

Linear Model

Dr. Parikshit N. Mahalle

Least Square Method

- Finds the line of best fit for a dataset, providing a visual demonstration of the relationship between the data points.
- The differences between the actual and estimated function values on the training examples are called residuals

$$\epsilon_i = f(x_i) - \hat{f}(x_i).$$

- The *least-squares method*, consists in finding \hat{f} such that $\sum_{i=1}^n \epsilon_i^2$ is minimised

Linear Regression

- **Simple:**

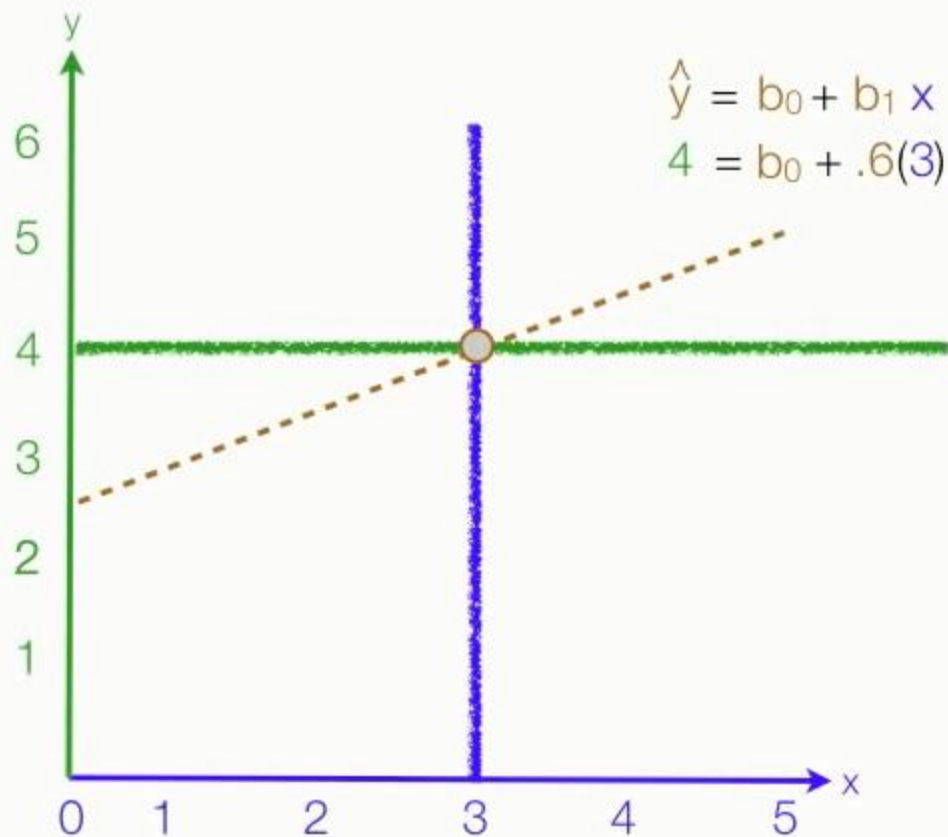
$$y = b_0 + b_1 * x$$

- **Multiple:**

$$y = b_0 + b_1 * x_1 + \dots + b_n * x_n$$

Ex: Least Square method using Univariate Regression

| x | y | $x - x \text{ mean}$ | $y - y \text{ mean}$ | $(x - x \text{ mean})^2$ | $(x - x \text{ mean}).(y - y \text{ mean})$ |
|---|---|----------------------|----------------------|--------------------------|---|
| 1 | 2 | -2 | -2 | 4 | 4 |
| 2 | 4 | -1 | 0 | 1 | 0 |
| 3 | 5 | 0 | 1 | 0 | 0 |
| 4 | 4 | 1 | 0 | 1 | 0 |
| 5 | 5 | 2 | 1 | 4 | 2 |



