Machine Learning

Support Vector Machine (SVM)

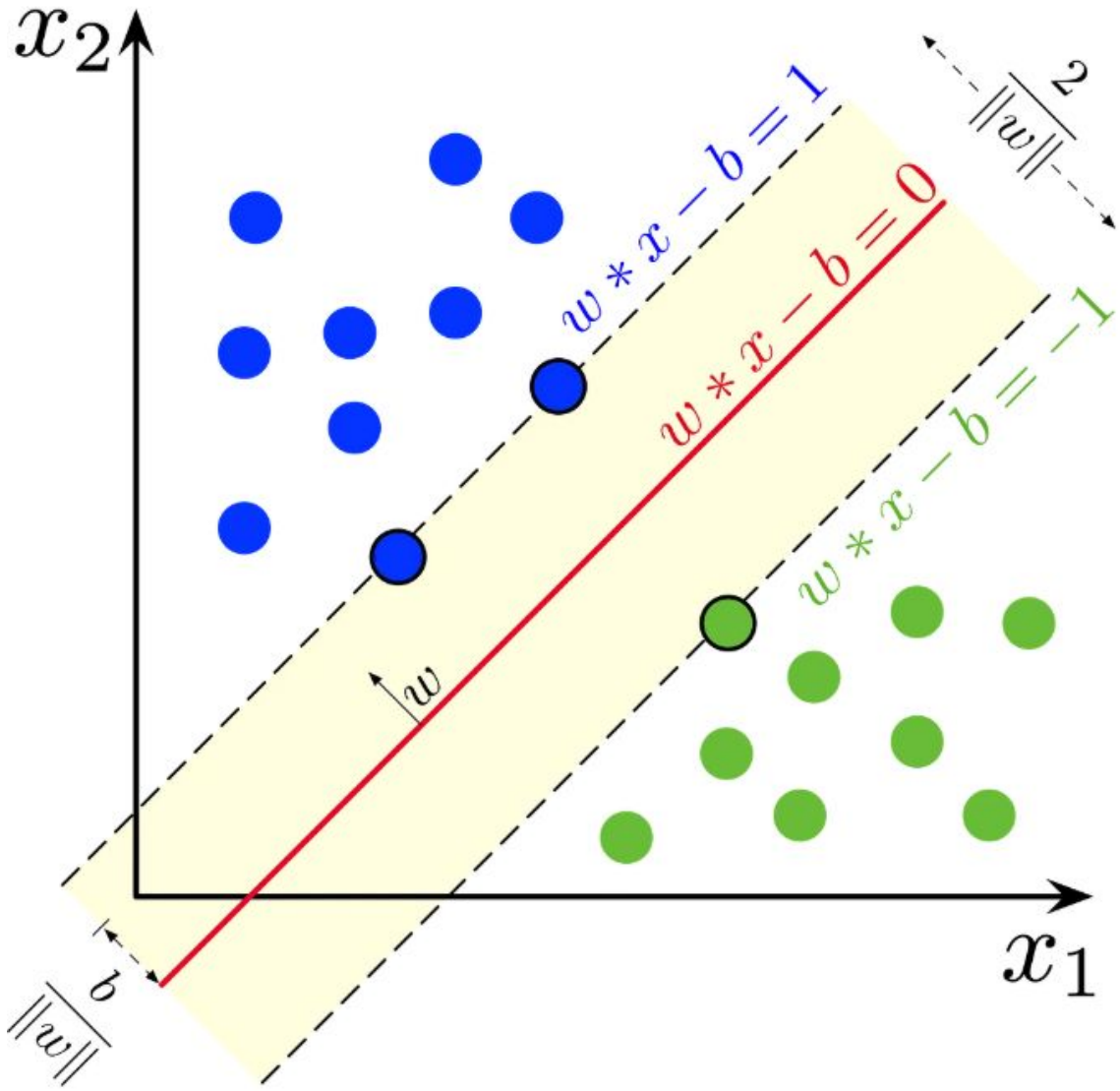
Support Vector Machine

- Support Vector Machine (SVM) is a supervised machine learning algorithm used for classification and regression tasks.
- While it can handle regression problems, SVM is particularly well-suited for classification tasks.

