Logistic Regression:
It is a classification model which is used to predict the odds in favour of a particular event. The odds ratio represents the positive event which we want to predict, for example, how likely a sample has breast cancer/ how likely is it for an individual to become diabetic in future. It used the sigmoid function to convert an input value between 0 and 1.
The basic idea of logistic regression is to adapt linear regression so that it estimates the probability a new entry falls in a class. The linear decision boundary is simply a consequence of the structure of the regression function and the use of a threshold in the function to classify.
Logistic Regression tries to maximize the conditional likelihood of the training data, it is highly prone to outliers. Standardization (as co-linearity checks) is also fundamental to make sure a features' weights do not dominate over the others.
Support Vector Machine (SVM):
It is a very powerful classification algorithm to maximize the margin among class variables. This margin (support vector) represents the distance between the separating hyperplanes (decision boundary). The reason to have decision boundaries with large margin is to separate positive and negative hyperplanes with adjustable bias-variance proportion. The goal is to separate so that negative samples would fall under negative hyperplane and positive samples would fall under positive hyperplane. SVM is not as prone to outliers as it only cares about the points closest to the decision boundary. It changes its decision boundary depending on the placement of the new positive or negative events.
The decision boundary is much more important for Linear SVM's – the whole goal is to place a linear boundary in a smart way. There isn't a probabilistic interpretation of individual classifications, at least not in the original formulation.

Hence, key points are:

- SVM try to maximize the margin between the closest support vectors whereas logistic regression maximize the posterior class probability
- SVM is deterministic (but we can use Platts model for probability score) while LR is probabilistic.
- For the kernel space, SVM is faster

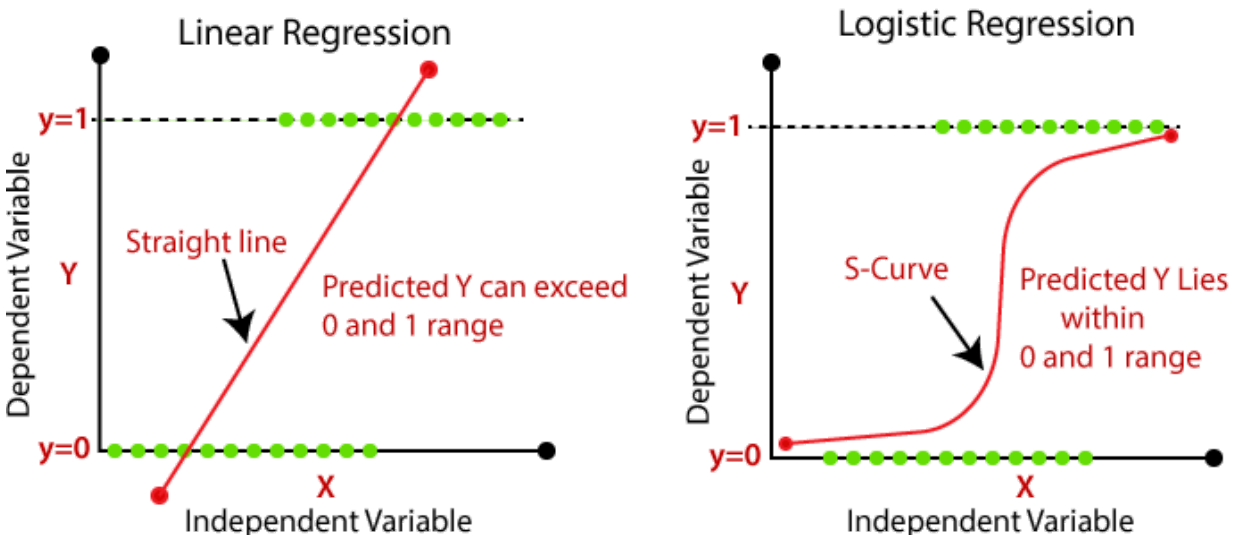
S.No.	Logistic Regression	Support Vector Machine
1.	It is an algorithm used for solving classification problems.	It is a model used for both classification and regression.

