SUPPOT VECTOR MACHINE

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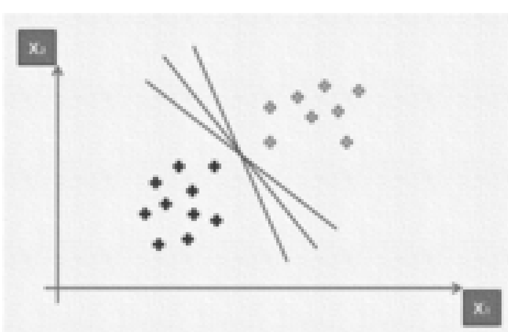
INTRODUCTION

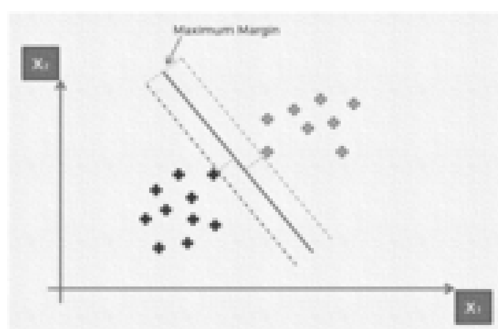
- One of the most popular and talked about machine learning algorithms
- They were extremely popular around the time they were developed in the 1990s and continue to be the go-to method for a high-performing algorithm with little tuning

MAXIMAL-MARGIN CLASSIFIER

- The Maximal-Margin Classifier is a hypothetical classifier that best explains how SVM works in practice
- The numeric input variables (x) in your data (the columns) form an n-dimensional space. For example, if you had two input variables, this would form a two-dimensional space
- A hyperplane is a line that splits the input variable space. In SVM, a hyperplane is selected to best separate the points in the input variable space by their class, either class 0 or class 1.

CONTD..





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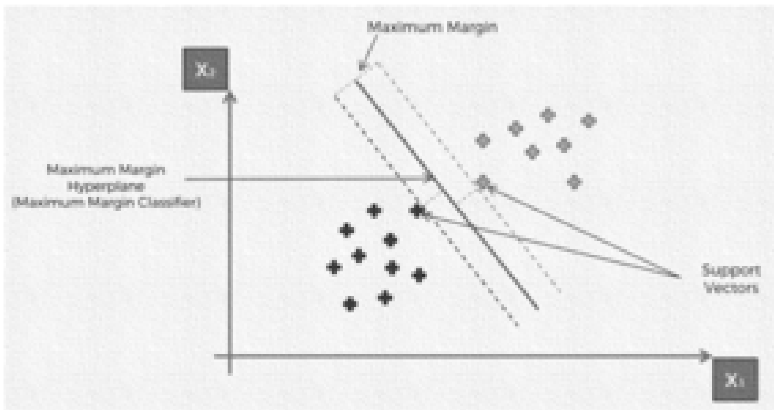
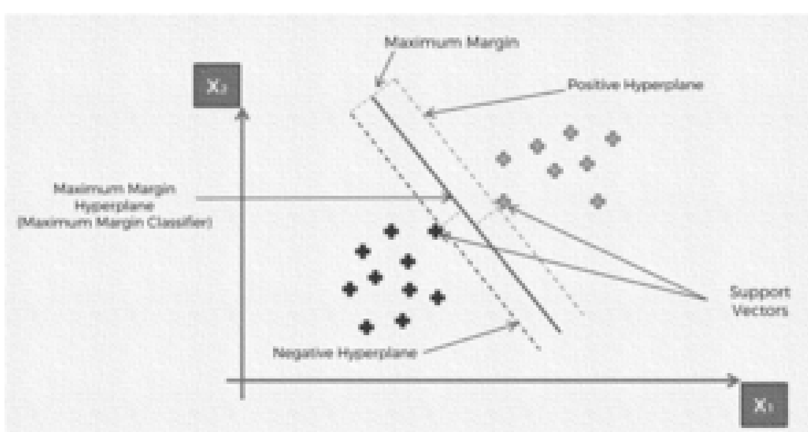