$$b_0 = 2.2$$

$$b_1 = .6$$

$$\hat{y} = 2.2 + .6x$$

| x | y | $x - \bar{x}$ | $y - \bar{y}$ | $(x - \bar{x})^2$ | $(x - \bar{x})(y - \bar{y})$ |
|---|---|---------------|---------------|-------------------|------------------------------|
| 1 | 2 | -2 | -2 | 4 | 4 |
| 2 | 4 | -1 | 0 | 1 | 0 |
| 3 | 5 | 0 | 1 | 0 | 0 |
| 4 | 4 | 1 | 0 | 1 | 0 |
| 5 | 5 | 2 | 1 | 4 | 2 |

mean

3

4

10

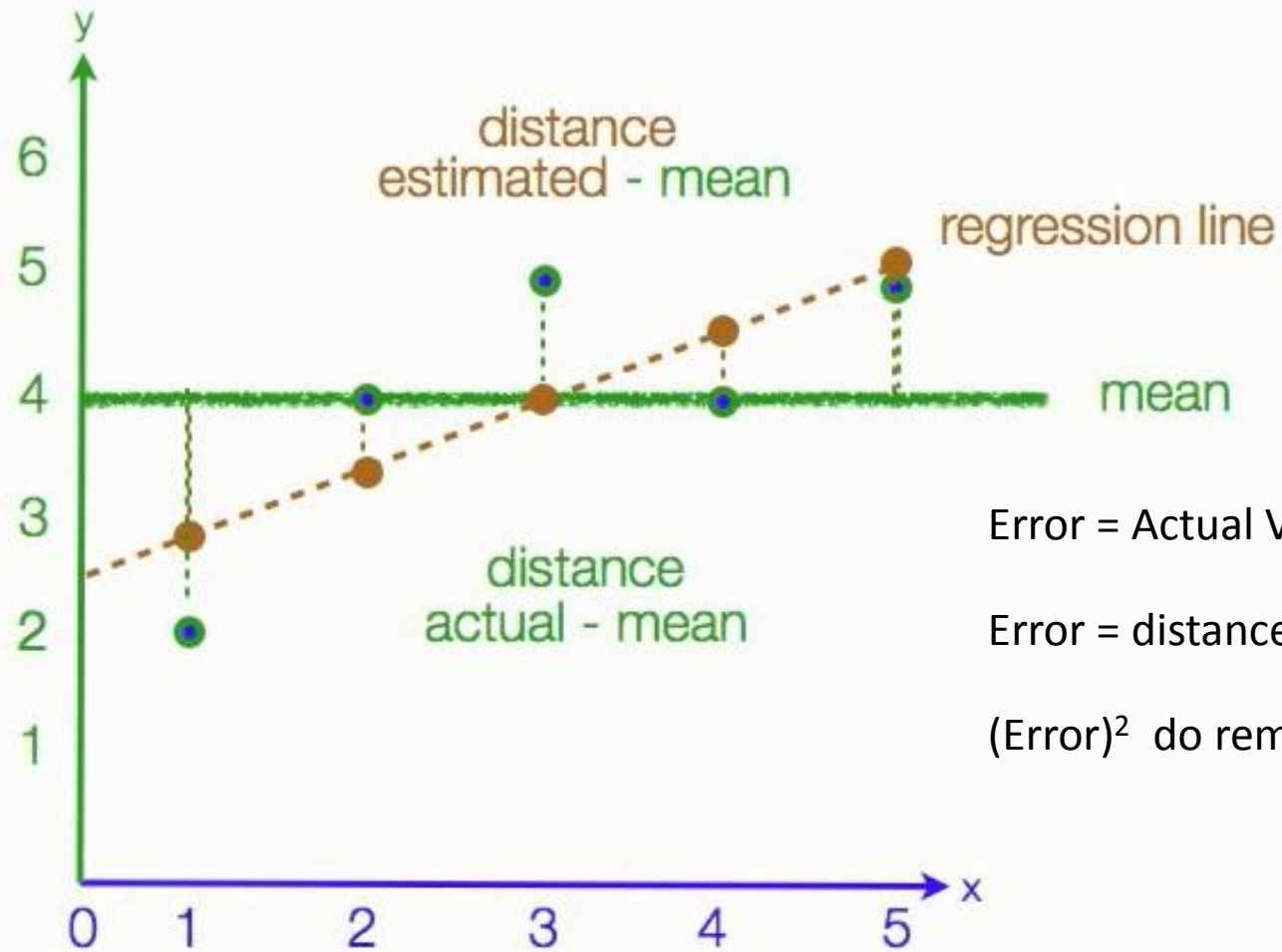
6

$$4 = b_0 + .6(3)$$

$$4 = b_0 + 1.8$$

$$\begin{array}{r} 4 \\ -1.8 \\ \hline 2.2 = b_0 \end{array}$$

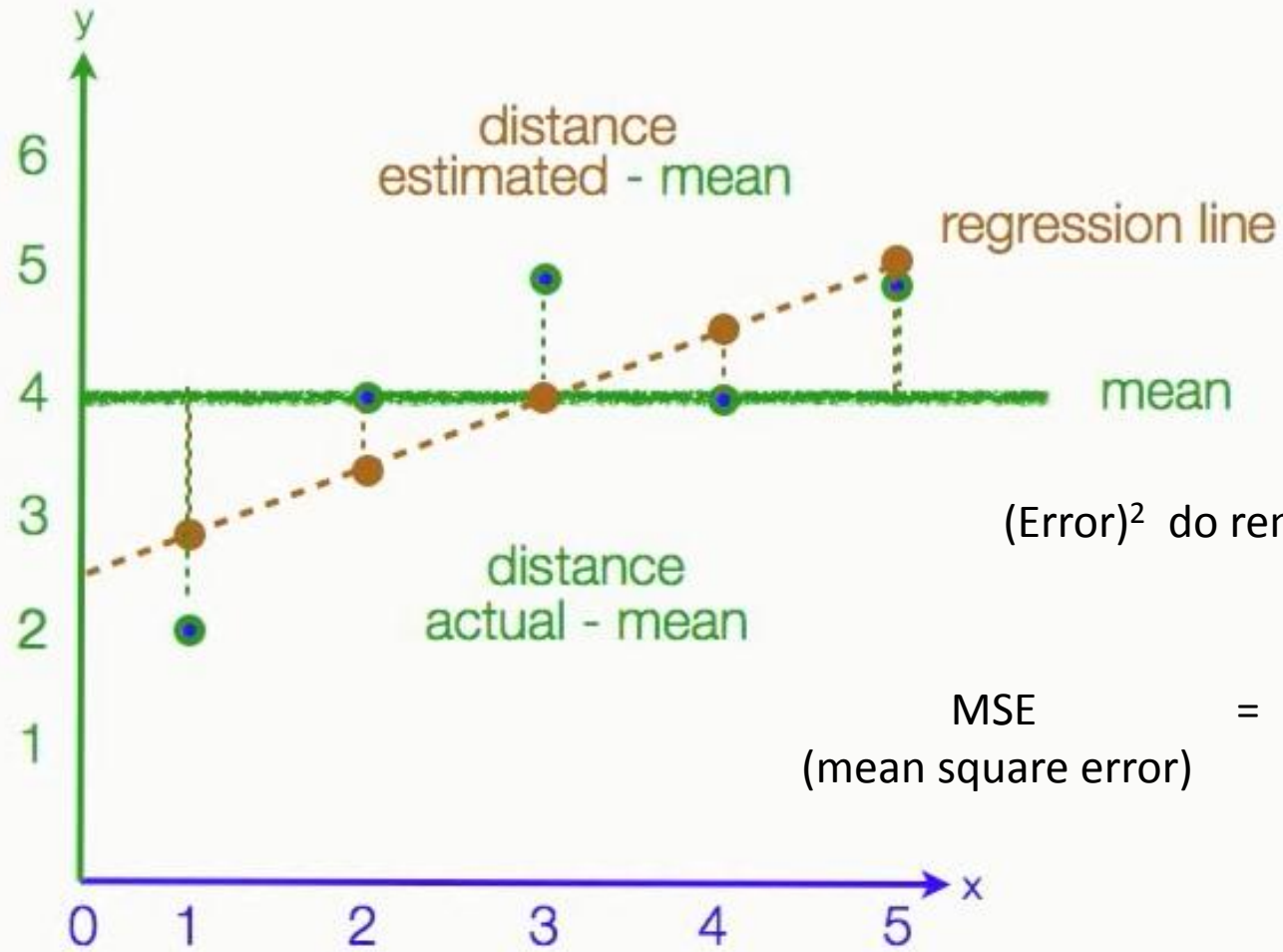
$$b_1 = \frac{6}{10} = .6 = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sum (x - \bar{x})^2}$$



