SNS COLLEGE OF ENGINEERING

Kurumbapalayam(Po), Coimbatore – 641 107
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Department of AI &DS

Course Name – 19AD602 DEEP LEARNING

III Year / VI Semester

Unit 1-INTRODUCTION
Topic: LINEAR MODELS

LINEAR MODELS

Case Study

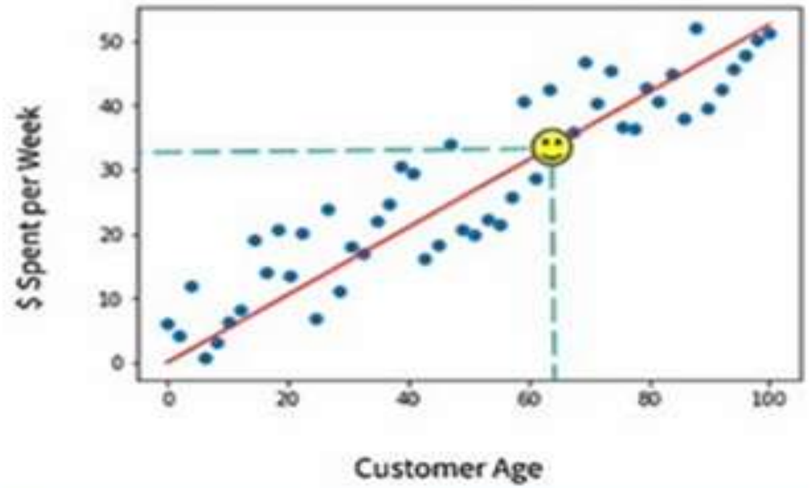
Task: Predict whether an email is spam or not using logistic regression.

Approach: Logistic regression uses email features (e.g., frequency of specific words) to predict spam likelihood.

Outcome: The model achieves 92% accuracy in classifying spam emails in a test dataset.

Linear Models

Linear models generate a formula to create a best-fit line to predict unknown values. Linear models are not as predictive as newer algorithm classes, but they can be trained relatively quickly and are generally more straightforward to interpret.



The data points are in blue. The red line is the line of best fit, which the model generated, and captures the direction of those points as best as possible.

Support Vector Machine (SVM)

- Support Vector Machine or SVM is one of the most popular Supervised Learning algorithms, which is used for Classification as well as Regression problems.
- However, primarily, it is used for Classification problems in Machine Learning.
- The goal of the SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space that distinctly classifies data points.
- This best decision boundary is called a hyperplane.
- SVM chooses the extreme points/vectors that help in creating the hyperplane.
- Hyperplane will be created with a maximum margin, which means the maximum distance between the data points.
- These extreme cases are called as support vectors, and hence algorithm is termed as Support Vector Machine.

Support Vectors:

