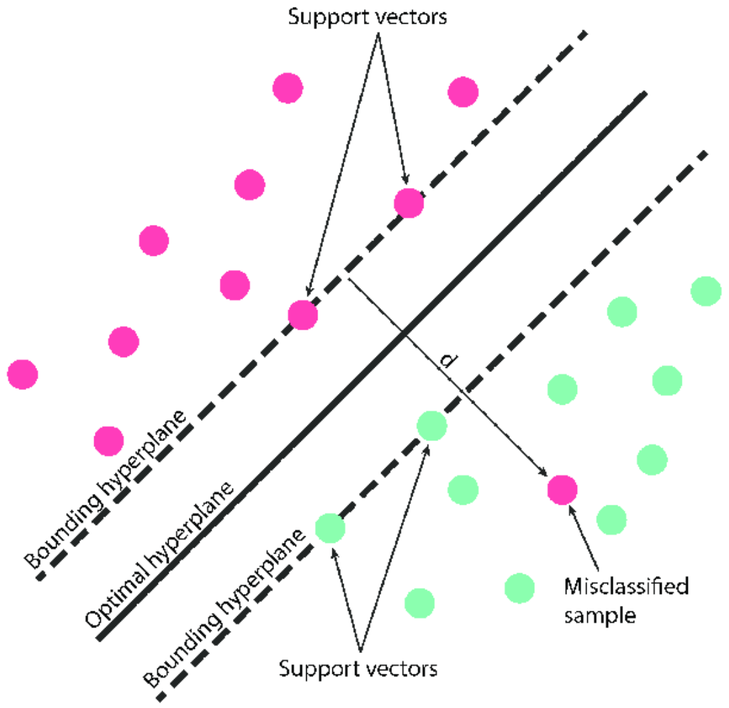
SVM

DEMO AND EXPLANATION

¿What is SVM?

A support vector machine (SVM) is a supervised ML algorithm that performs classification or regression tasks by constructing a divider that separates data in two categories. The optimal divider is the one which is in equal distance from the boundaries of each group.

Support Vectors: These are the points that are closest to the hyperplane. A separating line will be defined with the help of these data points.



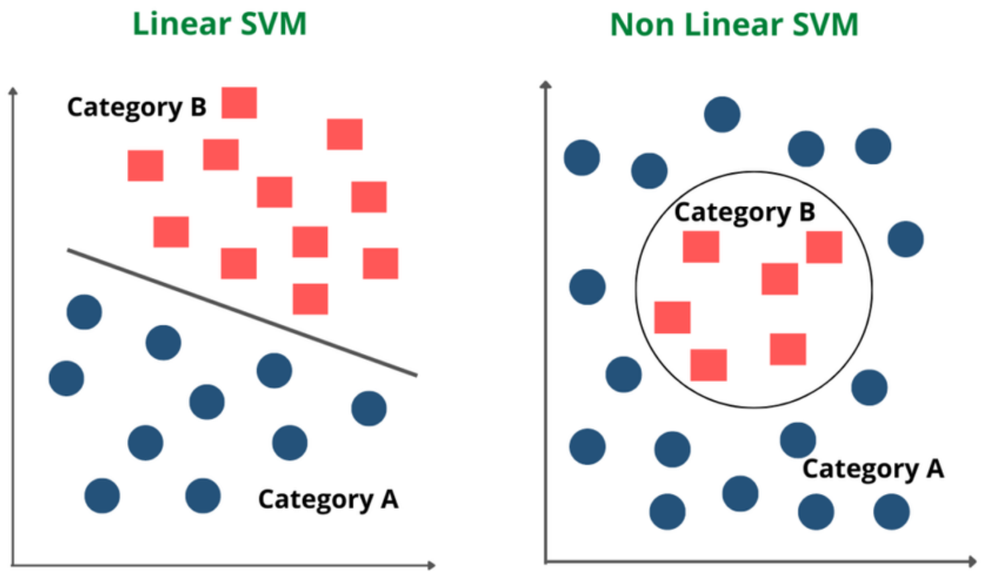
TYPES

1. Linear SVM

When the data is perfectly linearly separable, only then we can use Linear SVM. Perfectly linearly separable means that the data points can be classified into 2 classes by using a single straight line(if 2D).

