in our predicted value of m and c.

Goal - minimize this error to obtain the most accurate value of m and c.

Here we will use the MSE function to calculate the loss.

$$E = \frac{1}{n}\sum_{i=0}^{n}(y_i - \underbrace{\bar{y}_i}_{=\ y\ \text{predicted}})^2 \qquad \boxed{y = \underbrace{m}_{0.1}x + \underbrace{c}_{0.1}} \ \text{for each } x_i$$

Mean Squared Error Equation

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L = 0.001  # The learning Rate
m values:  [0.1]
c values:  [0.1]
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Y_predicted = $mx_i + c$

X(week)	Y(sales in thousands	y_pred ($mx+c$)	(Y-y_pred)^2
1	1.2	0.9413	0.06692569
2	1.8	1.614391	0.03445070088
3	2.6	2.287482	0.09766750032
4	3.2	2.960572	0.05732576718
5	3.8	3.633663	0.02766799757

$= \frac{\Sigma (y - y\_pred)^2}{n}$

Mse = 0.284037656/5= 0.013908918347787921

Here are the update rules using gradient descent:

$$m = m - \alpha \frac{\partial J}{\partial m}$$

$$b = b - \alpha \frac{\partial J}{\partial b} \quad = \quad c = c - \alpha \frac{\partial J}{\partial c}$$

where α is the learning rate, a hyperparameter that controls the step size in the update process.

The partial derivatives are given by:

$$\frac{\partial J}{\partial m} = \frac{1}{n} \sum_{i=1}^{n} (mx_i + b - y_i)x_i$$

$$\frac{\partial J}{\partial b} = \frac{1}{n} \sum_{i=1}^{n} (mx_i + b - y_i)$$

A	B	C	D	E
X(week)	Y(sales in thousands	y_pred	Y-y_pred	(Y-y_pred)xi
1	1.2	0.9413	0.2587	0.2587
2	1.8	1.614391	0.185609	0.371218
3	2.6	2.287482	0.312518	0.937554
4	3.2	2.960572	0.239428	0.957712
5	3.8	3.633663	0.166337	0.831685
		$\frac{\sum (y - y\_pred_i) x_i}{n}$	=	0.6713738

$$\frac{\partial J}{\partial m} = 0.6713738$$

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X(week)	Y(sales in thousands	y_pred	Y-y_pred
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4	3.2	2.960572	0.239428
5	3.8	3.633663	0.166337
			0.2325184 ×
		$\frac{\partial J}{\partial c} =$	=SUM(D2:D6)/5

c= c - 0.2325184 = 0.1 - 0.2325184 = -0.133
M = m - 0.06713738 =
0.1- 0.06713738= 0.033

Iteration 2 : same as previous calculate y_predicted by taking value of new m and c and solving similarly.