Perceptron

April 29, 2023

[10]:
```
import numpy as np
import matplotlib.pyplot as plt
from tabulate import tabulate
```

[11]:
```
x1 = np.array([[1], [-1], [0], [0.1], [0.2],[0.9]])
x2 = np.array([[1], [-1], [0.5], [0.5], [0.2], [0.5]])
print("*"*100)
print("\n GIVEN INPUT :  \n")
print("*"*100)
print("\n X1 : \n", x1)
print("\n X2 : \n", x2)

data = np.hstack((x1, x2)).tolist()
y = np.array([[1], [-1], [-1], [-1], [1], [1]])
print("\n class : \n", y)

data = np.hstack((x1, x2)).tolist()
final_data = np.hstack((data, y)).tolist()
headers = ["x1", "x2", "Class"]
tablefmt = "fancy_grid"
print("*"*100)
print("\n SAMPLE DATA :  \n")
print("*"*100)
print(tabulate(final_data, headers=headers, tablefmt=tablefmt))
print(np.mean(data,axis=0))
data = data - np.mean(data,axis=0)
final_data = np.hstack((data, y)).tolist()
print("*"*100)
print("\n MEAN SQUARED DATA :  \n")
print("*"*100)
print(tabulate(final_data, headers=headers, tablefmt=tablefmt))
```

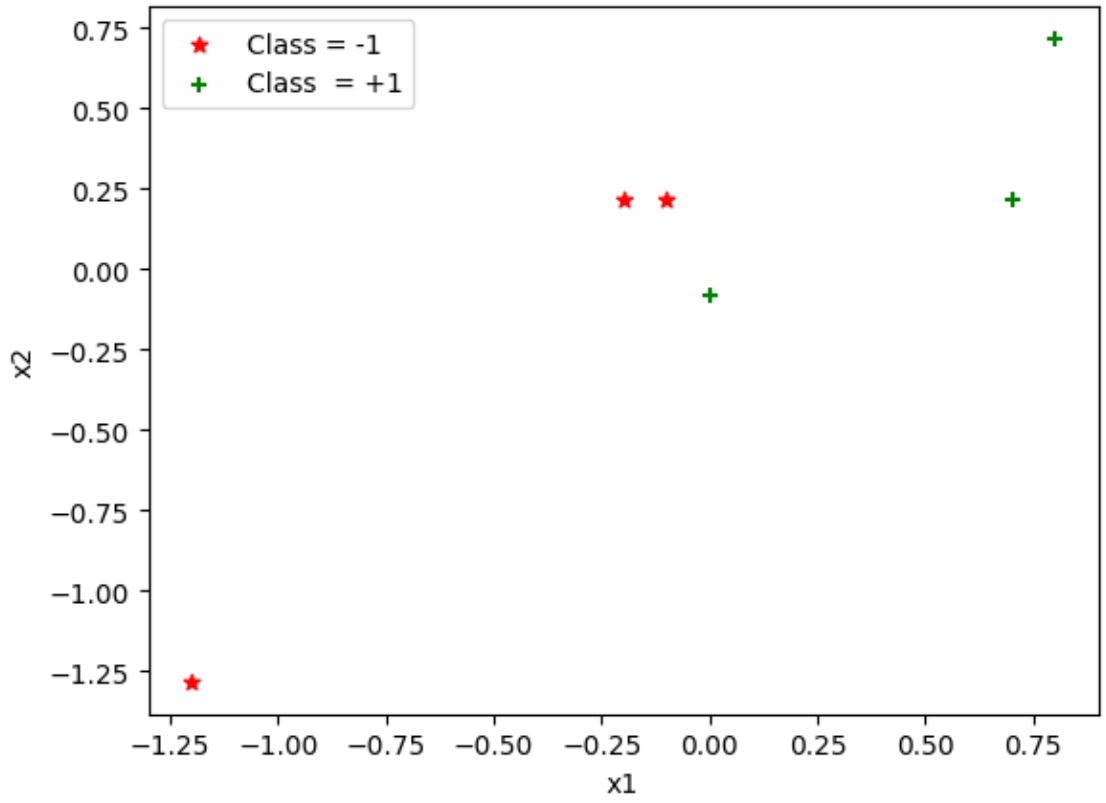
```
****************************************************************************************************

 GIVEN INPUT :

****************************************************************************************************
```

```
********************

 X1 :
 [[ 1. ]
 [-1. ]
 [ 0. ]
 [ 0.1]
 [ 0.2]
 [ 0.9]]

 X2 :
 [[ 1. ]
 [-1. ]
 [ 0.5]
 [ 0.5]
 [ 0.2]
 [ 0.5]]

 class :
 [[ 1]
 [-1]
 [-1]
 [-1]
 [ 1]
 [ 1]]
********************************************************************************
********************

 SAMPLE DATA :

********************************************************************************
********************

    x1     x2     Class

   1      1           1

  -1     -1          -1

   0      0.5        -1

   0.1    0.5        -1

   0.2    0.2         1

   0.9    0.5         1

[0.2        0.28333333]
```

```
********************************************************************************
********************

 MEAN SQUARED DATA :

********************************************************************************
********************

           x1           x2     Class

  0.8            0.716667          1

 -1.2           -1.28333          -1

 -0.2            0.216667         -1

 -0.1            0.216667         -1

