## ****What is Linear Regression?****

Linear regression is a type of [supervised machine learning](https://www.geeksforgeeks.org/supervised-machine-learning/) algorithm that computes the linear relationship between a dependent variable and one or more independent features. When the number of the independent feature, is 1 then it is known as Univariate Linear regression, and in the case of more than one feature, it is known as multivariate linear regression.

### Why Linear Regression is Important?

The interpretability of linear regression is a notable strength. The model’s equation provides clear coefficients that elucidate the impact of each independent variable on the dependent variable, facilitating a deeper understanding of the underlying dynamics. Its simplicity is a virtue, as linear regression is transparent, easy to implement, and serves as a foundational concept for more complex algorithms.

Linear regression is not merely a predictive tool; it forms the basis for various advanced models. Techniques like regularization and support vector machines draw inspiration from linear regression, expanding its utility. Additionally, linear regression is a cornerstone in assumption testing, enabling researchers to validate key assumptions about the data.

PRACTICAL 9

Perform the Linear regression on the given data warehouse data.

Input Data

Below is the sample data representing the observations –

# Values of height

151, 174, 138, 186, 128, 136, 179, 163, 152, 131

# Values of weight.

63, 81, 56, 91, 47, 57, 76, 72, 62, 48

lm() Function :

This function creates the relationship model between the predictor and the response variable.

Syntax :

The basic syntax for lm() function in linear regression is −

lm(formula,data)

Following is the description of the parameters used :−

• formula is a symbol presenting the relation between x and y.

• data is the vector on which the formula will be applied.

1. A. Create Relationship Model & get the Coefficients

# Values of height

x <- c(151, 174, 138, 186, 128, 136, 179, 163, 152, 131)

# Values of width

y <- c(63, 81, 56, 91, 47, 57, 76, 72, 62, 48)

# Apply the lm() function.

relation <- lm(y~x)

print(relation)

OUTPUT:



1. B. Get the Summary of the Relationship

# Values of height

x <- c(151, 174, 138, 186, 128, 136, 179, 163, 152, 131)

# Values of width

y <- c(63, 81, 56, 91, 47, 57, 76, 72, 62, 48)

# Apply the lm() function.

relation <- lm(y~x)

print(summary(relation))

OUTPUT:



predict() Function

Syntax

The basic syntax for predict() in linear regression is −

predict(object, newdata)

Following is the description of the parameters used −

• object is the formula which is already created using the lm() function.

• newdata is the vector containing the new value for predictor variable.

1. C. Predict the weight of new persons

# The predictor vector.

x <- c(151, 174, 138, 186, 128, 136, 179, 163, 152, 131)

# The response vector.

y <- c(63, 81, 56, 91, 47, 57, 76, 72, 62, 48)

# Apply the lm() function.

relation <- lm(y~x)

# Find weight of a person with height 170.

a <- data.frame(x = 170)

result <- predict(relation,a)

print(result)

OUTPUT:



1. D. Visualize the Regression Graphically

# Create the predictor and response variable.

x <- c(151, 174, 138, 186, 128, 136, 179, 163, 152, 131)

y <- c(63, 81, 56, 91, 47, 57, 76, 72, 62, 48)

relation <- lm(y~x)

# Give the chart file a name.

png(file = "linearregression.png")

# Plot the chart.

plot(y,x,col = "blue",main = "Height & Weight Regression", abline(lm(x~y)),cex = 1.3,pch = 16,xlab = "Weight in Kg",ylab = "Height in cm")

# Save the file.

dev.off()

# Plot the chart.

plot(y,x,col = "blue",main = "Height & Weight Regression", abline(lm(x~y)),cex = 1.3,pch = 16,xlab = "Weight in Kg",ylab = "Height in cm")

OUTPUT:



**What is Logistic Regression?**

Logistic regression is used for binary [classification](https://www.geeksforgeeks.org/getting-started-with-classification/) where we use [sigmoid function](https://www.geeksforgeeks.org/derivative-of-the-sigmoid-function/), that takes input as independent variables and produces a probability value between 0 and 1.

For example, we have two classes Class 0 and Class 1 if the value of the logistic function for an input is greater than 0.5 (threshold value) then it belongs to Class 1 it belongs to Class 0. It’s referred to as regression because it is the extension of[linear regression](https://www.geeksforgeeks.org/ml-linear-regression/) but is mainly used for classification problems.

**Key Points:**

* Logistic regression predicts the output of a categorical dependent variable. Therefore, the outcome must be a categorical or discrete value.
* It can be either Yes or No, 0 or 1, true or False, etc. but instead of giving the exact value as 0 and 1, it gives the probabilistic values which lie between 0 and 1.
* In Logistic regression, instead of fitting a regression line, we fit an “S” shaped logistic function, which predicts two maximum values (0 or 1).

**Logistic Function – Sigmoid Function**

* The sigmoid function is a mathematical function used to map the predicted values to probabilities.
* It maps any real value into another value within a range of 0 and 1. The value of the logistic regression must be between 0 and 1, which cannot go beyond this limit, so it forms a curve like the “S” form.
* The S-form curve is called the Sigmoid function or the logistic function.
* In logistic regression, we use the concept of the threshold value, which defines the probability of either 0 or 1. Such as values above the threshold value tends to 1, and a value below the threshold values tends to 0

## Assumptions of Logistic Regression

We will explore the assumptions of logistic regression as understanding these assumptions is important to ensure that we are using appropriate application of the model. The assumption include:

1. Independent observations: Each observation is independent of the other. meaning there is no correlation between any input variables.
2. Binary dependent variables: It takes the assumption that the dependent variable must be binary or dichotomous, meaning it can take only two values. For more than two categories SoftMax functions are used.
3. Linearity relationship between independent variables and log odds: The relationship between the independent variables and the log odds of the dependent variable should be linear.
4. No outliers: There should be no outliers in the dataset.
5. Large sample size: The sample size is sufficiently large

## ****Terminologies involved in Logistic Regression****

Here are some common terms involved in logistic regression:

* **Independent variables:** The input characteristics or predictor factors applied to the dependent variable’s predictions.
* **Dependent variable:** The target variable in a logistic regression model, which we are trying to predict.
* **Logistic function:** The formula used to represent how the independent and dependent variables relate to one another. The logistic function transforms the input variables into a probability value between 0 and 1, which represents the likelihood of the dependent variable being 1 or 0.
* **Odds:**It is the ratio of something occurring to something not occurring. it is different from probability as the probability is the ratio of something occurring to everything that could possibly occur.
* **Log-odds:**The log-odds, also known as the logit function, is the natural logarithm of the odds. In logistic regression, the log odds of the dependent variable are modeled as a linear combination of the independent variables and the intercept.
* **Coefficient:**The logistic regression model’s estimated parameters, show how the independent and dependent variables relate to one another.
* **Intercept:**A constant term in the logistic regression model, which represents the log odds when all independent variables are equal to zero.
* [**Maximum likelihood estimation**](https://www.geeksforgeeks.org/probability-density-estimation-maximum-likelihood-estimation/)**:** The method used to estimate the coefficients of the logistic regression model, which maximizes the likelihood of observing the data given the model.