2. Non-Linear SVM

When the data is not linearly separable then we can use Non-Linear SVM, which means when the data points cannot be separated into 2 classes by using a straight line (if 2D).



Background

Unlike Neural Networks, SVMs were developed beginning from the theory first, and as such has a very strong theoretical background. The paper, initially published 1964/65, was met with the ambivalent attitude of “it’s not practical, it’s just theory” (Kecman 2005), until benchmark performances proved its effectiveness (multiple as cited in Kecman 2005).

$$y = f(x)$$

where x is a highly dimensional input vector

and y is, either a scalar or, a vector output

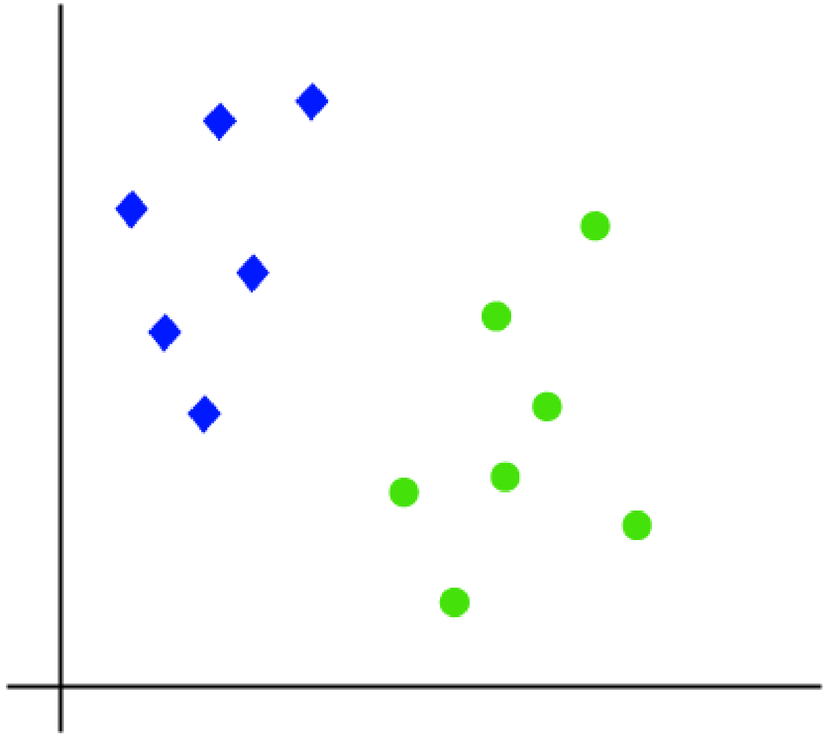
$$D = \{(x_i, y_i) \in X \times Y\}, i = 1, l$$

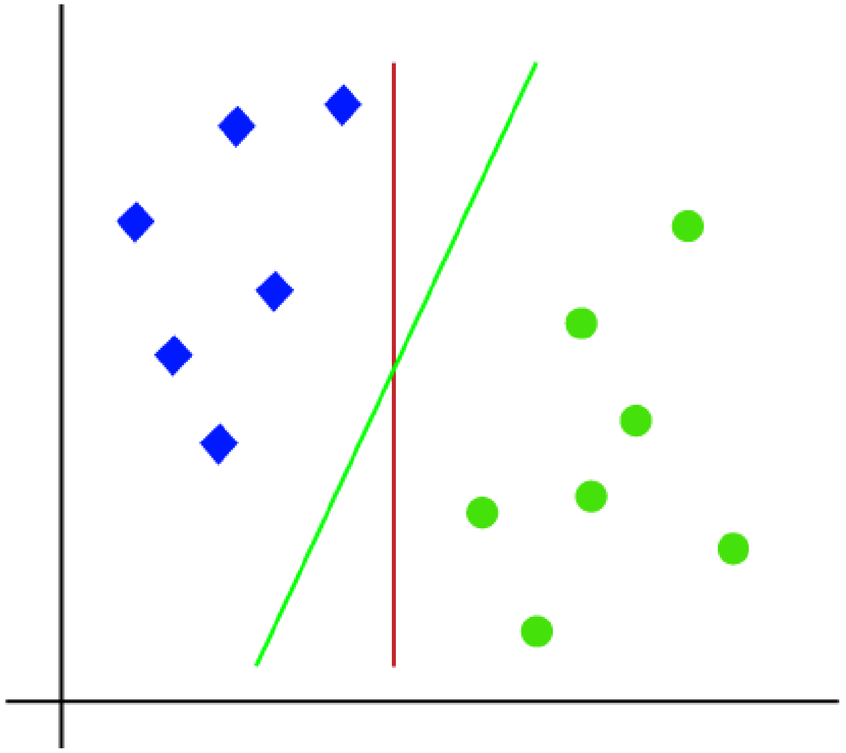
where l = #data training pairs

How does SVM works?