 -2.77556e-17   -0.0833333         1

  0.7            0.216667          1
```

[12]:
```
# Create two arrays for the x and y coordinates of the points
x_coords = data[:,0]
y_coords = data[:,1]

y = y.ravel()
# Loop through the two classes
for i, class_label in enumerate(np.unique(y)):
    # Get the data points for the current class
    class_data = data[y == class_label]
    # Get the x and y coordinates for the current class
    class_x = class_data[:,0]
    class_y = class_data[:,1]
    # Plot the data points with different symbols and colors for each class
    if class_label == 1:
        plt.scatter(class_x, class_y, marker='+', color='green', label='Class ␣
 ↪= +1')
    else:
        plt.scatter(class_x, class_y, marker='*', color='red', label='Class =␣
 ↪-1')
# Set the axis labels and legend
plt.xlabel('x1')
plt.ylabel('x2')
plt.legend()
# Show the plot
```

```
plt.show()
```

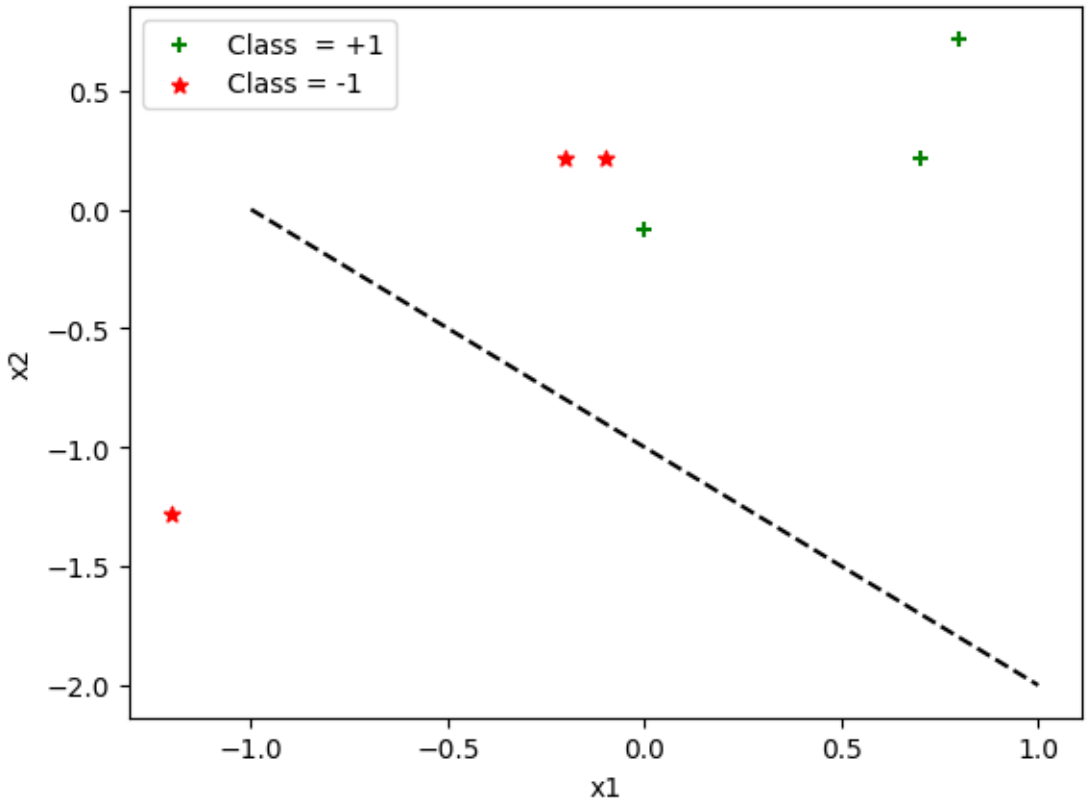


[13]:
```
def graph(data,w):
    # Create boolean mask for each class
    mask_plus = y.ravel() == 1
    mask_minus = y.ravel() == -1

    # Plot points for each class with different marker symbols and colors
    plt.scatter(data[mask_plus,0], data[mask_plus,1], marker='+',␣
 ↪color='green', label='Class  = +1')
    plt.scatter(data[mask_minus,0], data[mask_minus,1], marker='*',␣
 ↪color='red', label='Class = -1')

    # Plot decision boundary
    slope = -w[1] / w[2]
    intercept = -w[0] / w[2]
    x_vals = np.array([-1, 1])
    y_vals = intercept + slope * x_vals
    plt.plot(x_vals, y_vals, '--', color='black')

    # Set labels and legend
```

```
    plt.xlabel('x1')
    plt.ylabel('x2')
    plt.legend()

    # Show the plot
    plt.show()
```

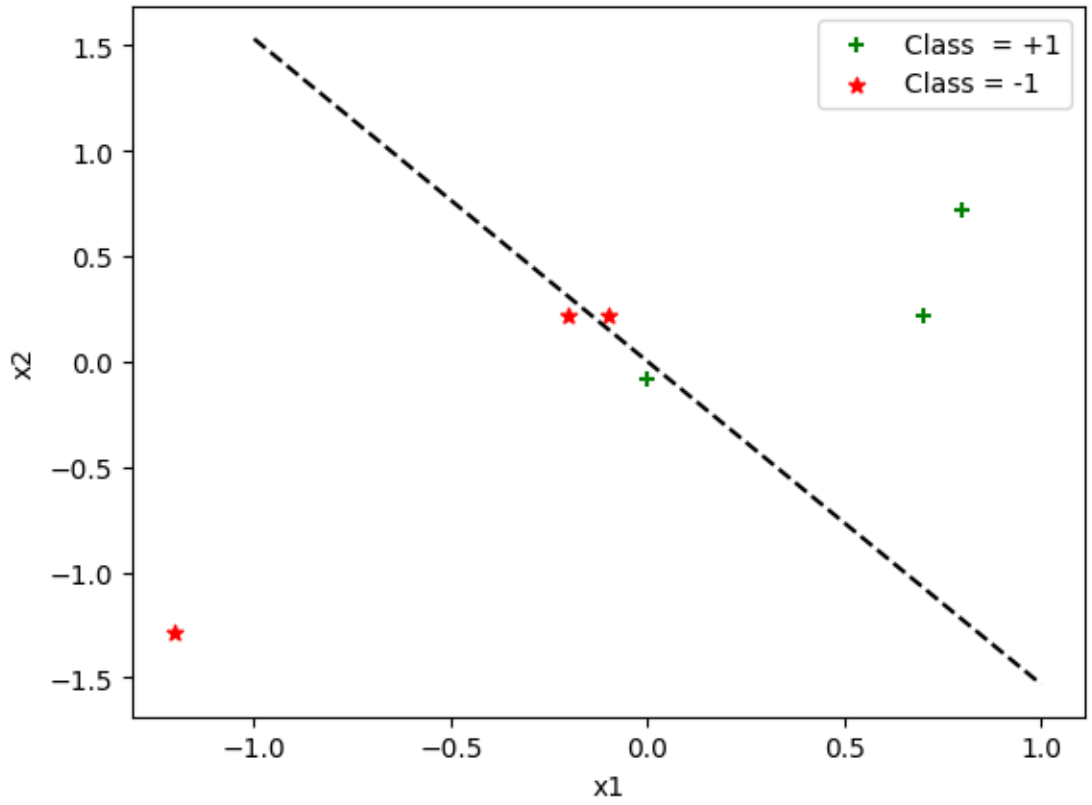
[14]:
```
correctClassified = 0
w = [1,1,1]
graph(data, w)

iteration = 0
while (correctClassified != len(data)): #Until everything is classified
    iteration += 1
    print("Iteration: ", iteration)

    for sample in range(len(data)):
        x = np.append(1, data[sample,0:2])
        print("*"*100)
        print("X : ",x)
        print("*"*100)

        if y[sample] == 1:
            print("W^TX =", np.dot(np.transpose(w), x))
            if np.dot(np.transpose(w), x) >= 0:
                correctClassified += 1
