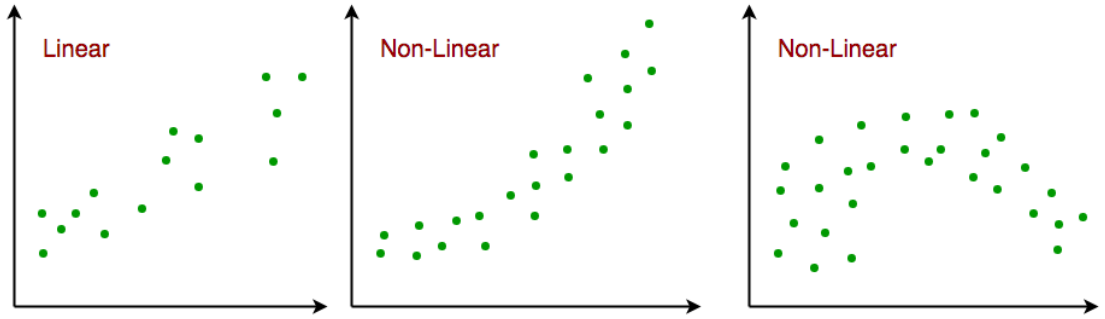
Linear Regression

Linear regression is a statistical method used to model the relationship between a dependent variable and one or more independent variables. In simpler terms, it's about finding the best-fitting straight line through a set of data points.

Condition for LR

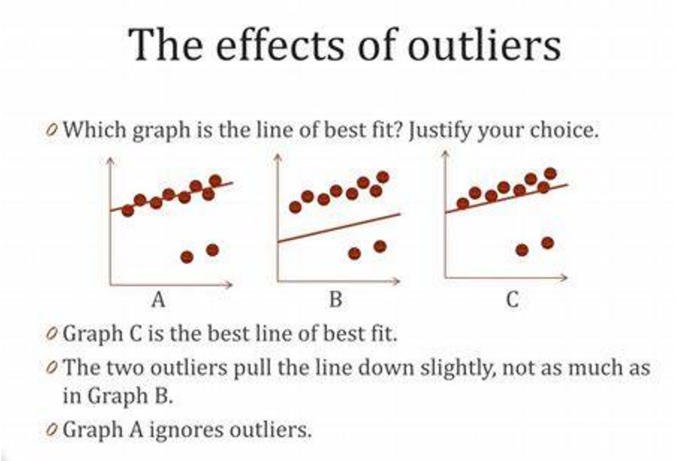
1. Linear relationship

The relationship between response and feature variables should be linear.



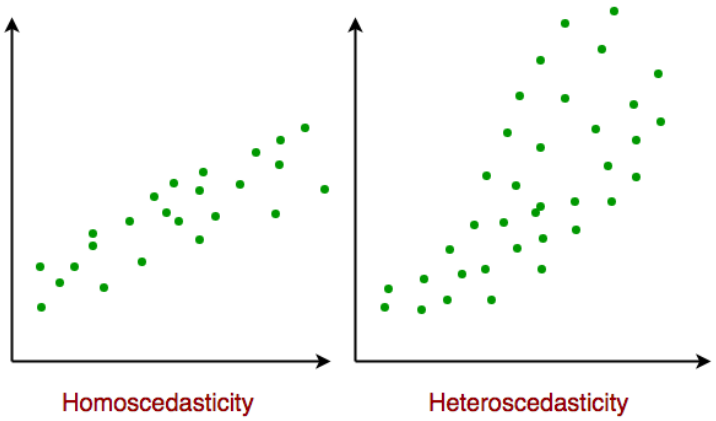
2. No outliers

Outliers can affect the results of the analysis.



3. Homoscedasticity

is a statistical term that describes a situation where the variance of the error term (the "noise" or random disturbance in the relationship between the independent variables and the dependent variable) is constant across all values of the independent variables.



Types of Linear Regression

There are two main types of linear regression:

- **Simple linear regression:** This involves predicting a dependent variable based on a single independent variable.
- **Multiple linear regression:** This involves predicting a dependent variable based on multiple independent variables.

Simple Linear Regression:

1. Equation:

$$y = \beta_0 + \beta_1 x$$

Where:

- y is the dependent variable (target)
- x is the independent variable (feature)
- β_0 is the y-intercept (constant term)
- β_1 is the slope (coefficient)

2. Predicted value:

$$\hat{y} = \beta_0 + \beta_1 x$$

Where ŷ is the predicted value of y

3. Calculate the Cost Function

$$MSE = (1/n) * \Sigma(\hat{y} - y)^2$$

4. Calculate Gradients

$$\partial MSE/\partial\beta_1 = (2/n) * \Sigma(x * (\hat{y} - y))$$

$$\partial MSE/\partial\beta_0 = (2/n) * \Sigma(\hat{y} - y)$$

5. Update Weights

$$\beta_1 = \beta_1 - learning_rate * \partial MSE/\beta_1$$

$$\beta_0 = \beta_0 - learning_rate * \partial MSE/\partial\beta_0$$

Multiple Linear Regression:

1. Equation:

$$y = b0 + b1 * x1 + b2 * x2 + ... + bn * xn$$

Where:

- y is the dependent variable
- b0 is the intercept
- b1, b2, ..., bn are the coefficients for the independent variables x1, x2, ..., xn

2. Prediction

$$\hat{y} = b0 + b1 * x1 + b2 * x2 + ... + bn * xn$$

3. Calculate the Cost Function

- Use the Mean Squared Error (MSE) as the cost function:

$$MSE = (1/n) * \Sigma(\hat{y} - y)^2$$

4. Calculate Gradients

- Calculate the partial derivatives of the cost function with respect to each coefficient:

  Where i ranges from 0 to n.

$$\partial MSE/\partial bi = (2/n) * \Sigma(xi * (\hat{y} - y))$$

5. Update Weights

$$bi = bi - learning_rate * \partial MSE/\partial bi$$