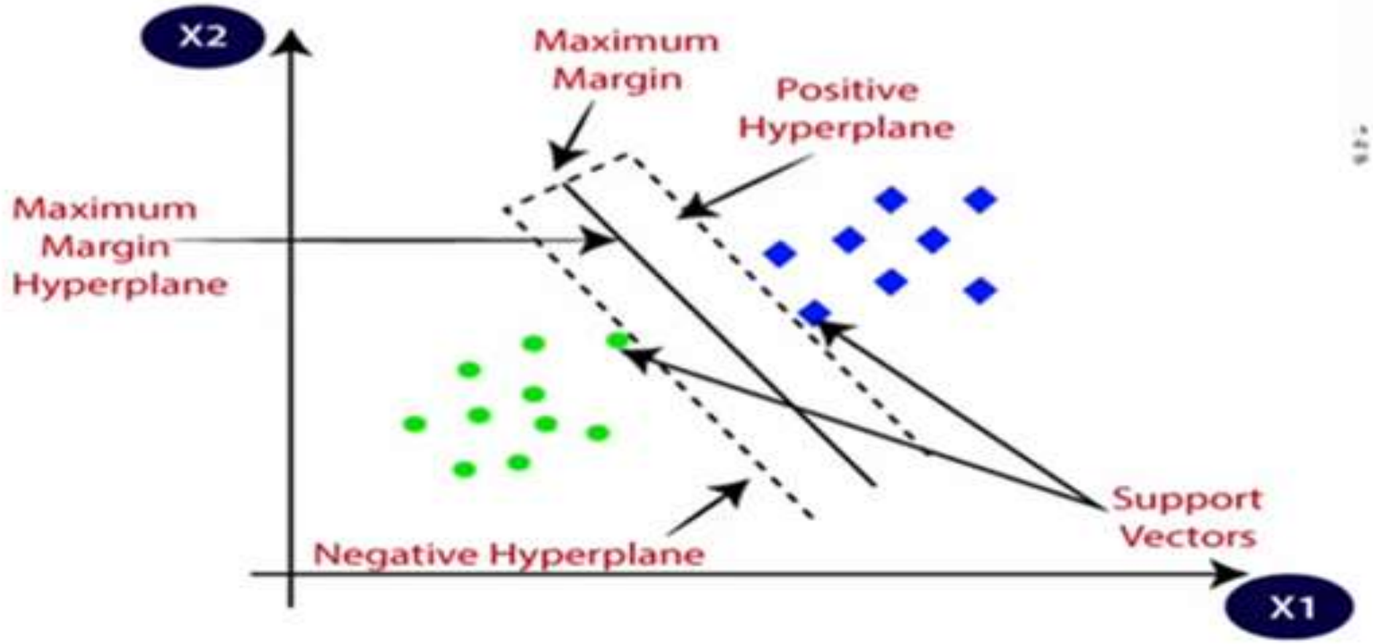
The data points or vectors that are closest to the hyperplane and which affect the position of the hyperplane are termed as Support Vector.

LINEAR MODELS

Linear Models

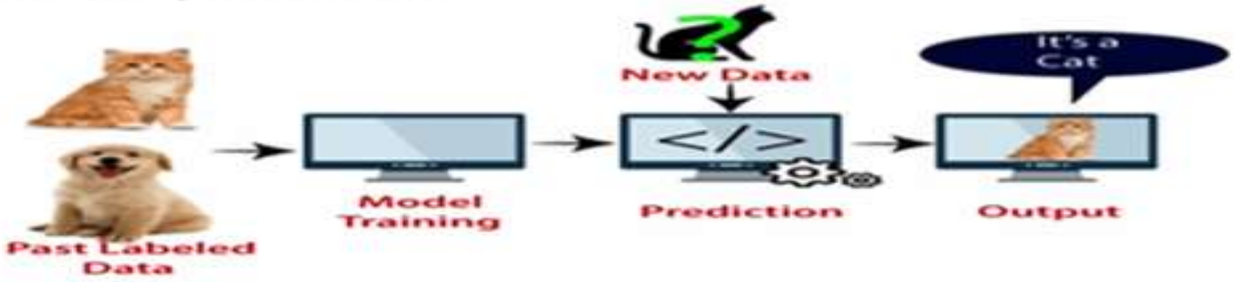
Support Vector Machine:

$$x.w+b=0$$



Working of SVM

- Suppose we see a strange cat that also has some features of dogs, so if we want a model that can accurately identify whether it is a cat or dog, so such a model can be created by using the SVM algorithm. We will first train our model with lots of images of cats and dogs so that it can learn about different features of cats and dogs, and then we test it with this strange creature. So as support vector creates a decision boundary between these two data (cat and dog) and choose extreme cases (support vectors), it will see the extreme case of cat and dog. On the basis of the support vectors, it will classify it as a cat.



LINEAR MODELS

Support Vector Machine:

- ✓ Used for Classification as well as Regression problems.
- ✓ Primarily used for Classification problems in Machine Learning.
- ✓ The goal of the SVM algorithm is to find out the best decision boundary to classify the points.