                print("\n","Classified Correctly","\n")
                print("The Weights are : ", w)
            else: #orange is classified as apple
                w = w + x
                print("\n","MisClassified", "\n")
                print("w = w + x", "\n")
                print("The Updated Weights are : ", w)
                graph(data, w)
                break

        else:
            print("W^TX =", np.dot(np.transpose(w), x))
            if np.dot(np.transpose(w), x) < 0:
                correctClassified += 1
                print("\n","Classified Correctly","\n")
                print("The Weights are : ", w)
            else:
                w = w - x
                print("\n","MisClassified", "\n")
                print("w = w - x", "\n")
                print("The Updated Weights are : ", w)
```

```
                graph(data, w)
                break

    if (correctClassified != len(data)):
        correctClassified = 0

print("Final weights: ", w)
```



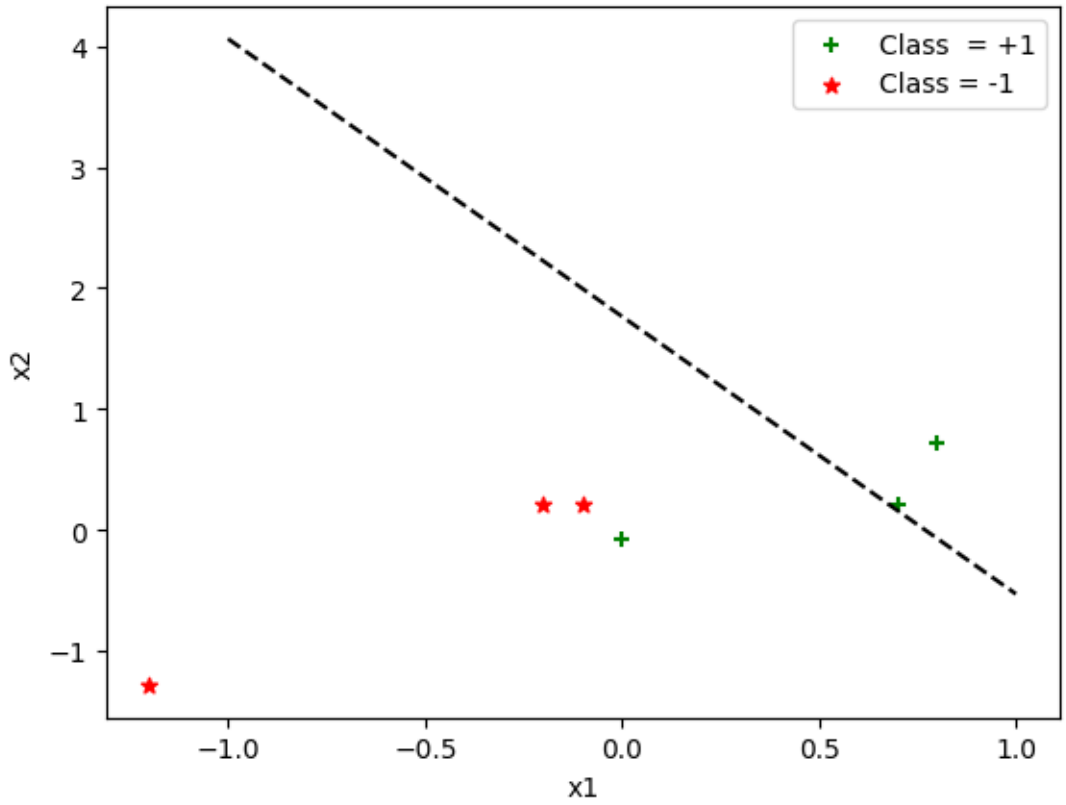

```
Iteration:  1
**************************************************************************************
********************
X :  [1.         0.8        0.71666667]
**************************************************************************************
********************
W^TX = 2.5166666666666666

 Classified Correctly

The Weights are :  [1, 1, 1]
**************************************************************************************
********************
```

```
X :  [ 1.         -1.2        -1.28333333]
********************************************************************************
********************
W^TX = -1.4833333333333332

 Classified Correctly

The Weights are :  [1, 1, 1]
********************************************************************************
********************
X :  [ 1.         -0.2         0.21666667]
********************************************************************************
********************
W^TX = 1.0166666666666666

 MisClassified

w = w - x

The Updated Weights are :  [0.         1.2        0.78333333]
```



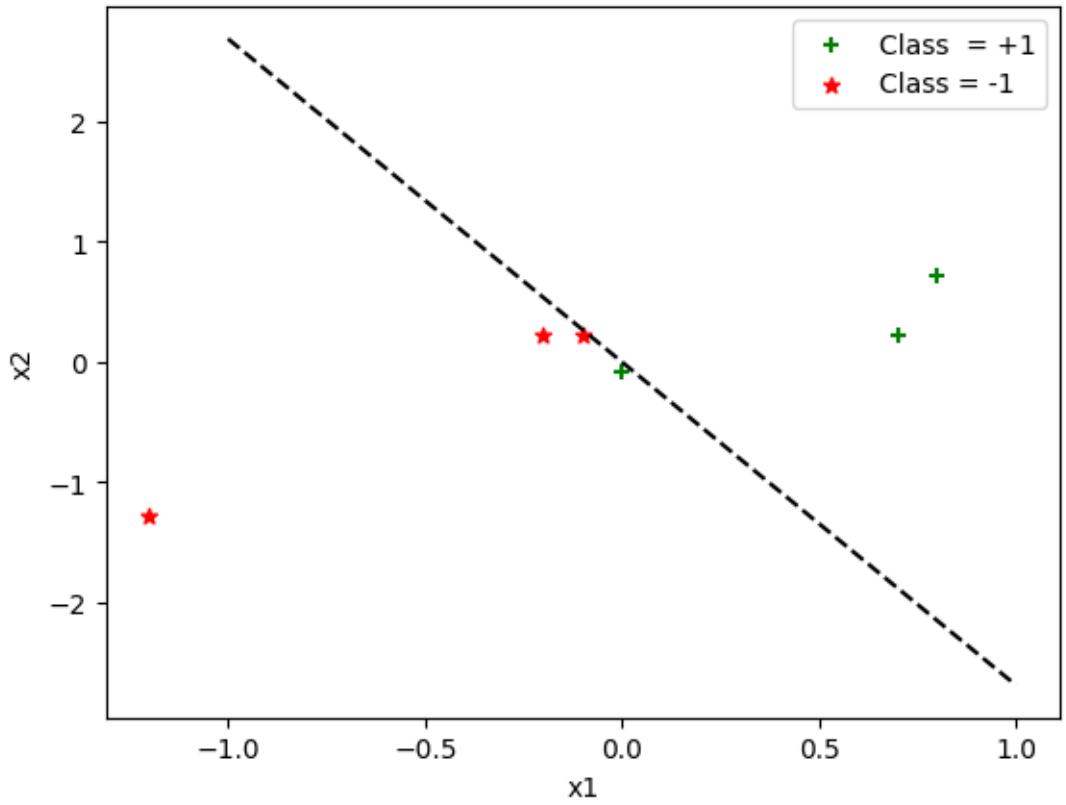

```
Iteration:  2
```

```
**********************************************************************************
********************
X :  [1.         0.8        0.71666667]
