# Regression Analysis

# What is regression analysis

- Linear regression is a basic and commonly used type of predictive analysis
- The dictionary meaning of the word Regression is 'Stepping back' or 'Going back'
- Set of statistical processes for estimating the relationships between a dependent variable and one or more independent variables
  → estimating coefficients of regression → β (beta) estimators
- It attempts to establish the functional relationship between the variables and thereby provide a mechanism for prediction or forecasting → formula → model
- The overall idea of regression is to examine two things
  - does a set of predictor variables do a good job in predicting an outcome (dependent) variable?
  - Which variables in particular are significant predictors of the outcome variable, and in what way do they–indicated by the magnitude and sign of the beta estimates–impact the outcome variable?
- These regression estimates are used to explain the relationship between one dependent variable and one or more independent variables

① Whether relationship can be used for prediction
② Which independent variables are significant

# Correlation vs Regression

- Correlation is a statistical measure which determines co-relationship or association of two variables while Regression describes how an independent variable is numerically related to the dependent variable
- Correlation is used to represent linear relationship between two variables while regression is used to fit a best line and estimate one variable on the basis of another variable.
- Cov(x, y) = Cov(y, x)
- but reg(x,y) != reg(y, x)

$y = 2x \neq x = 2y$

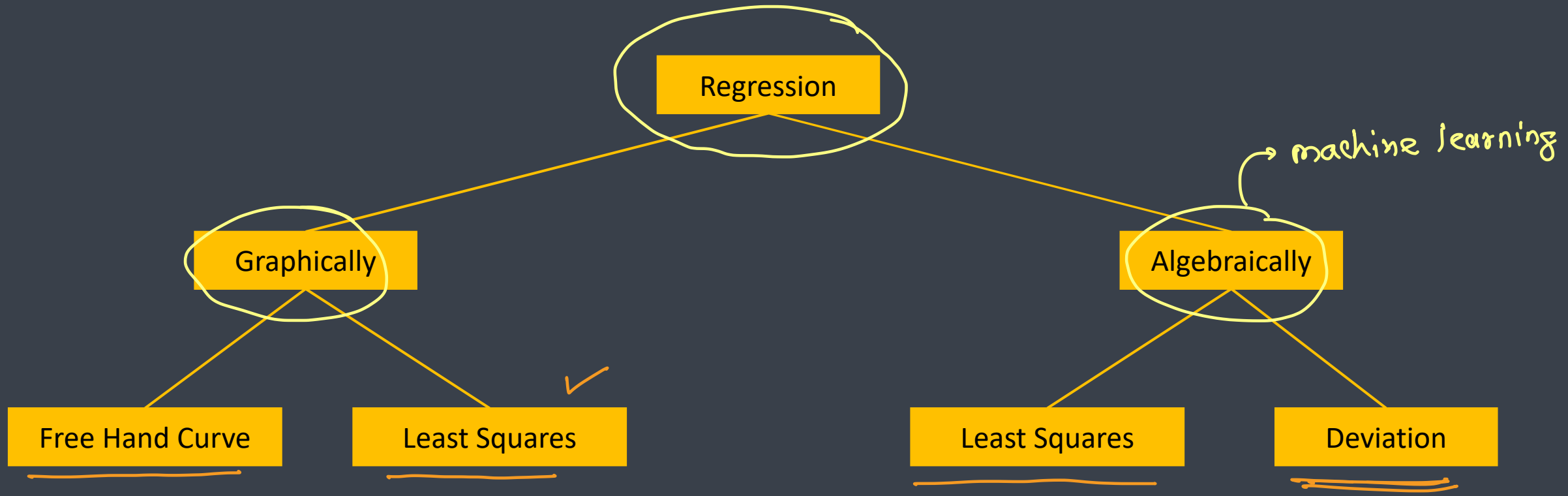
$reg(x,y) \neq reg(y,x)$


model

# Applications of regression analysis

- It helps in the formulation and determination of functional relationship between two or more variables
- It helps in establishing a cause and effect relationship between two variables in economics and business research
- It helps in predicting and estimating the value of dependent variable as price production sales etc
- It helps to measure the variability or spread of values of a dependent variable with respect to the regression line
- In the field of business regression is widely used by businessmen in
  - Predicting future production
  - Investment analysis
  - Forecasting on sales etc.

# Methods of studying regression



# Types of regression

- Linear Regression
- Polynomial Regression
- Logistic Regression
- Ridge Regression
- Lasso Regression
- Elastic Net Regression
- Support Vector Regression
- Quantile Regression
- Principle Component Regression
- Partial Least Square Regression
- Ordinal Regression
- Poisson Regression
- Negative Binomial Regression
- Cox Regression

# Least Square Method

- A form of mathematical regression analysis used to determine the line of best fit for a set of data, providing a visual demonstration of the relationship between the data points
- Each point of data represents the relationship between a known independent variable and an unknown dependent variable
- The least squares method provides the overall rationale for the placement of the line of best fit among the data points being studied
- It aims to create a straight line that minimizes the sum of the squares of the errors that are generated by the results of the associated equations, such as the squared residuals resulting from differences in the observed value, and the value anticipated, based on that model
- It begins with a set of data points to be plotted on an x- and y-axis graph
- An analyst using the least squares method will generate a line of best fit that explains the potential relationship between independent and dependent variables.