Ex. Face detection, image classification, text categorization

LINEAR MODELS

Types of SVM:

1. **Linear SVM** - linearly separable data

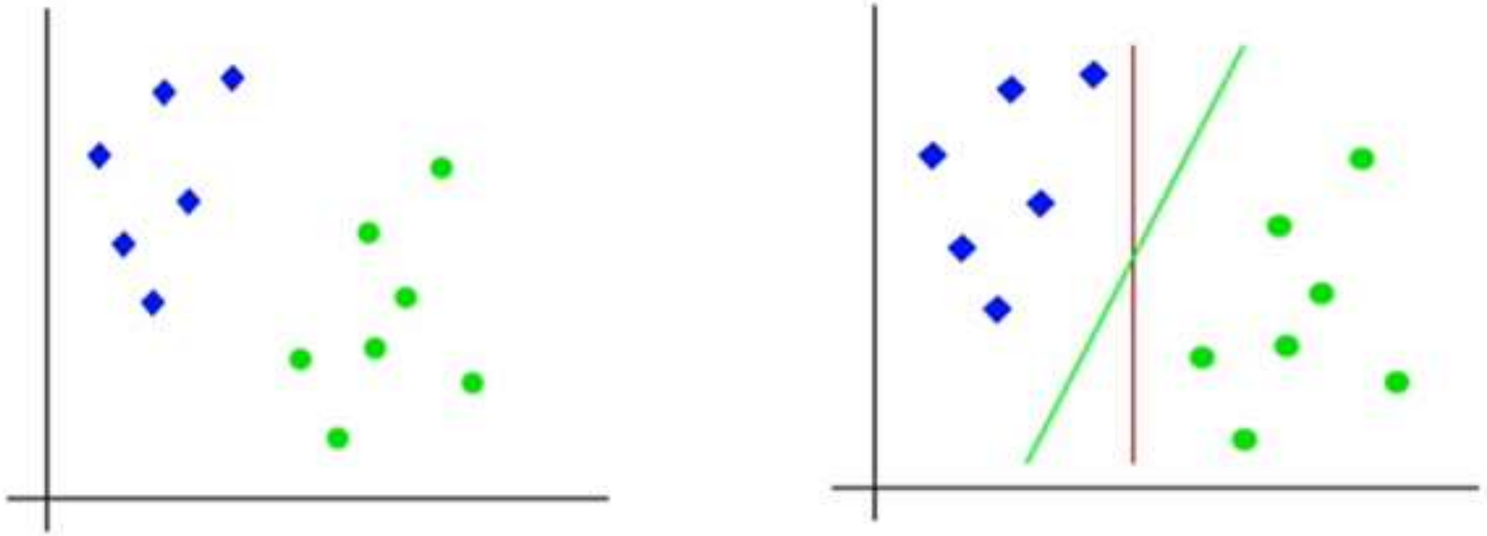
   - if a dataset can be classified into two classes by using a single straight line, then such data is termed as linearly separable data, and classifier used is called as Linear SVM classifier.

2. **Non-linear SVM** - non-linearly separable data

   - if a dataset cannot be classified by using a straight line, then such data is termed as non-linear data and classifier used is called as Non-linear SVM classifier.

LINEAR MODELS

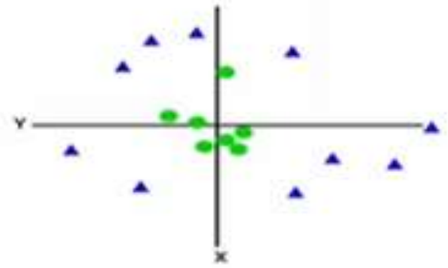
Linear SVM:



LINEAR MODELS

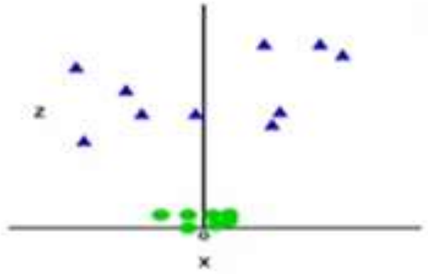
Non-Linear SVM:

1. Cant draw single straight line for non-linear data

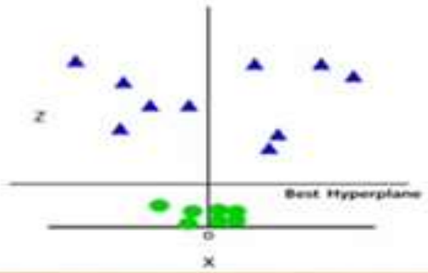


2. One more dimension is added

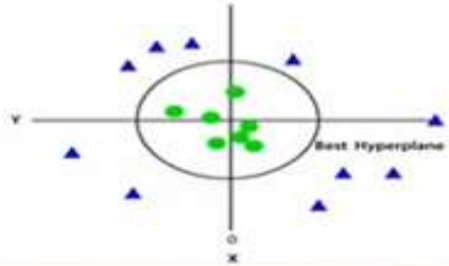
$z=x^2+y^2$



3. Datasets divided into classes

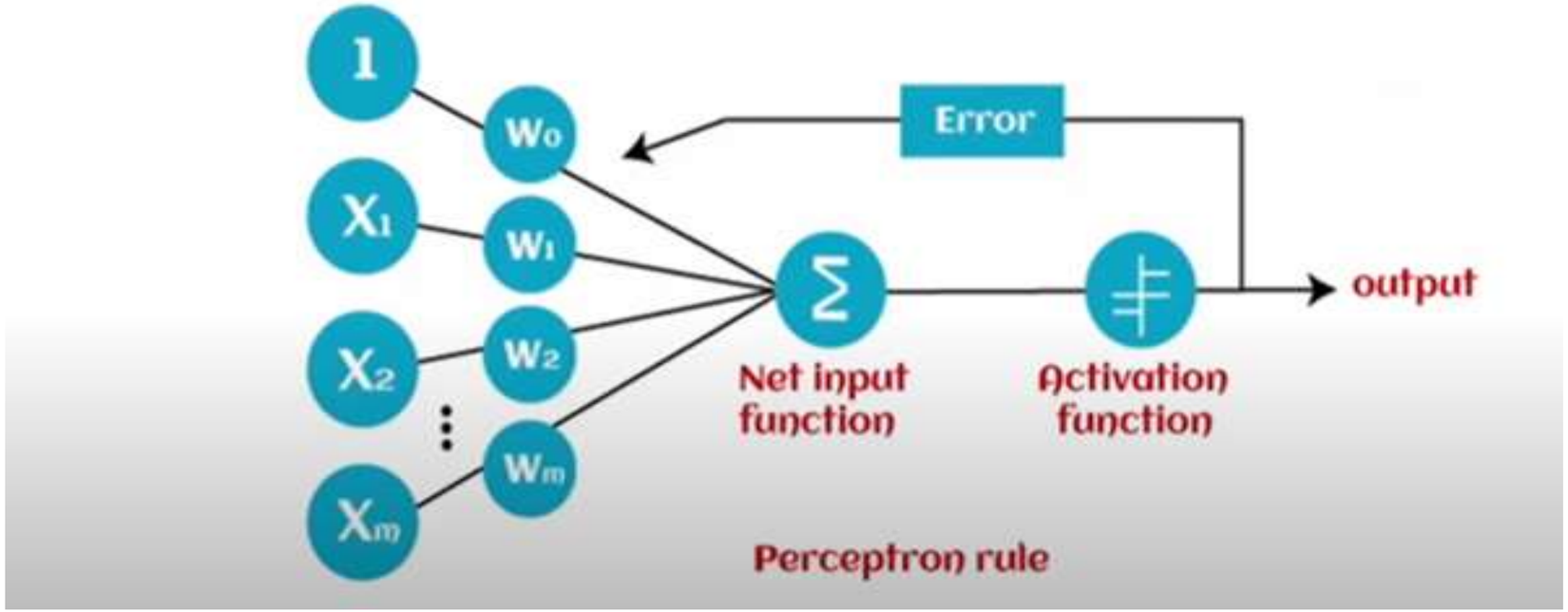


4. Converted into two dimensional one



LINEAR MODELS

Perceptron:



LINEAR MODELS

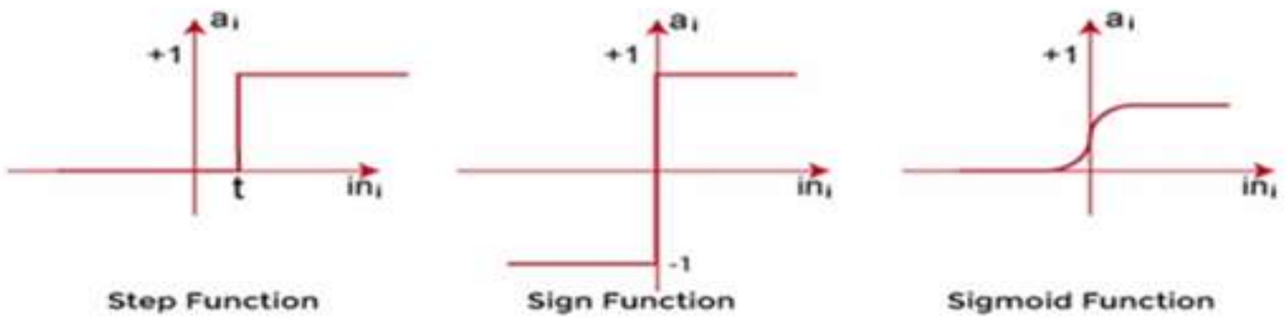
Perceptron:

- ***Artificial Neuron or neural network unit that helps to detect certain input data computations in business intelligence.***
- One of the best and simplest types of Artificial Neural networks.
- It is a supervised learning algorithm of binary classifiers.
- single-layer neural network with four main parameters, i.e., **input values, weights and Bias, net sum, and an activation function.**

LINEAR MODELS

Types of Activation functions:

- Sign function
- Step function, and
- Sigmoid function



LINEAR MODELS

Characteristics of Perceptron:

- Supervised learning of binary classifiers.
- Weight coefficient is automatically learned.
- Initially, weights are multiplied with input features, and the decision is made whether the neuron is fired or not.
- The activation function applies a step rule to check whether the weight function is greater than zero.
- Linear decision boundary is drawn, enabling the distinction between the two linearly separable classes +1 and -1.

LINEAR MODELS

Perceptron model works in two important steps as follows:

Step-1

In the first step first, multiply all input values with corresponding weight values and then add them to determine the weighted sum. Mathematically, we can calculate the weighted sum as follows:

$$\sum wi*xi = x1*w1 + x2*w2 + \ldots wn*xn$$

Add a special term called **bias 'b'** to this weighted sum to improve the model's performance.

$$\sum wi*xi + b$$

Step-2

In the second step, an activation function is applied with the above-mentioned weighted sum, which gives us output either in binary form or a continuous value as follows:

$$Y = f(\sum wi*xi + b)$$

LINEAR MODELS

Logistic Regression:

- ✓ It is used for predicting the categorical dependent variable using a given set of independent variables.
- ✓ 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**.
- ✓ 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).
- ✓ It has the ability to provide probabilities and classify new data using continuous and discrete datasets.