2.	It is not used to find the best margin, instead, it can have different decision boundaries with different weights that are near the optimal point.	it tries to find the “best” margin (distance between the line and the support vectors) that separates the classes and thus reduces the risk of error on the data.
3.	It works with already identified identified independent variable.	It works well with unstructured and semi-structured data like text and images.
4.	It is based on statistical approach.	It is based on geometrical properties of the data.
5.	It is vulnerable to overfitting.	The risk of overfitting is less in SVM.
6.	Problems to apply logistic regression algorithm. 1. Cancer Detection: It can be used to detect if a patient has cancer(1) or not(0) 2. Test Score: Predict if the student is passed(1) or not(0). 3. Marketing: Predict if a customer will purchase a product(1) or not(0).	Problems that can be solved using SVM 1. Image Classification 2. Recognizing handwriting 3. Cancer Detection

Linear Regression vs Logistic Regression

Linear Regression and Logistic Regression are the two famous Machine Learning Algorithms which come under supervised learning technique. Since both the algorithms are of supervised in nature hence these algorithms use labeled dataset to make the predictions. But the main difference between them is how they are being used. The Linear Regression is used for solving Regression problems whereas Logistic Regression

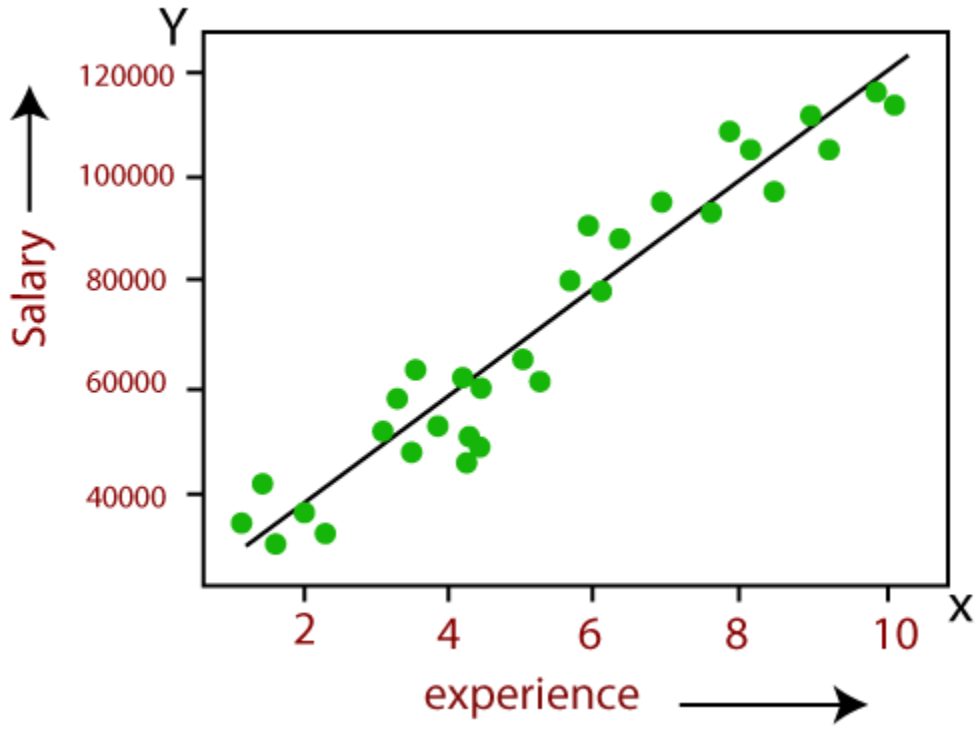
is used for solving the Classification problems. The description of both the algorithms is given below along with difference table.



Linear Regression:

- Linear Regression is one of the most simple Machine learning algorithm that comes under Supervised Learning technique and used for solving regression problems.
- It is used for predicting the continuous dependent variable with the help of independent variables.
- The goal of the Linear regression is to find the best fit line that can accurately predict the output for the continuous dependent variable.
- If single independent variable is used for prediction then it is called Simple Linear Regression and if there are more than two independent variables then such regression is called as Multiple Linear Regression.
- By finding the best fit line, algorithm establish the relationship between dependent variable and independent variable. And the relationship should be of linear nature.

- The output for Linear regression should only be the continuous values such as price, age, salary, etc. The relationship between the dependent variable and independent variable can be shown in below image:



In above image the dependent variable is on Y-axis (salary) and independent variable is on x-axis(experience). The regression line can be written as:

