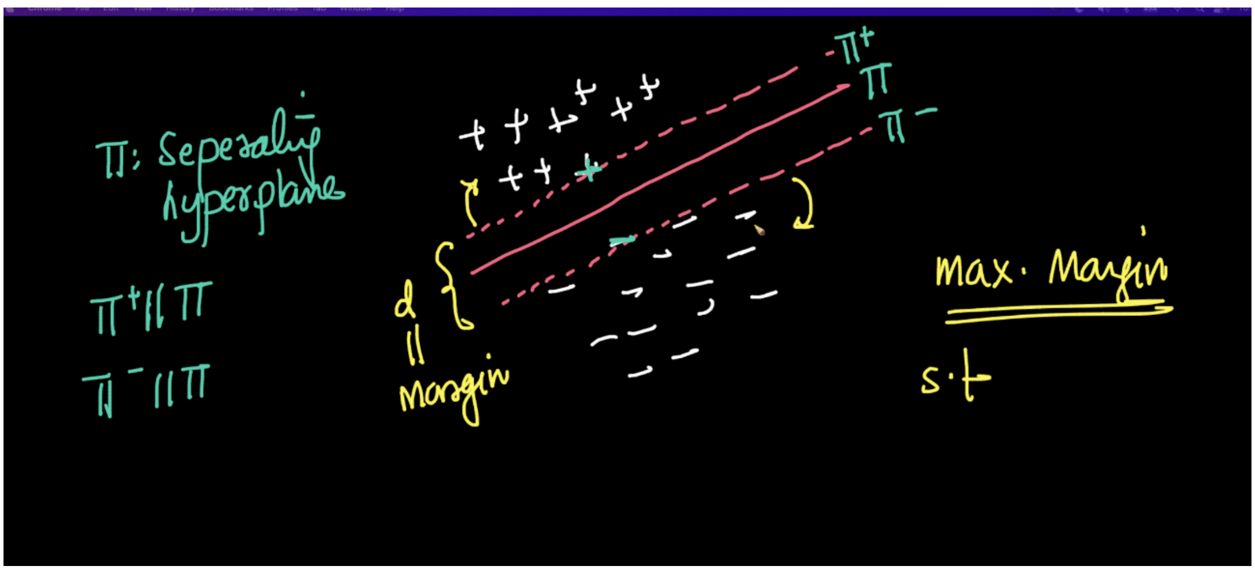
SVM-Introduction

- Support Vector Machine (SVM) is a powerful supervised machine learning algorithm.
- It works by finding the optimal hyperplane that best separates data points into different classes while maximizing the margin between the classes, making it highly effective in high-dimensional spaces.

What is the key idea behind SVM?

- The best hyperplane π: $w^T x + b = 0$ classifying between 2 classes is the one that has maximum gap/margin (d) between itself and the closest +ve and -ve datapoints.



Margin/gap

The hyperplane parallel to π, that touches the closest +ve point:

$\pi^{+}: w^T x + b = 1;$

The hyperplane parallel to π, that touches the closest -ve point:

$\pi^{-}: w^T x + b = -1$

Margin is measured as the distance between them: $d(\pi^{+}, \pi^{-}) = \frac{2}{||w||}$;

- where w is the weight of the model.

The optimization problem in SVM

Optimization problem: $max \frac{2}{||w||}$

The goal is to maximize generalization.

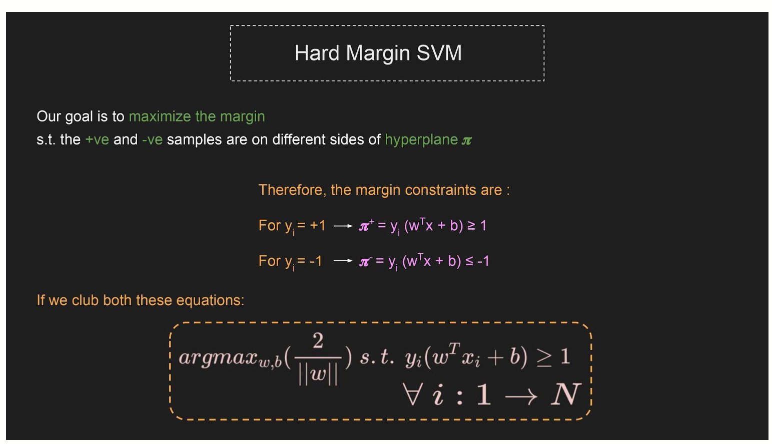
Support Vectors

These are the data points:-

- Are within the margin
- Or, are misclassified
- Or, which lies on the hyperplanes (π^{+}, π^{-})
- $\propto_i = 0$ for nonsupport vectors, whereas, $\propto_i > 0$ for support vectors.

Different Types of SVM model

A. **Hard Margin SVM:**
   - The simplest form of the SVM model.
   - It assumes no data point can lie inside the Margin.
   - Rarely works in real-life problems.



B. **Soft Margin SVM:**
   - Introduces ζ as error for an incorrectly placed data point.

- $\zeta = 0$; datapoint is placed such that the hyperplane classifies the point correctly
- $\zeta > 1$; datapoint is placed such that the hyperplane classifies the point incorrectly
- $\zeta < 1$; datapoint is placed such that the hyperplane still manages to classify the point correctly, but lies inside the margin.

- Linear soft margin SVM is similar to LogReg