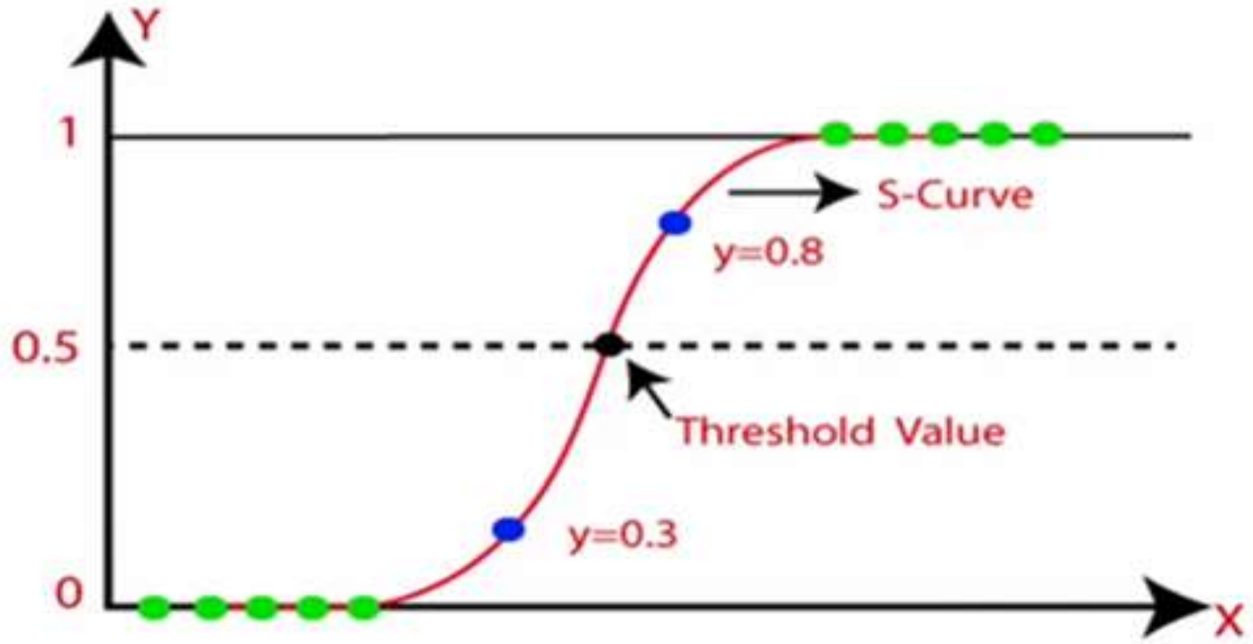
LINEAR MODELS

Logistic Function (Sigmoid Function):

- It 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 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.
- The concept of the threshold value is used such as values above the threshold value tends to 1, and a value below the threshold values tends to 0.

LINEAR MODELS

Logistic Regression:



LINEAR MODELS

Steps in Logistic Regression:

1. Data Pre-processing step.
2. Fitting Logistic Regression to the Training set.
3. Predicting the test result.
4. Test accuracy of the result.
5. Visualizing the test set result.

LINEAR MODELS

Type of Logistic Regression:

1. **Binomial** - Only two possible types of the dependent variables, such as 0 or 1, Pass or Fail, etc.
2. **Multinomial** - 3 or more possible unordered types of the dependent variable, such as "cat", "dogs", or "sheep"
3. **Ordinal** - 3 or more possible ordered types of dependent variables, such as "low", "Medium", or "High".

LINEAR MODELS

ACTIVITY:

Activity

Title: Build a Simple Classifier for a Yes/No Decision

1. **Step 1:** Provide students with data points (e.g., height vs. sports eligibility).
2. **Step 2:** Plot a decision boundary (straight line) using a simple model like SVM or perceptron.
3. **Step 3:** Adjust parameters manually (like weights and bias) to see how the boundary changes.

Objective: Show how linear models separate data and make predictions.

LINEAR MODELS

Classify Shapes Using a Linear Model

Objective: Understand how linear models (e.g., SVM or perceptron) create decision boundaries.

Setup

1. **Materials Needed:**
   - A whiteboard or chart paper.
   - Markers or colored pens.
   - A set of cards or paper cutouts of two shapes (e.g., circles and squares) labeled as 0 and 1.
2. **Scenario:** Classify shapes into two categories using a linear decision boundary.

THANK YOU