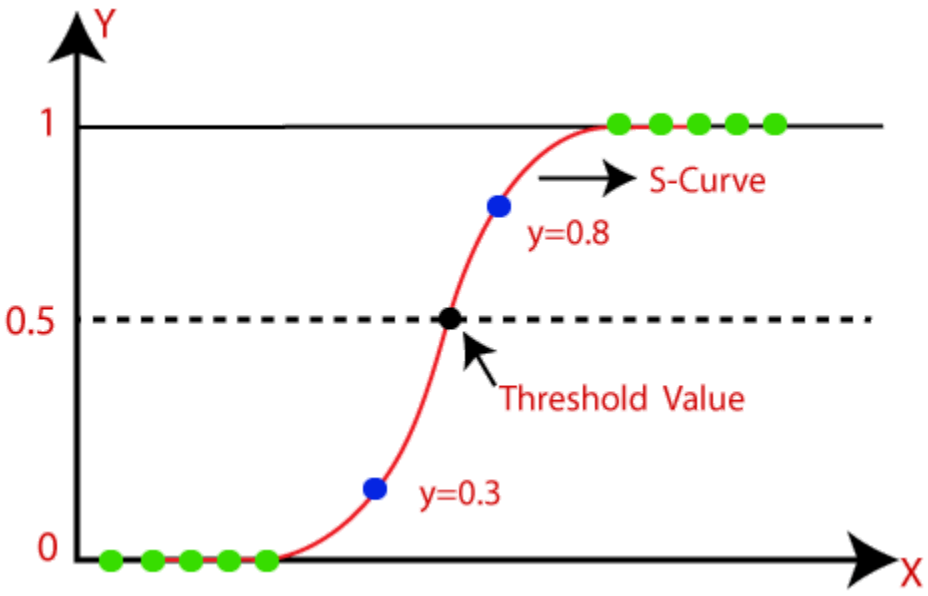
$y= a_0+a_1x+ \varepsilon$

Where, a_0 and a_1 are the coefficients and ε is the error term.

Logistic Regression:

- Logistic regression is one of the most popular Machine learning algorithm that comes under Supervised Learning techniques.

- It can be used for Classification as well as for Regression problems, but mainly used for Classification problems.
- Logistic regression is used to predict the categorical dependent variable with the help of independent variables.
- The output of Logistic Regression problem can be only between the 0 and 1.
- Logistic regression can be used where the probabilities between two classes is required. Such as whether it will rain today or not, either 0 or 1, true or false etc.
- Logistic regression is based on the concept of Maximum Likelihood estimation. According to this estimation, the observed data should be most probable.
- In logistic regression, we pass the weighted sum of inputs through an activation function that can map values in between 0 and 1. Such activation function is known as **sigmoid function** and the curve obtained is called as sigmoid curve or S-curve. Consider the below image:



- The equation for logistic regression is:

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

Difference between Linear Regression and Logistic Regression:

Linear Regression	Logistic Regression
Linear regression is used to predict the continuous dependent variable using a given set of independent variables.	Logistic Regression is used to predict the categorical dependent variable using a given set of independent variables.
Linear Regression is used for solving Regression problem.	Logistic regression is used for solving Classification problems.
In Linear regression, we predict the value of continuous variables.	In logistic Regression, we predict the values of categorical variables.
In linear regression, we find the best fit line, by which we can easily predict the output.	In Logistic Regression, we find the S-curve by which we can classify the samples.
Least square estimation method is used for estimation of accuracy.	Maximum likelihood estimation method is used for estimation of accuracy.
The output for Linear Regression must be a continuous value, such as price, age, etc.	The output of Logistic Regression must be a Categorical value such as 0 or 1, Yes or No, etc.

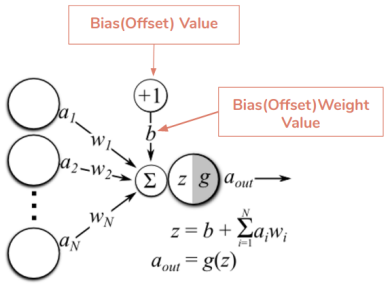
In Linear regression, it is required that relationship between dependent variable and independent variable must be linear.	In Logistic regression, it is not required to have the linear relationship between the dependent and independent variable.
In linear regression, there may be collinearity between the independent variables.	In logistic regression, there should not be collinearity between the independent variable.

Weights and biases (commonly referred to as *w and b*) are the learnable parameters of a some machine learning models, including neural networks.
Neurons are the basic units of a neural network. In an ANN, each neuron in a layer is connected to some or all of the neurons in the next layer. When the inputs are transmitted between neurons, the weights are applied to the inputs along with the bias.

$$Y = \sum (weight * input) + bias$$

A neuron

Weights control the signal (or the strength of the connection) between two neurons. In other words, a weight decides how much influence the input will have on the output.
Biases, which are constant, are an additional input into the next layer that will always have the value of 1. Bias units are not influenced by the previous layer (they do not have any incoming connections) but they do have outgoing connections with their own weights. The bias unit guarantees that even when all the inputs are zeros there will still be an activation in the neuron.



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