Linear regression is a statistical method used to model the relationship between a dependent variable and one or more independent variables. It helps us understand how different variables are related to each other.

The primary goal of linear regression is to find the best-fitting linear equation that describes the relationship between the dependent variable (Y) and the independent variable(s) (X).

The equation of a simple linear regression can be written as:

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Y = β0 + β1 * X + ε
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Where,

- Y is the dependent variable (the target or outcome variable).
- X is the independent variable (the predictor variable).
- β0 is the y-intercept, representing the value of Y when X is 0.
- β1 is the slope, representing the change in Y for a unit change in X.
- ε is the error term, representing the difference between the predicted value (Y) and the actual value (Y_actual).

The goal is to estimate the values of β0 and β1 that minimize the sum of squared errors between the predicted values and the actual values. This process is commonly done using a method called the Ordinary Least Squares (OLS) estimation.

There are two main types of linear regression:

1. Simple Linear Regression: In simple linear regression, there is only one independent

variable (X) that is used to predict the dependent variable (Y). The relationship between Y and X is assumed to be linear.

2. Multiple Linear Regression: In multiple linear regression, there are two or more independent variables (X1, X2, X3, ..., Xn) used to predict the dependent variable (Y). The relationship between Y and the multiple independent variables is assumed to be linear.

Linear regression is widely used in various fields, including

- Economics
- Finance
- Social sciences
- Engineering
- Machine learning.

Difference between Simple Linear Regression and Multiple Linear Regression

Aspect	Simple Linear Regression	Multiple Linear Regression
Number of Independent Variables	One (X)	Two or more (X1, X2, ..., Xn)
Number of Dependent Variables	One (Y)	One (Y)
Equation	$Y = \beta0 + \beta1 * X + \varepsilon$	$Y = \beta0 + \beta1 * X1 + \beta2 * X2 + ... + \beta n * Xn + \varepsilon$

Aspect	Simple Linear Regression	Multiple Linear Regression
Relationship	Represents a straight line	Represents a hyperplane (multidimensional plane)
Purpose	Modeling the relationship between Y and a single X	Modeling the relationship between Y and multiple X variables
Complexity	Simple and easy to interpret	More complex due to multiple predictor variables
Use Cases	Suitable for one-dimensional data	Suitable for multi-dimensional data
Data Interpretation	Limited to exploring one variable's effect on Y	Can analyze the combined effects of multiple variables on Y
Assumptions	Assumes a linear relationship between X and Y	Assumes a linear relationship between Y and all X variables
Interpretation of Coefficients	β0 (Intercept) and β1 (Slope) represent Y's starting point and change for a unit change in X	β0 (Intercept) and β1, β2, …, βn (Slopes) represent Y's starting point and change for unit changes in X1, X2, …, Xn
Example	Predicting house prices based on a single feature (e.g., area)	Predicting house prices based on multiple features (e.g., area, number of bedrooms, location)

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