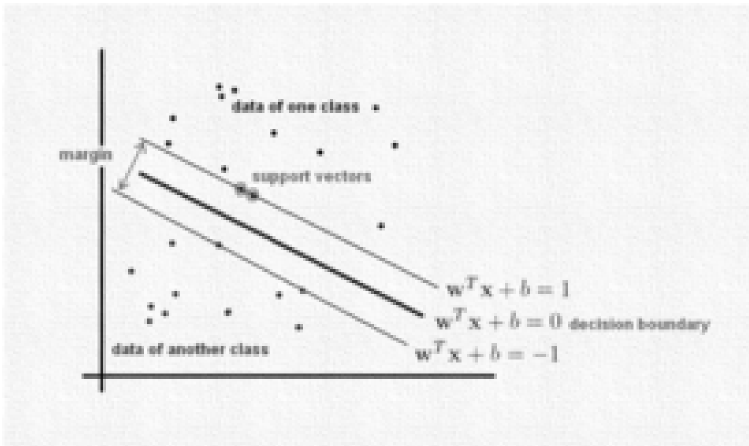
Maximum Margin
X2
Maximum Margin
Hyperplane
(Maximum Margin Classifier)
Support
Vectors
X1

CONTD..



Maximum Margin
Positive Hyperplane
X2
Maximum Margin
Hyperplane
(Maximum Margin Classifier)
Support
Vectors
Negative Hyperplane
X1

CONTD..



HYPERPLANE

- In two dimension, a hyperplane is a one dimension subspace namely a line
- In three dimension, a hyperplane is a flat two dimension subspace namely a plane
- In a p dimensional space, a hyperplane is a linear subspace of p-1 dimension
- Hyperplane in p dimension - Equation

$$w_0 + w_1 X_1 + w_2 X_2 + w_3 X_3 + \ldots\ldots + w_p X_p = 0$$

CONTD..

Suppose for $X = X_1, X_2, X_3 \ldots\ldots. X_p$

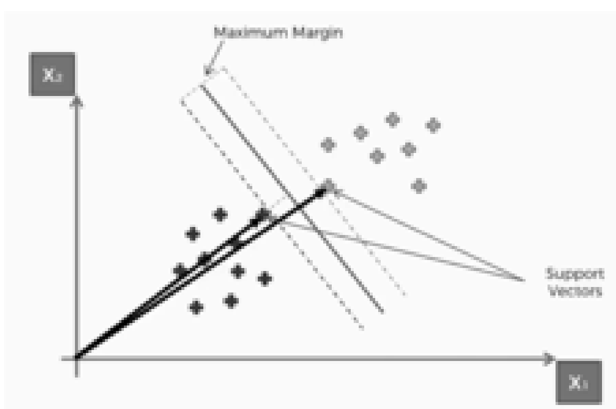
- If $w_0 + w_1 X_1 + w_2 X_2 + w_3 X_3 + \ldots\ldots.. + w_p X_p > 0$

  Then the X lies in one side of the hyperplane
- If $w_0 + w_1 X_1 + w_2 X_2 + w_3 X_3 + \ldots\ldots.. + w_p X_p < 0$

  Then the X lies in one the other side of the hyperplane
- Hyperplane divide p dimensional space into 2 halves
- A value close to the line returns a value close to zero and the point may be difficult to classify
- If the magnitude of the value is large, the model may have more confidence in the prediction

CONTD..

- Distance between the line and the closest data points is referred to as the margin
- Best or optimal line that can separate the two classes is the line that has the largest margin. This is called Maximal-Margin hyperplane.



