Exercise 6: Naïve Bayes Classification:

Dataset: You can use iris dataset (i.e. D2 dataset in exercise 2) or any dataset of your choice. Implement Naïve Bayes Classification algorithm and show the results. Split data into a train and a test split (70% and 30% respectively).

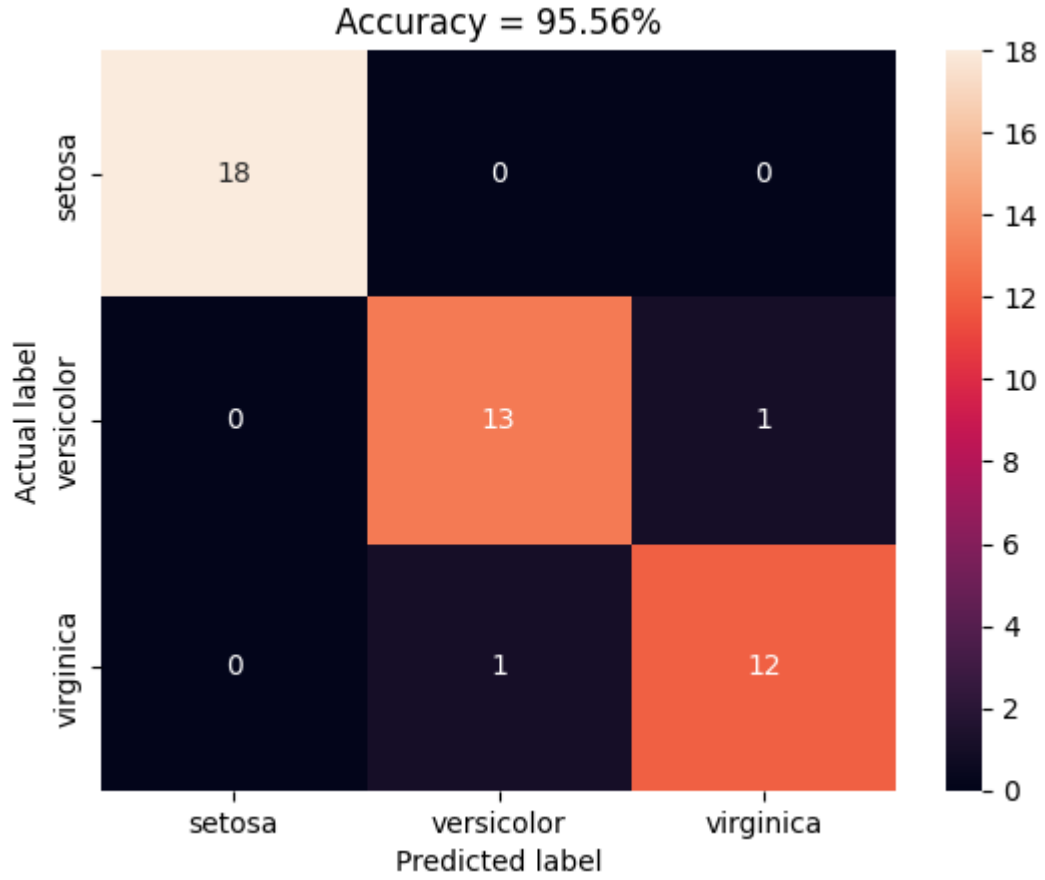
In [ ]:
```
from sklearn.datasets import load_iris
from sklearn.model_selection import train_test_split
from sklearn.naive_bayes import GaussianNB
from sklearn import metrics
import numpy as np
from matplotlib import pyplot as plt
from matplotlib import colors
from itertools import product
import pandas as pd
import seaborn as sns

# Input: Dataset
iris = load_iris()
X = iris.data
y = iris.target

# Splitting the data into training and testing data
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3)

# Create Gaussian Naive Bayes object
gnb = GaussianNB()

# Train the model using the training sets
gnb.fit(X_train, y_train)

# Make predictions using the testing set
y_pred = gnb.predict(X_test)
```

Output for Naive Bayes Classification.