# Regression Equation

| Adv | Sales |
|---|---|
| 100 | 500 |
| 90 | 400 |
| 80 | 450 |
| 95 | 510 |
| 150 | ?? |

Sales depends on advertisement
Y depends on X [Y on X]

$$(Y - \bar{Y}) = b_{yx} (X - \bar{X})$$

$$b_{yx} = \frac{n \sum XY - \sum X \sum Y}{n \sum X^2 - (\sum X)^2}$$

$$b_{yx} = r \frac{\sigma y}{\sigma x}$$

$$b_{yx} = \frac{cov(x, y)}{(\sigma x)^2}$$

# Regression Equation

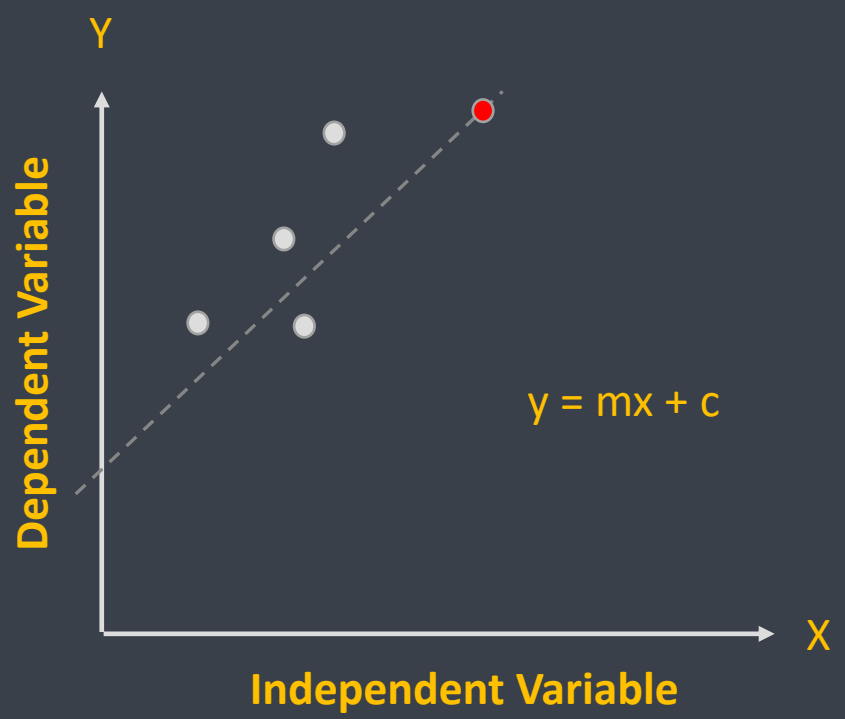
| X | Y |
|---|---|
| 3 | 11 |
| 4 | 12 |
| 8 | 9 |
| 7 | 3 |
| 2 | 5 |

What likely to be the value of Y if X = 10

# Linear Regression

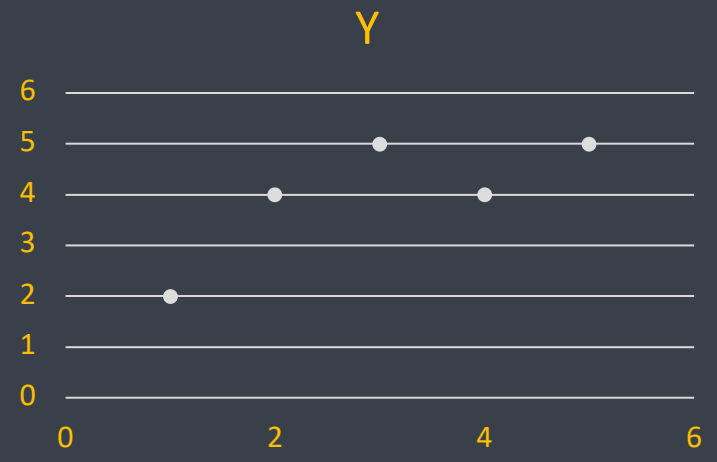
# Overview

- The data in Linear Regression is modelled using a straight line
- It is used with continuous variable
- It gives a future value as an output
- To calculate accuracy following methods are used
  - R-squared
  - Adjusted R-squared



# Least Square Method

| X | Y |
|---|---|
| 1 | 2 |
| 2 | 4 |
| 3 | 5 |
| 4 | 4 |
| 5 | 5 |




| X | Y | $(X - \bar{X})$ | $(Y - \bar{Y})$ | $(X - \bar{X})^2$ | $(X - \bar{X})(Y - \bar{Y})$ |
|---|---|---|---|---|---|
| 1 | 2 | | | | |
| 2 | 4 | | | | |
| 3 | 5 | | | | |
| 4 | 4 | | | | |
| 5 | 5 | | | | |

$$m = \frac{\sum (X - \bar{X})(Y - \bar{Y})}{\sum (X - \bar{X})^2}$$

# R-squared

- R-squared value is a statistical measure of how close the data are to the fitted regression line
- It is also known as coefficient of determination or coefficient of multiple determination

$$R^2 = \frac{\sum (\hat{Y} - \bar{Y})^2}{\sum (Y - \bar{Y})^2}$$