**********************************************************************************
********************
W^TX = 1.5213888888888887

 Classified Correctly

The Weights are :  [0.         1.2        0.78333333]
**********************************************************************************
********************
X :  [ 1.         -1.2        -1.28333333]
**********************************************************************************
********************
W^TX = -2.4452777777777777

 Classified Correctly

The Weights are :  [0.         1.2        0.78333333]
**********************************************************************************
********************
X :  [ 1.         -0.2         0.21666667]
**********************************************************************************
********************
W^TX = -0.07027777777777783

 Classified Correctly

The Weights are :  [0.         1.2        0.78333333]
**********************************************************************************
********************
X :  [ 1.         -0.1         0.21666667]
**********************************************************************************
********************
W^TX = 0.04972222222222218

 MisClassified

w = w - x

The Updated Weights are :  [-1.          1.3         0.56666667]
```



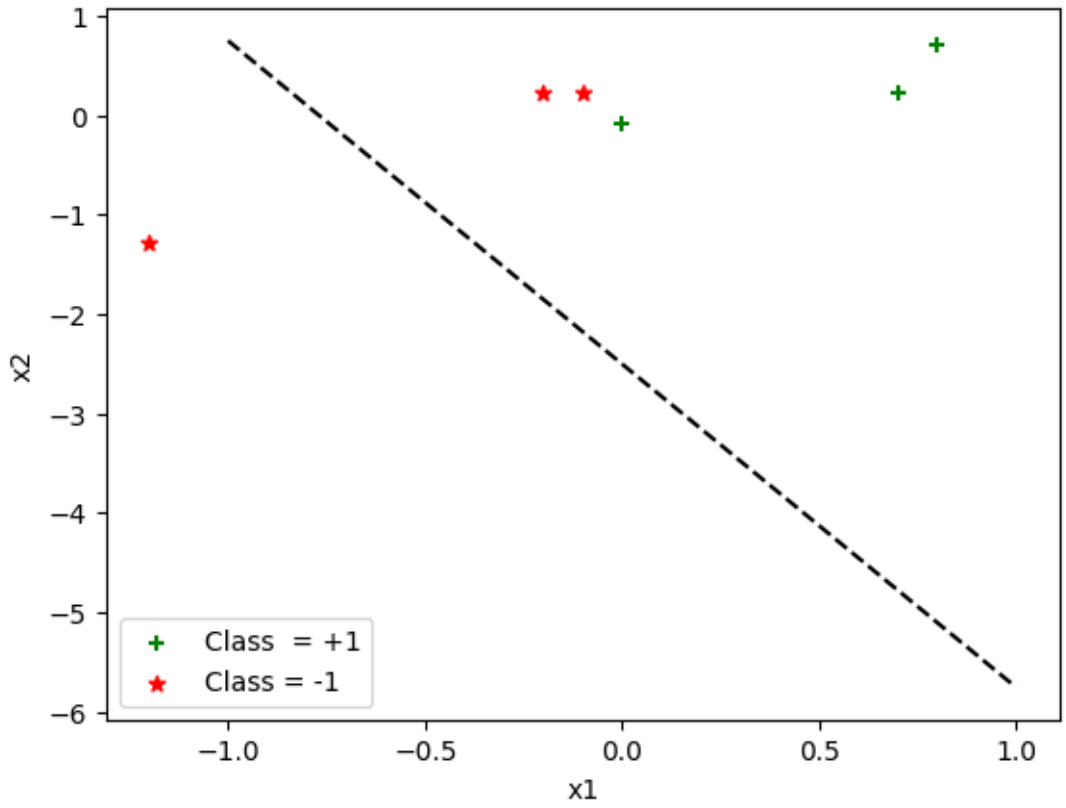

```
Iteration:  3
**************************************************************************************
********************
X :  [1.         0.8        0.71666667]
**************************************************************************************
********************
W^TX = 0.4461111111111111

 Classified Correctly

The Weights are :  [-1.          1.3         0.56666667]
**************************************************************************************
********************
X :  [ 1.         -1.2        -1.28333333]
**************************************************************************************
********************
W^TX = -3.2872222222222223

 Classified Correctly

The Weights are :  [-1.          1.3         0.56666667]
```

```
**********************************************************************************
********************
X :  [ 1.         -0.2         0.21666667]
**********************************************************************************
********************
W^TX = -1.1372222222222221

 Classified Correctly

The Weights are :  [-1.          1.3         0.56666667]
**********************************************************************************
********************
X :  [ 1.         -0.1         0.21666667]
**********************************************************************************
********************
W^TX = -1.0072222222222222

 Classified Correctly

The Weights are :  [-1.          1.3         0.56666667]
**********************************************************************************
********************
X :  [ 1.00000000e+00 -2.77555756e-17 -8.33333333e-02]
**********************************************************************************
********************
W^TX = -1.0472222222222223

 MisClassified

w = w + x

The Updated Weights are :  [0.         1.3        0.48333333]
```



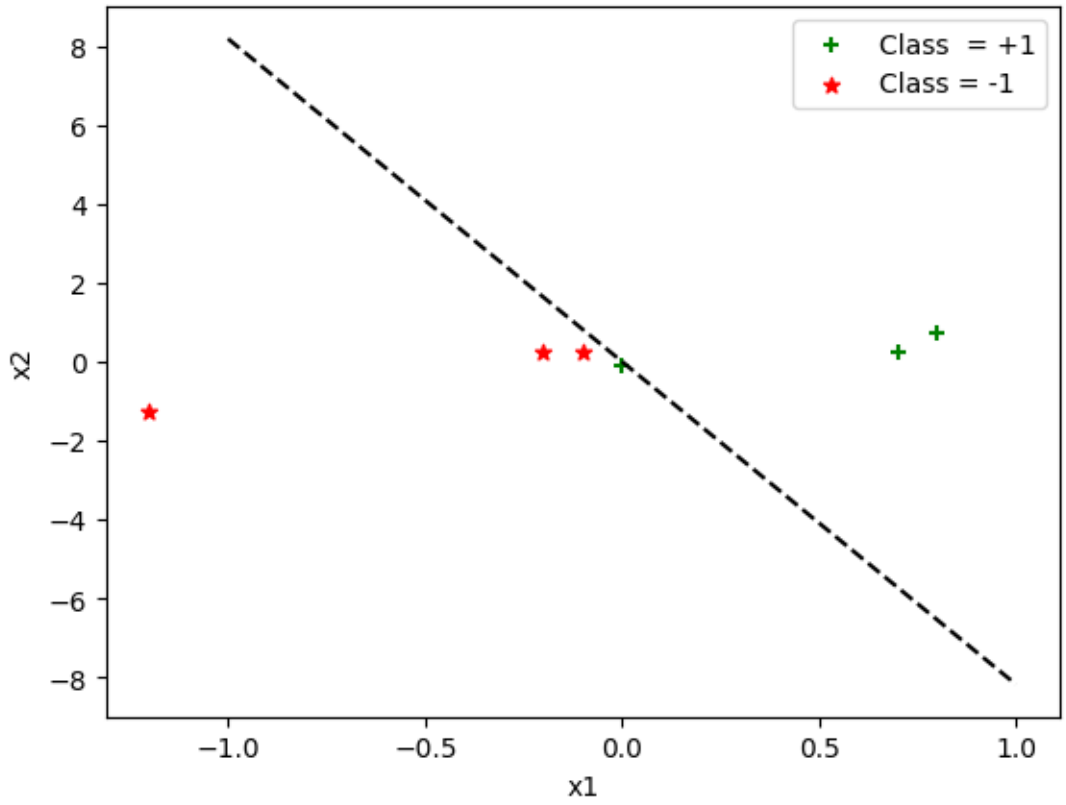

```
Iteration:  4
**************************************************************************************
********************
X :  [1.         0.8        0.71666667]
**************************************************************************************
********************
W^TX = 1.386388888888889

 Classified Correctly

The Weights are :  [0.         1.3        0.48333333]
**************************************************************************************
********************
X :  [ 1.         -1.2        -1.28333333]
**************************************************************************************
********************
W^TX = -2.1802777777777775

 Classified Correctly

The Weights are :  [0.         1.3        0.48333333]
```

```
**********************************************************************************
********************
X :  [ 1.         -0.2         0.21666667]
**********************************************************************************
********************
W^TX = -0.15527777777777785

 Classified Correctly

The Weights are :  [0.         1.3        0.48333333]
**********************************************************************************
********************
X :  [ 1.         -0.1         0.21666667]
