2. Support vector machine

In [1]:
```
%matplotlib inline
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.svm import SVC
```

(a) Is this data linearly separable?

In [2]:
```
print('Yes')
```

```
Yes
```

(b) Use sklearn.svm.SVC to fit a support vector machine classifier to the data. You will need to invoke the option kernel='linear'. Try at least 10 different values of the slack parameter C. In your writeup, include a table that shows these values of C and for each of them gives the training error and the number of support vectors.

In [3]:
```
from sklearn import datasets
iris = datasets.load_iris()
x = iris.data
y = iris.target
```

In [4]:
```
x_inputs_1 = x[:, [0, 2]]
x_inputs = x_inputs_1[y!=0]
y_labels = y[y!= 0]
```

In [5]:
```
C_list = [100, 10, 1, 0.1, 0.001, 0.000001, 0.000000001 ,0.000000000001 ,0.00000
error_list = []
num = []
for C in C_list:
    #print('\nC =', C)
    svc = SVC(kernel='linear', C=C).fit(x_inputs, y_labels)
    error = 1- svc.score(x_inputs, y_labels)
    #print('training_error =', error)
    error_list.append(error)
    num.append(svc.n_support_)
    #print('number_of_support_vectors =', svc.n_support_)

total_list = pd.DataFrame({'C' : C_list,
                           'Training Error' : error_list,
                           'Number of support vectors' : num },
                              columns=['C','Training Error', 'Number of suppor
total_list
```

Out[5]:

	C	Training Error	Number of support vectors
0	1.000000e+02	0.05	[7, 7]

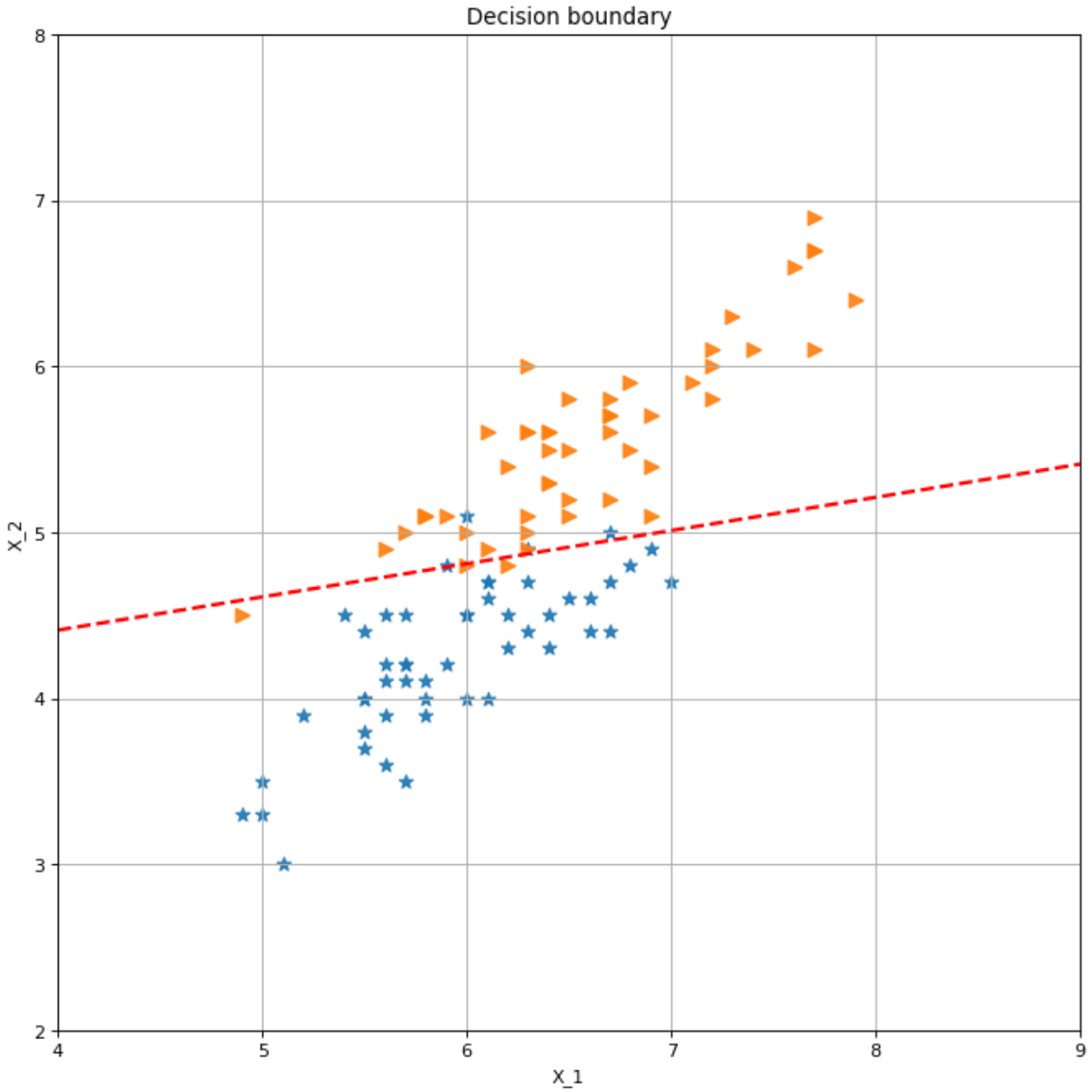
	C	Training Error	Number of support vectors
1	1.000000e+01	0.05	[9, 9]
2	1.000000e+00	0.07	[16, 15]
3	1.000000e-01	0.07	[28, 28]
4	1.000000e-03	0.17	[50, 50]
5	1.000000e-06	0.17	[50, 50]
6	1.000000e-09	0.17	[50, 50]
7	1.000000e-12	0.17	[50, 50]
8	1.000000e-15	0.16	[50, 50]
9	1.000000e-18	0.50	[50, 50]

(c) Which value of C do you think is best? For this value, include a plot of the data points and the linear decision boundary.

In [6]:
```
print('C = 1 is the best')
```

```
C = 1 is the best
```

In [7]:
```
clf = SVC(kernel='linear', C=1)
clf.fit(x_inputs, y_labels)

# Plot the data and the classification with the decision boundary.
xmin, xmax = 4, 9
ymin, ymax = 2, 8

xd = np.array([xmin, xmax])

weights1 = clf.coef_[0]
bias1 = clf.intercept_[0]
slope1 = - weights1[0]/weights1[1]
x2cut1 = - bias1/weights1[1]
yd1 = slope1*xd + x2cut1

from matplotlib.pyplot import figure
figure(figsize=(10, 10), dpi=80)

plt.title('Decision boundary')
plt.xlabel('X_1')
plt.ylabel('X_2')

plt.plot(xd, yd1, 'r', lw=2, ls='--')

plt.scatter(*x_inputs[:,[0,1]][y_labels==1].T, s = 60, alpha = 0.9, marker = '*'
plt.scatter(*x_inputs[:,[0,1]][y_labels==2].T, s = 60, alpha = 0.9, marker = '>'

plt.xlim(xmin, xmax)
plt.ylim(ymin, ymax)

plt.grid()
plt.show()
```



In [ ]: