

# Simple Linear Regression - Math Summary

## 1. Model (Hypothesis)

$$\hat{y}_i = b_0 + b_1 x_i$$

## 2. Error (Residual)

$$e_i = y_i - \hat{y}_i$$

## 3. Cost Function (Mean Squared Error)

$$J(b_0, b_1) = \frac{1}{n} \sum_{i=1}^n (y_i - (b_0 + b_1 x_i))^2$$

## 4. Means

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i \quad \bar{y} = \frac{1}{n} \sum_{i=1}^n y_i$$

## 5. Variance of $x$

$$\text{Var}(x) = \frac{1}{n} \sum_{i=1}^n (x_i - \bar{x})^2$$

## 6. Covariance of $x$ and $y$

$$\text{Cov}(x, y) = \frac{1}{n} \sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})$$

## 7. Optimal Slope

$$b_1 = \frac{\text{Cov}(x, y)}{\text{Var}(x)}$$

## 8. Optimal Intercept

$$b_0 = \bar{y} - b_1 \bar{x}$$

## 9. Prediction

$$\hat{y}_{\text{new}} = b_0 + b_1 x_{\text{new}}$$

## 10. Feature Scaling (Standardization)

$$z = \frac{x - \mu}{\sigma} \quad \hat{y} = b_0 + b_1 z$$

## 11. Mean Squared Error

$$\text{MSE} = \frac{1}{n} \sum_{i=1}^n (y_i - \hat{y}_i)^2$$

## 12. Coefficient of Determination ( $R^2$ )

$$R^2 = 1 - \frac{\sum_{i=1}^n (y_i - \hat{y}_i)^2}{\sum_{i=1}^n (y_i - \bar{y})^2}$$