**********************************************************************************
********************
W^TX = -0.02527777777777783

 Classified Correctly

The Weights are :  [0.         1.3        0.48333333]
**********************************************************************************
********************
X :  [ 1.00000000e+00 -2.77555756e-17 -8.33333333e-02]
**********************************************************************************
********************
W^TX = -0.0402777777777778

 MisClassified

w = w + x

The Updated Weights are :  [1.  1.3 0.4]
```



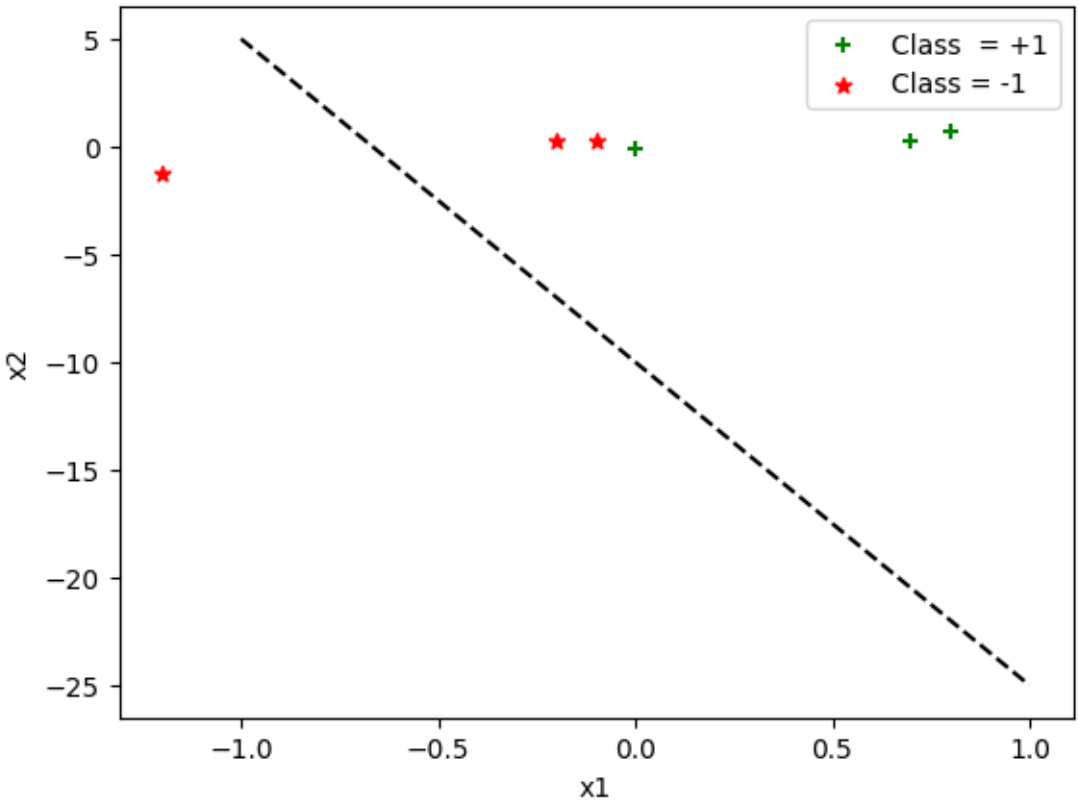

```
Iteration:  5
**************************************************************************************
**********************
X :  [1.         0.8        0.71666667]
**************************************************************************************
**********************
W^TX = 2.3266666666666667

 Classified Correctly

The Weights are :  [1.  1.3 0.4]
**************************************************************************************
**********************
X :  [ 1.         -1.2        -1.28333333]
**************************************************************************************
**********************
W^TX = -1.0733333333333333

 Classified Correctly

The Weights are :  [1.  1.3 0.4]
```

```
**********************************************************************************
********************
X :  [ 1.         -0.2         0.21666667]
**********************************************************************************
********************
W^TX = 0.8266666666666667

 MisClassified

w = w - x

The Updated Weights are :  [0.         1.5        0.18333333]
```



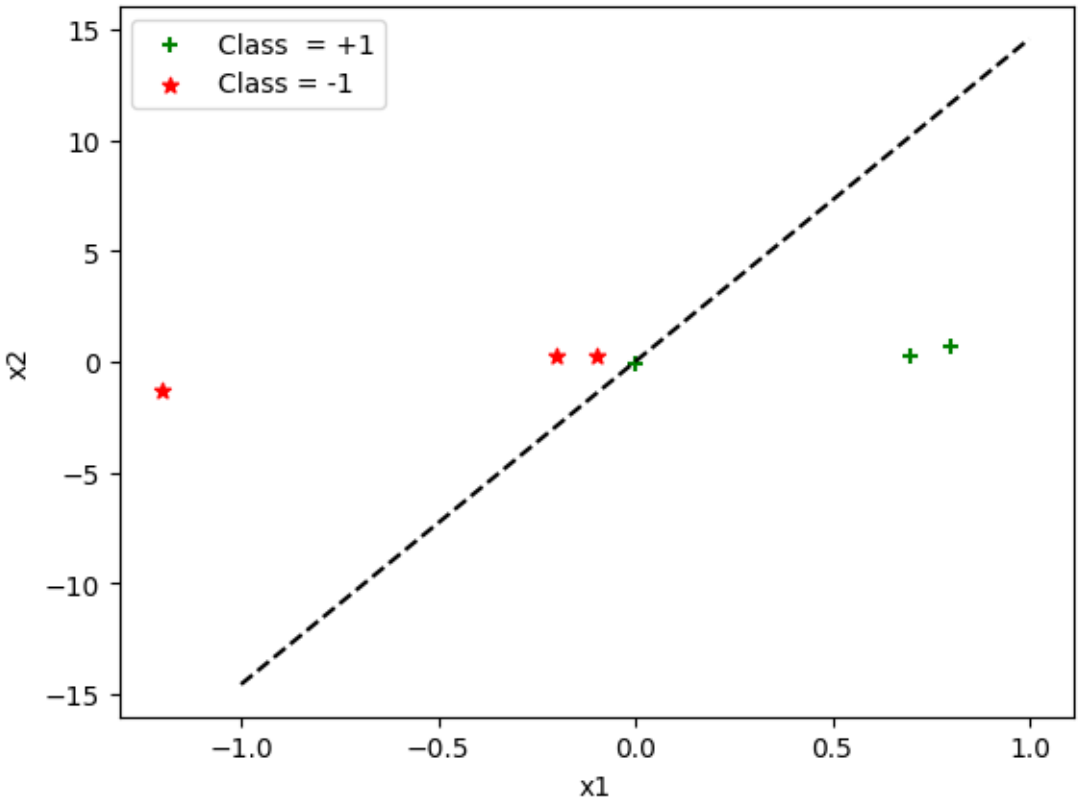

```
Iteration:  6
**********************************************************************************
********************
X :  [1.         0.8        0.71666667]
**********************************************************************************
********************
W^TX = 1.3313888888888887

 Classified Correctly
```

```
The Weights are :  [0.         1.5        0.18333333]
********************************************************************************
********************
X :  [ 1.         -1.2        -1.28333333]