SVM - QUADRATIC PROGRAMMING PROBLEM

$(\vec{x}_1, y_1), \ldots, (\vec{x}_n, y_n)$ y_i are either 1 or −1

$\vec{w} \cdot \vec{x} - b = 0,$

$\vec{w} \cdot \vec{x} - b = 1$

$\vec{w} \cdot \vec{x} - b = -1$

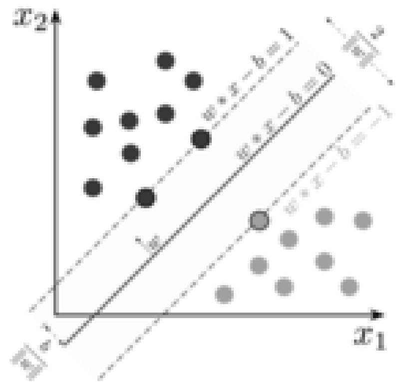
$\vec{w} \cdot \vec{x}_i - b \geq 1$, if $y_i = 1$

or

$\vec{w} \cdot \vec{x}_i - b \leq -1$, if $y_i = -1$.

$y_i(\vec{w} \cdot \vec{x}_i - b) \geq 1,$ for all $1 \leq i \leq n$.

"Minimize $\|\vec{w}\|$ subject to $y_i(\vec{w} \cdot \vec{x}_i - b) \geq 1$, for $i = 1, \ldots, n$"



EXERCISE

- Develop a model to predict the Iris plant class (1 : Iris-setosa, 2:Iris-versicolor & 3: Iris-virginica) based on sepal length, sepal width, petal length, petal width using SVM. The data is given in Iris_data.csv file.
- Validate the model with Iris_test.csv data

PYTHON CODE:

```
import numpy as np
import matplotlib.pyplot as plt
from sklearn import datasets, svm
iris = datasets.load_iris()
X = iris.data
print(X)
y = iris.target
print(y)
X = X[y != 0, :2]
y = y[y != 0]
n_sample = len(X)
```

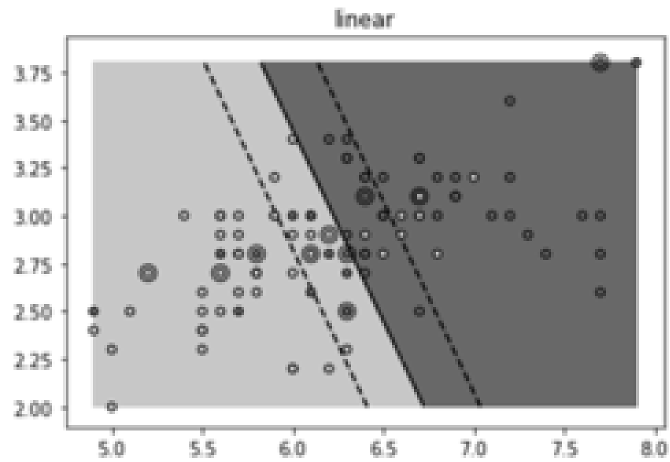
```
np.random.seed(0)
order = np.random.permutation(n_sample)
X = X[order]
y = y[order].astype(np.float)
X_train = X[:int(.9 * n_sample)]
y_train = y[:int(.9 * n_sample)]
X_test = X[int(.9 * n_sample):]
y_test = y[int(.9 * n_sample):]
```

CONTD..

```
classifier = svm.SVC(kernel='linear',
gamma=10)
classifier.fit(X_train, y_train)
plt.figure()
plt.clf()
plt.scatter(X[:, 0], X[:, 1], c=y, zorder=10,
cmap=plt.cm.Paired, edgecolor='k', s=20)
# Circle out the test data
plt.scatter(X_test[:, 0], X_test[:, 1], s=80,
facecolors='none',  zorder=10, edgecolor='k')
plt.axis('tight')
x_min = X[:, 0].min()
x_max = X[:, 0].max()
```

```
y_min = X[:, 1].min()
y_max = X[:, 1].max()
XX, YY = np.mgrid[x_min:x_max:200j,
y_min:y_max:200j]
Z = classifier.decision_function(np.c_[XX.ravel(),
YY.ravel()])
# Put the result into a color plot
Z = Z.reshape(XX.shape)
plt.pcolormesh(XX, YY, Z > 0, cmap=plt.cm.Paired)
plt.contour(XX, YY, Z, colors=['k', 'k', 'k'],
                linestyles=['--', '-', '--'],
levels=[-.5, 0, .5])
plt.title('linear')
plt.show()
```

VISUALIZATION



THANK YOU