Support Vector Machine

- SVM aims to find the optimal hyperplane in an N-dimensional space to separate data points into different classes.
- The algorithm maximizes the margin between the closest points of different classes.

Support Vector Machine



SVM Terminology

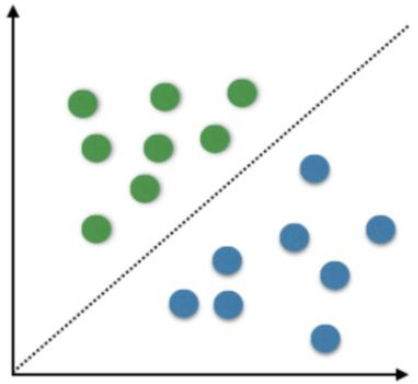
- **Hyperplane**: A decision boundary separating different classes in feature space, represented by the equation **wx + b = 0** in linear classification.
- **Support Vectors**: The closest data points to the hyperplane, crucial for determining the hyperplane and margin in SVM.

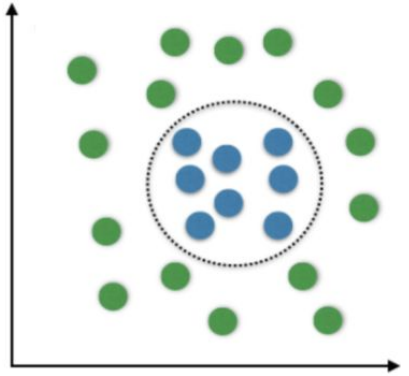
SVM Terminology

- **Margin**: The distance between the hyperplane and the support vectors. SVM aims to maximize this margin for better classification performance.
- **Hard Margin**: A maximum-margin hyperplane that perfectly separates the data without misclassifications.
- **Soft Margin**: Allows some misclassifications by introducing slack variables, balancing margin maximization and misclassification penalties when data is not perfectly separable.

Types of SVM

- **Linear SVM:**
  - Linear SVMs use a linear decision boundary to separate the data points of different classes.
- **Non-Linear SVM:**
  - Non-Linear SVM can be used to classify data when it cannot be separated into two classes by a straight line (in the case of 2D).
  - By using kernel functions, nonlinear SVMs can handle nonlinearly separable data.