********************************************************************************
********************
W^TX = -2.0352777777777775

 Classified Correctly

The Weights are :  [0.         1.5        0.18333333]
********************************************************************************
********************
X :  [ 1.         -0.2         0.21666667]
********************************************************************************
********************
W^TX = -0.26027777777777783

 Classified Correctly

The Weights are :  [0.         1.5        0.18333333]
********************************************************************************
********************
X :  [ 1.         -0.1         0.21666667]
********************************************************************************
********************
W^TX = -0.11027777777777782

 Classified Correctly

The Weights are :  [0.         1.5        0.18333333]
********************************************************************************
********************
X :  [ 1.00000000e+00 -2.77555756e-17 -8.33333333e-02]
********************************************************************************
********************
W^TX = -0.015277777777777817

 MisClassified

w = w + x

The Updated Weights are :  [1.  1.5 0.1]
```




```
Iteration:  7
**********************************************************************************
********************
X :  [1.         0.8        0.71666667]
**********************************************************************************
********************
W^TX = 2.271666666666667

 Classified Correctly

The Weights are :  [1.  1.5 0.1]
**********************************************************************************
********************
X :  [ 1.         -1.2        -1.28333333]
**********************************************************************************
********************
W^TX = -0.9283333333333332

 Classified Correctly

The Weights are :  [1.  1.5 0.1]
```

```
**********************************************************************************
********************
X :  [ 1.         -0.2         0.21666667]
**********************************************************************************
********************
W^TX = 0.7216666666666667

