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## Machine Learning

### Experiment No – 03

#### Aim: Logistic Regression Analysis

#### Theory:

- Logistic regression is one of the most popular Machine Learning algorithms, which comes under the Supervised Learning technique. It is used for predicting the categorical dependent variable using a given set of independent variables.
- 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.**
- Logistic Regression is much similar to the Linear Regression except that how they are used. Linear Regression is used for solving Regression problems, whereas **Logistic regression is used for solving the classification problems.**
- In Logistic regression, instead of fitting a regression line, we fit an "S" shaped logistic function, which predicts two maximum values (0 or 1).
- The curve from the logistic function indicates the likelihood of something such as whether the cells are cancerous or not, a mouse is obese or not based on its weight, etc.
- Logistic Regression is a significant machine learning algorithm because it has the ability to provide probabilities and classify new data using continuous and discrete datasets.
- Logistic Regression can be used to classify the observations using different types of data and can easily determine the most effective variables used for the classification

Regression analysis is a statistical method to model the relationship between a dependent (target) and independent (predictor) variables with one or more independent variables. More specifically, Regression analysis helps us to understand how the value of the dependent variable is changing corresponding to an independent variable when other independent variables are held fixed.

○ **A Practical approach to Logistic Regression :**

- 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 for Logistic Regression:
- The dependent variable must be categorical in nature.
- The independent variable should not have multi-collinearity.

**Logistic Regression Equation:**

The Logistic regression equation can be obtained from the Linear Regression equation. The mathematical steps to get Logistic Regression equations are given below:

- We know the equation of the straight line can be written as:

$$y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + \dots + b_nx_n$$

- In Logistic Regression y can be between 0 and 1 only, so for this let's divide the above equation by (1-y):

$$\frac{y}{1-y} ; 0 \text{ for } y=0, \text{ and infinity for } y=1$$

- But we need range between  $-\infty$  to  $+\infty$ , then take logarithm of the equation it will become:

$$\log \left[ \frac{y}{1-y} \right] = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + \dots + b_nx_n$$

The above equation is the final equation for Logistic Regression.

- **Implementation of Logistic Regression Algorithm**

**Steps in Logistic Regression:** To implement the Logistic Regression using Python, we will use the same steps as we have done in previous topics of Regression. Below are the steps:

**Step-1: Loading the Dataset**

**Step -2: Splitting the Dataset. Into independent and dependant variable**

**Step -3: Splitting the dataset into training and test set.**

**Step -3: Fitting the Logistic Regression to the Training Dataset.**

**Step -4: Predicting the best set results**

**Step -5: Test Accuracy of the result**

**Problem Statement example for Logistic Regression:**

There is a dataset given which contains the information of various users obtained from the social networking sites. There is a car making company that has recently launched a new SUV car. So the company wanted to check how many users from the dataset, wants to purchase the car.

For this problem, we will build a Machine Learning model using the Logistic regression algorithm. The dataset is shown in the below image. In this problem, we will predict the purchased variable (Dependent Variable) by using age and salary (Independent variables).

**Write a program to implement the Logistic regression Analysis model in machine learning using Python language Take the printout with output and attached**



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**Questions:**

- 1 .Explain Logistic Regression in with example.
  2. Write Difference between Linear Regression and Logistic Regression algorithms
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(Subject In-charge)

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