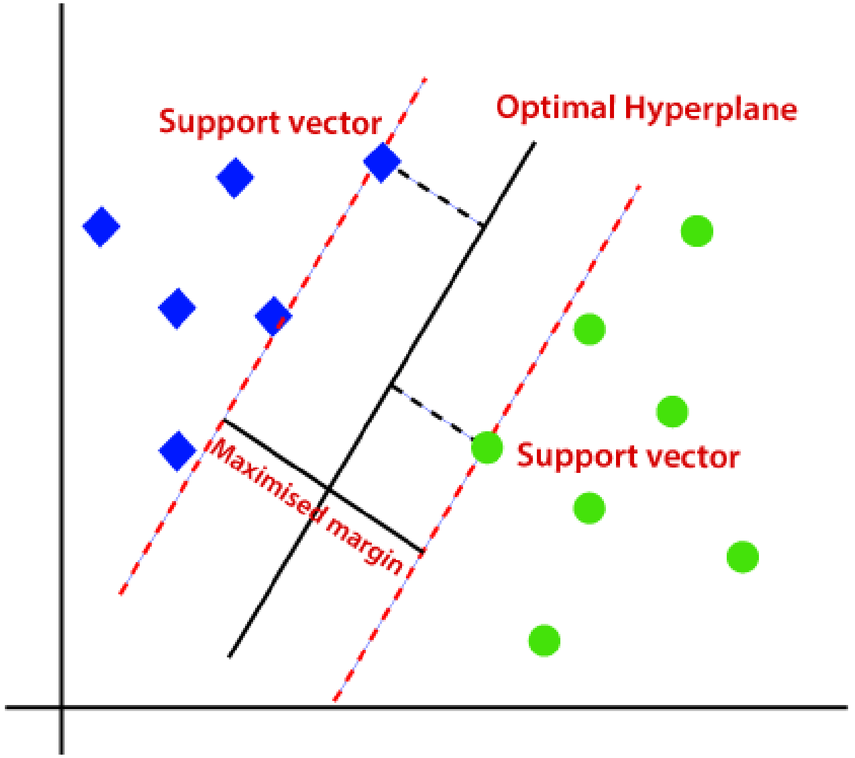
Linear SVM

The working of the SVM algorithm can be understood by using an example. Suppose we have a dataset that has two tags (green and blue), and the dataset has two features x1 and x2. We want a classifier that can classify the pair(x1, x2) of coordinates in either green or blue.





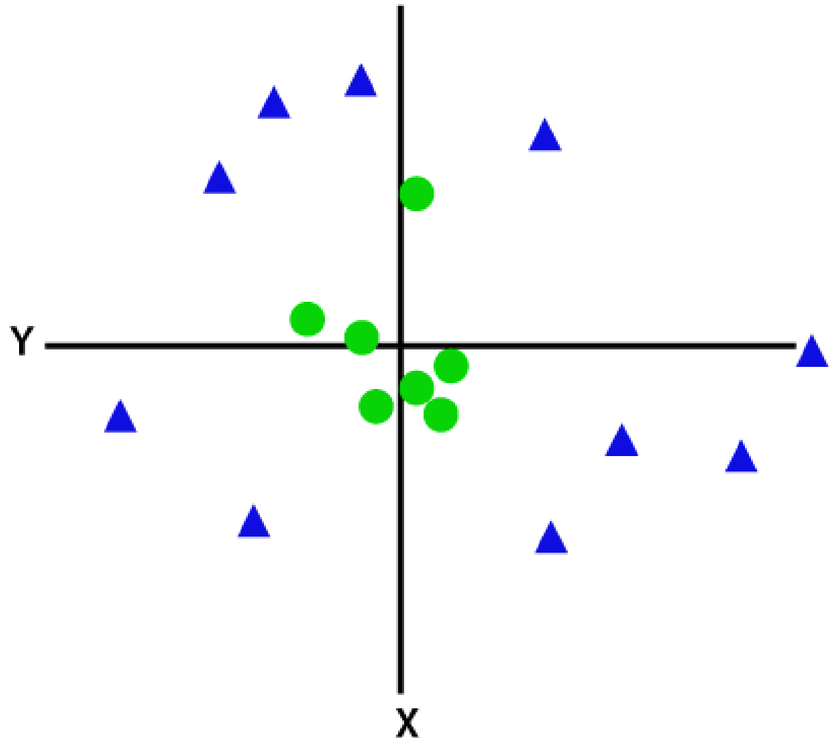
As it is 2-d space by just using a straight line, it is easy to separate the classes. But there can be multiple of them.