 MisClassified

w = w - x

The Updated Weights are :  [ 0.          1.7        -0.11666667]
```




```
Iteration:  8
**********************************************************************************
********************
X :  [1.         0.8        0.71666667]
**********************************************************************************
********************
W^TX = 1.2763888888888888

 Classified Correctly
```

```
The Weights are :  [ 0.          1.7        -0.11666667]
**************************************************************************
********************
X :  [ 1.         -1.2        -1.28333333]
**************************************************************************
********************
W^TX = -1.890277777777778

 Classified Correctly

The Weights are :  [ 0.          1.7        -0.11666667]
**************************************************************************
********************
X :  [ 1.         -0.2         0.21666667]
**************************************************************************
********************
W^TX = -0.36527777777777787

 Classified Correctly

The Weights are :  [ 0.          1.7        -0.11666667]
**************************************************************************
********************
X :  [ 1.         -0.1         0.21666667]
**************************************************************************
********************
W^TX = -0.19527777777777783

 Classified Correctly

The Weights are :  [ 0.          1.7        -0.11666667]
**************************************************************************
********************
X :  [ 1.00000000e+00 -2.77555756e-17 -8.33333333e-02]
**************************************************************************
********************
W^TX = 0.00972222222222217

 Classified Correctly

The Weights are :  [ 0.          1.7        -0.11666667]
**************************************************************************
********************
X :  [1.          0.7         0.21666667]
**************************************************************************
********************
W^TX = 1.1647222222222222
```

```
 Classified Correctly

The Weights are :  [ 0.          1.7         -0.11666667]
Final weights:  [ 0.          1.7         -0.11666667]
```