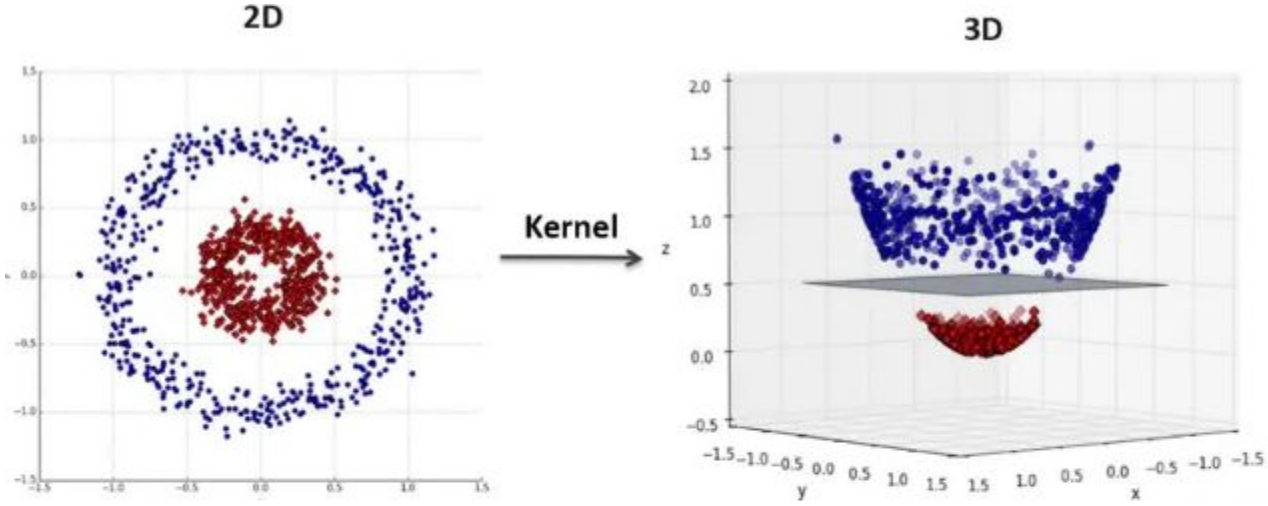


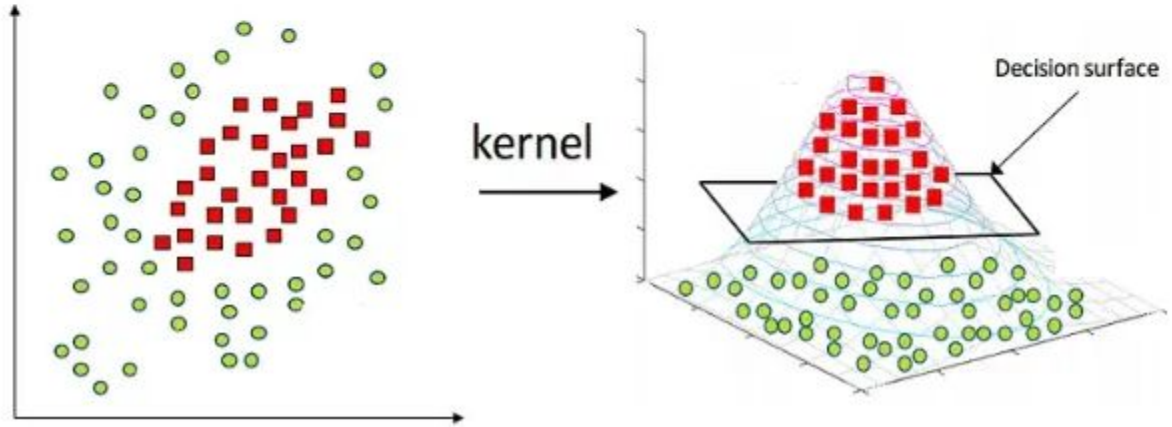
Kernel Functions

- A **kernel** is a mathematical function that helps organize data and make it easier to classify.
- Kernels help by implicitly mapping the original feature space into a higher-dimensional space where the data might be more easily separable.
- Using proper kernel function with SVM, a non-linear decision boundary can be treated as linear.

Kernel Functions

- When data is not linearly separable (i.e., it can't be divided by a straight line), SVM uses **kernels** to map the data into a higher-dimensional space where it becomes separable.
- This transformation helps SVM find a decision boundary even for non-linear data.





Support Vector Machine

- For the given points of two classes:
    - Yellow: { (1, 4), (2,5), (3,4), (3,5)}
    - Green : { (4,0), (5,1), (5,2), (6,1)}
- Plot a graph for the red and blue categories.
- Find the support vectors and optimal separating line.
- Calculate the margin.

Support Vector Machine

- For the given points of two classes:
    - Red: { (0,0), (0,1), (0,2), (1,0), (1,1)}
    - Green : { (1,3), (2,3), (2,4), (3,2)}
- Plot a graph for the red and blue categories.
- Find the support vectors and optimal separating line.
- Calculate the margin.

Support Vector Machine

- For the given points of two classes:
    - Blue: { (1, 2), (2,1), (1,-2), (2,-2)}
    - Red : { (4,-1), (4,1), (5,-1), (6,1)}
- Plot a graph for the red and blue categories.
- Find the support vectors and optimal separating line.
- Calculate the margin.