Error = Actual Value – Predicted value

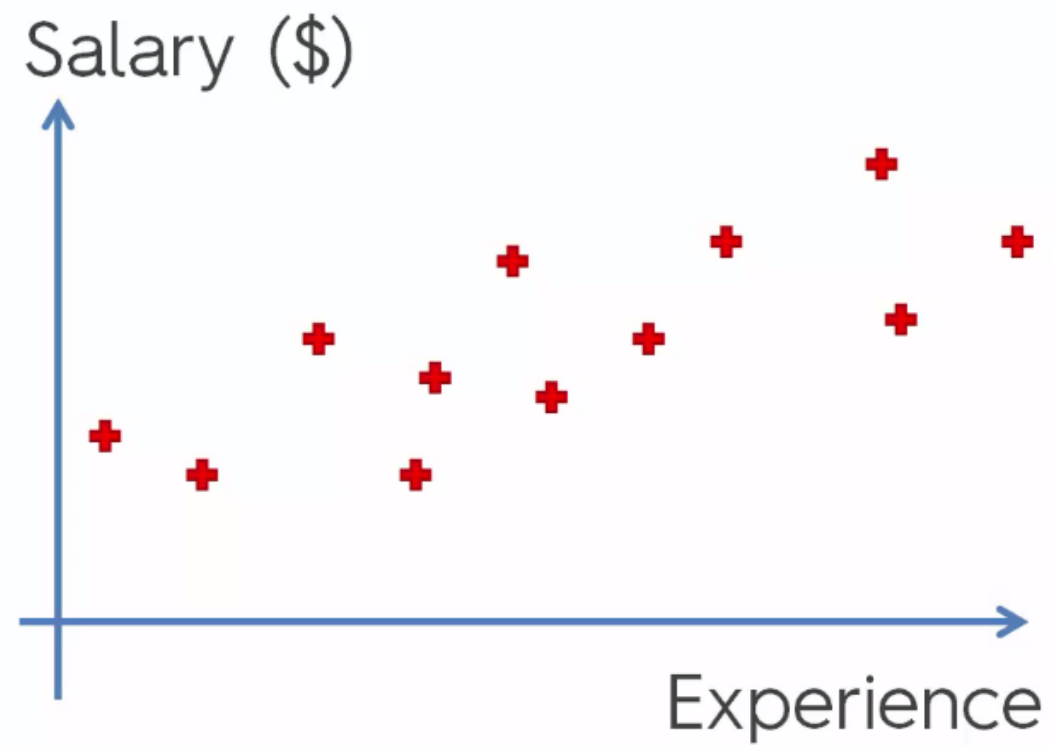
Error = distance(green dot – brown dot)