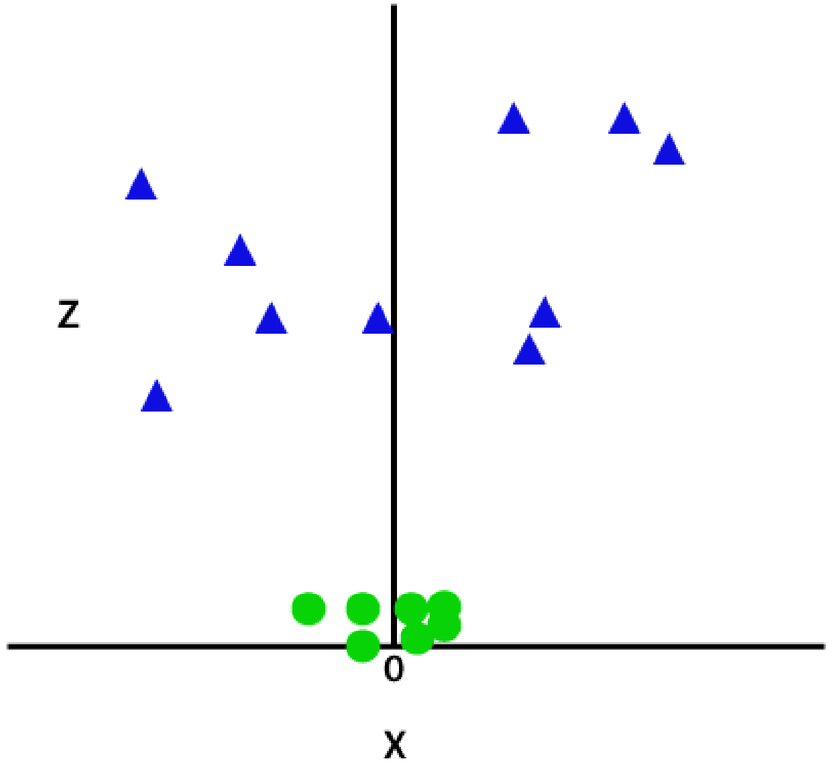


The SVM algorithm helps to find the best line or decision boundary. And the goal of SVM is to maximize this margin.

Non-Linear SVM

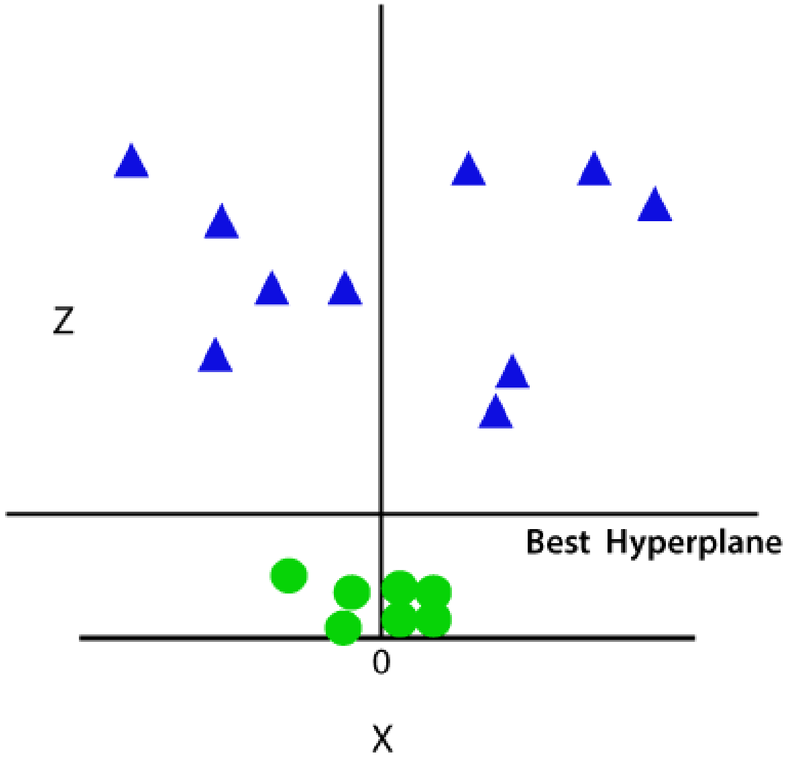
Considering the data points in the image on the right.



