DS Lab Assignment 6

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Q2) Implement Support Vector Machines (SVM) From Scratch

In [31]:
```
#Importing Libraries
import matplotlib
import matplotlib.pyplot as plt
import pandas as pd
import numpy as np
from cvxopt import matrix, solvers
from sklearn.datasets import load_iris
ds = pd.read_csv('./Iris.csv')   #Importing Data
iris_df = ds.iloc[0:100]
iris_df
```

Out[31]:

	Id	SepalLengthCm	SepalWidthCm	PetalLengthCm	PetalWidthCm	Species
0	1	5.1	3.5	1.4	0.2	Iris-setosa
1	2	4.9	3.0	1.4	0.2	Iris-setosa
2	3	4.7	3.2	1.3	0.2	Iris-setosa
3	4	4.6	3.1	1.5	0.2	Iris-setosa
4	5	5.0	3.6	1.4	0.2	Iris-setosa
...	...	...	...	...	...	...
95	96	5.7	3.0	4.2	1.2	Iris-versicolor
96	97	5.7	2.9	4.2	1.3	Iris-versicolor
97	98	6.2	2.9	4.3	1.3	Iris-versicolor
98	99	5.1	2.5	3.0	1.1	Iris-versicolor
99	100	5.7	2.8	4.1	1.3	Iris-versicolor

100 rows × 6 columns

Classify classes as -1 and +1

In [33]:
```
for i in range(len(iris_df)):
    if iris_df.iloc[i,5] == 'Iris-setosa':
```

```
        iris_df.iloc[i,5] = -1.0
    elif iris_df.iloc[i,5] == 'Iris-versicolor':
        iris_df.iloc[i,5] = 1.0
```

Convert to numpy

In [34]:
```
x_max = max(iris_df['SepalLengthCm'].max(),iris_df['SepalWidthCm'].max(),iris_df['Petal
x_min = min(iris_df['SepalLengthCm'].min(),iris_df['SepalWidthCm'].min(),iris_df['Petal
print(x_min,"\t", x_max)
y_max = iris_df["Species"].max()
y_min = iris_df["Species"].min()
print(y_min,"\t", y_max)
X = iris_df[["Id","SepalLengthCm","SepalWidthCm","PetalLengthCm", "PetalWidthCm"]].to_n
y = iris_df[["Species"]].to_numpy()
```

```
0.1     7.0
-1.0    1.0
```

Training SVM

In [35]:
```
n = X.shape[0]
H = np.dot(y*X, (y*X).T)

q = np.repeat([-1.0], n)[..., None]

A = y.reshape(1, -1)
b = 0.0

G = np.negative(np.eye(n))
h = np.zeros(n)
```

In [36]:
```
H = H.astype(np.double)
P = matrix(H)
q = matrix(q)
G = matrix(G)
h = matrix(h)
A = A.astype(np.double)
A = matrix(A)
b = matrix(b)
```

In [37]:
```
sol = solvers.qp(P, q, G, h, A, b)
alphas = np.array(sol["x"])
```

```
    pcost       dcost       gap    pres   dres
0: -3.3831e+00 -5.5541e+00  2e+02  1e+01  2e+00
1: -1.1180e+00 -1.3327e+00  2e+01  1e+00  1e-01
2: -4.0984e-01 -7.8046e-01  4e+00  2e-01  2e-02
3: -3.5502e-01 -3.3526e-01  9e-01  5e-02  5e-03
4: -2.8717e-01 -1.8492e-01  4e-01  2e-02  2e-03
5: -2.0998e-01 -1.3301e-01  2e-01  8e-03  8e-04
6: -1.7023e-01 -1.2926e-01  1e-01  5e-03  5e-04
7: -1.3714e-01 -1.1967e-01  4e-02  1e-03  1e-04
8: -1.1591e-01 -1.1853e-01  3e-03  1e-17  5e-14
9: -1.1824e-01 -1.1832e-01  8e-05  2e-17  5e-14
```

```
10: -1.1831e-01 -1.1831e-01  2e-06  9e-18  4e-14
11: -1.1831e-01 -1.1831e-01  2e-08  1e-17  4e-14
Optimal solution found.
```

In [38]:

```python
w = np.dot((y * alphas).T, X)[0]

S = (alphas > 1e-5).flatten()
b = np.mean(y[S] - np.dot(X[S], w.reshape(-1,1)))

print("W:", w)
print("b:", b)
```

```
W: [0.18444323823912354 0.20356524746476318 -0.03166894939963256
 0.3750092548051074 0.1397740276758747]
b: -11.688448385590783
```

In [39]:

```python
# Predicting from model

predictions = np.dot(X,w)+b
for i in range(len(iris_df)):
    if predictions[i]<=-1:
        print("Predicted : Iris-setosa i.e, -1 |\t Original: ", ds["Species"][i] )
    elif predictions[i]>=1:
        print("Predicted : Iris-versicolor i.e, +1 |\t Original: ", ds["Species"][i] )
```

```
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
```

```
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-setosa i.e, -1 |        Original:  -1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
```

```
Predicted : Iris-versicolor i.e, +1 |    Original:  1.0
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```