$(\text{Error})^2$ do remove negative distances

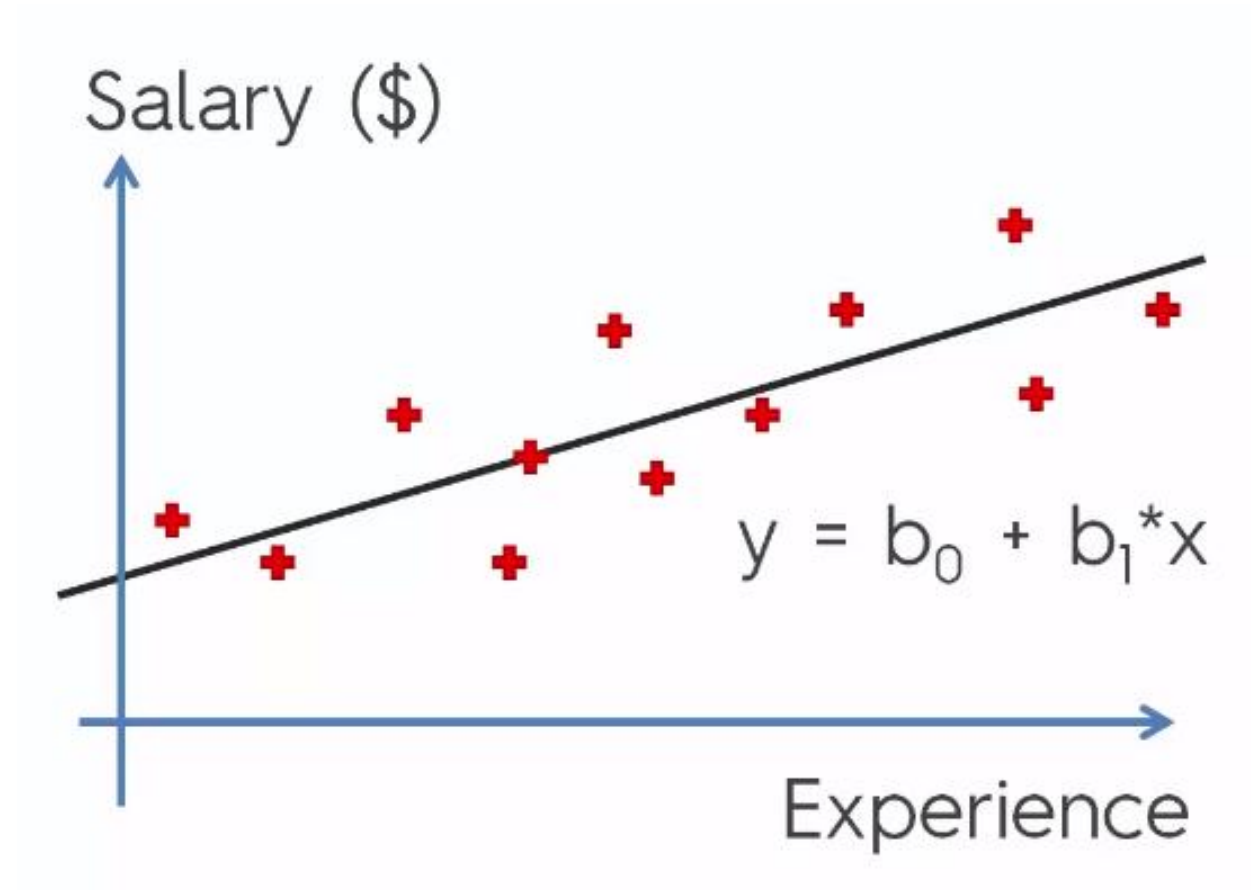


$$\text{MSE (mean square error)} = \frac{\text{Sum of all Squared Errors (SE)}}{\text{Total number of errors}}$$

We know this:



We can solve this using Linear Regression



For Help on Pandas:

- <https://towardsdatascience.com/a-quick-introduction-to-the-pandas-python-library-f1b678f34673>

Thank You