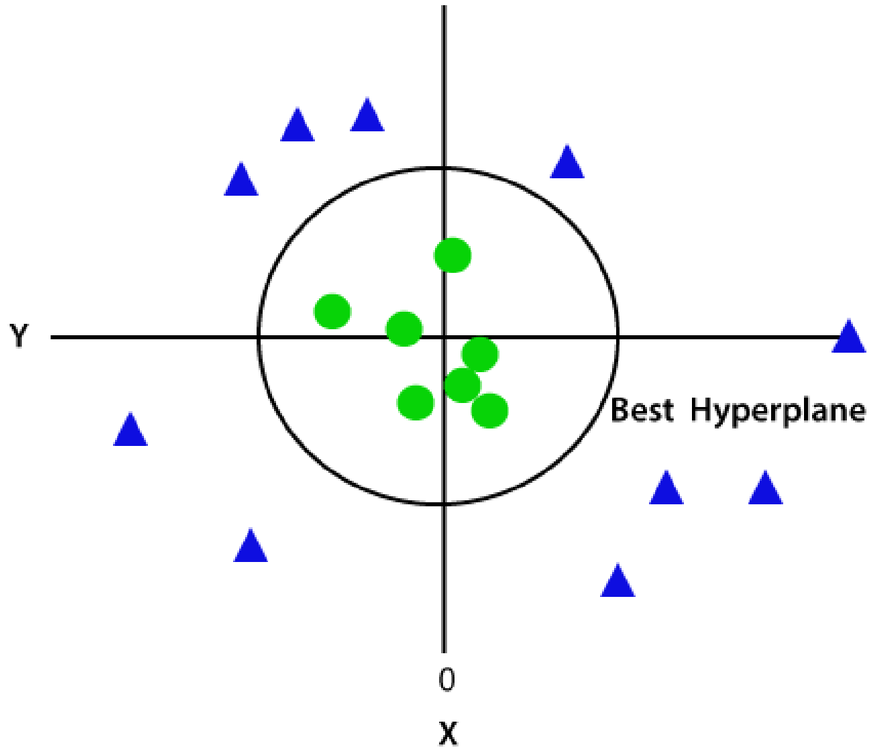


To separate these data points, we need to add one more dimension.
It can be calculated as:
z=x^(2) +y^(2)

By adding the third dimension, the sample space will become this way.



SVM will divide the datasets into classes. This is the 3d space visualization.



Then, in the 2d space we get a circumference of radius 1 in case of non-linear data.

Types of Kernel in SVM

Linear

$$K(x_1, x_2) = {x_1}^T * x_2$$

Polynomial

$$K(x_1, x_2) = (x_1 * x_2 + 1)^d$$

Radial Basis Function (RBF)

$$K(x_1, x_2) = e^{\left(-\frac{||x_1 - x_2||^2}{2 * sigma^2}\right)}$$

Sigmoid

$$K(x_1, x_2) = tanh(a{x_1}^T * x_2 + c)$$

REFERENCES

- Logunova, I. (2022, October 18). Support Vector Machine Algorithm. Guide to Support Vector Machine (SVM) Algorithm. https://serokell.io/blog/support-vector-machine-algorithm

- Kecman, V. (2005, January 1). *Support Vector machines – an introduction.* Studies in Fhttps://doi.org/10.1007/10984697_1uzziness and Soft Computing (177) pgs 1-47. https://doi.org/10.1007/10984697_1

- Support vector machine (SVM) algorithm - javatpoint. (s.f.). www.javatpoint.com. https://www.javatpoint.com/machine-learning-support-vector-machine-algorithm