In [ ]:
```
# Output: The Predicted vs Actual Class, Confusion Matrix and Classificat
print("\n\nACCURACY OF GAUSSIAN NAIVE BAYES CLASSIFIER WITH ALL ATTRIBUTE
print("\nPredicted Class: \n")
print(*y_pred, sep=' ')
print("\nActual Class: \n")
print(*y_test, sep=' ')
print("\nNumber of mislabeled points out of a total %d points : %d"
      % (X_test.shape[0], (y_test != y_pred).sum()))
print("\nThe Confusion Matrix for the Gaussian Naive Bayes Model\n")
cm = metrics.confusion_matrix(y_test, y_pred)
cm_df = pd.DataFrame(cm,
                     index = ['setosa','versicolor','virginica'],
                     columns = ['setosa','versicolor','virginica'])
sns.heatmap(cm_df, annot=True)
plt.title('Accuracy = {0:.2f}%'.format(metrics.accuracy_score(y_test, y_p
plt.ylabel('Actual label')
plt.xlabel('Predicted label')
plt.show()
print("\nThe Classification Report for the Gaussian Naive Bayes Model\n\n
      ,metrics.classification_report(y_test, y_pred))
print("\n_____
```

```
# Output: The Decision Boundary Plot for Pair of Attributes
Feature = ['Sepal Length', 'Sepal Width', 'Petal Length', 'Petal Width' ]
print("\n\nPLOTS OF GAUSSIAN NAIVE BAYES MODEL WITH ANY TWO ATTRIBUTES")
for i in (0,1,2,3):
    for j in (0,1,2,3):
        if(j!=i):
            if(j<i):
                X = X_test[:, [i, j]]
                y = y_test
                gnb.fit(X,y)
                # Plotting decision regions
                x_min, x_max = X[:, 0].min() - 1, X[:, 0].max() + 1
                y_min, y_max = X[:, 1].min() - 1, X[:, 1].max() + 1
                xx, yy = np.meshgrid(np.arange(x_min, x_max, 0.1),
                                     np.arange(y_min, y_max, 0.1))
                Z = gnb.predict(np.c_[xx.ravel(), yy.ravel()])
                Z = Z.reshape(xx.shape)
                plt.contourf(xx, yy, Z, alpha=0.4)
                plt.scatter(X[:, 0], X[:, 1], c=y, s=20, edgecolor='k')
                plt.xlabel('{}'.format(Feature[i]))
                plt.ylabel('{}'.format(Feature[j]))
                plt.title('Naive Bayes Classification for Feature {} vs F
                          .format(i,j))
                plt.show()
```

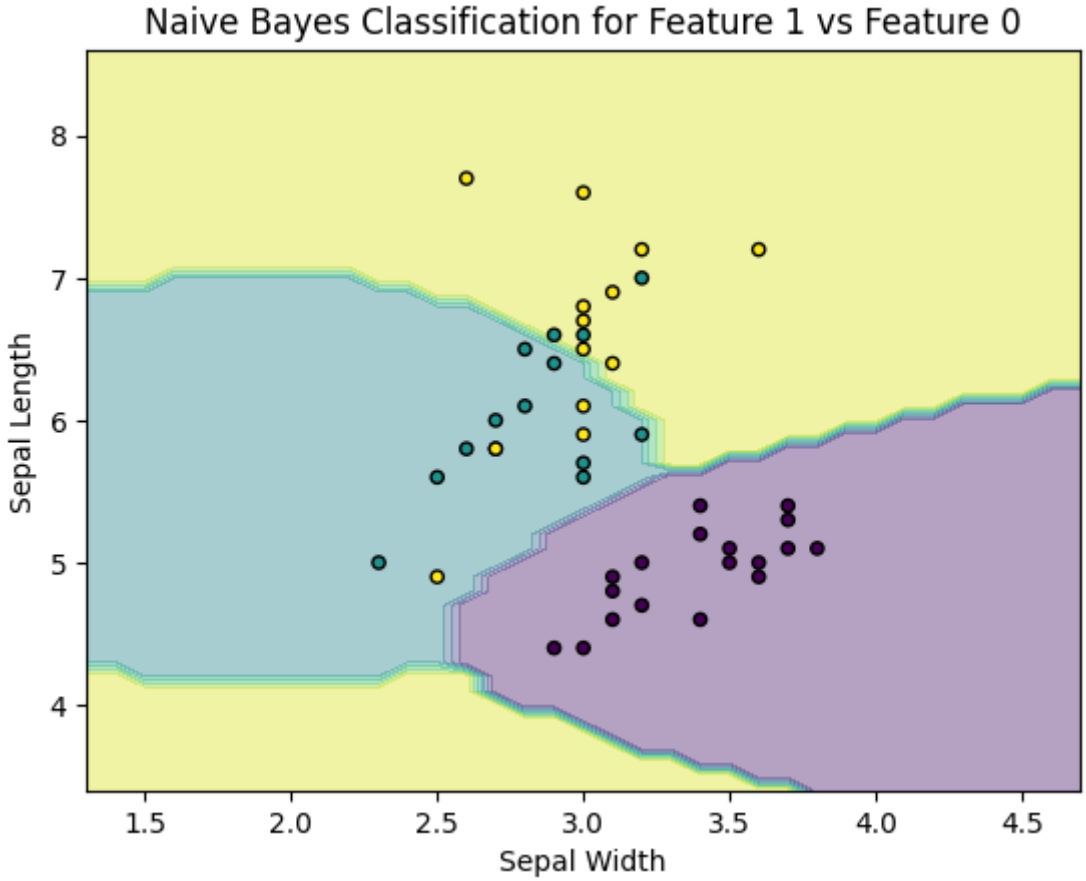
```
ACCURACY OF GAUSSIAN NAIVE BAYES CLASSIFIER WITH ALL ATTRIBUTES

Predicted Class:

0 0 1 1 1 0 0 1 1 1 0 2 1 0 2 0 0 1 0 0 2 2 2 2 0 0 0 1 2 0 0 2 0 1 1 2
2 2 0 2 2 0 1 1 1

Actual Class:

0 0 1 1 1 0 0 1 2 1 0 2 1 0 2 0 0 1 0 0 2 2 2 2 0 0 0 1 2 0 0 1 0 1 1 2
2 2 0 2 2 0 1 1 1

Number of mislabeled points out of a total 45 points : 2

The Confusion Matrix for the Gaussian Naive Bayes Model
```

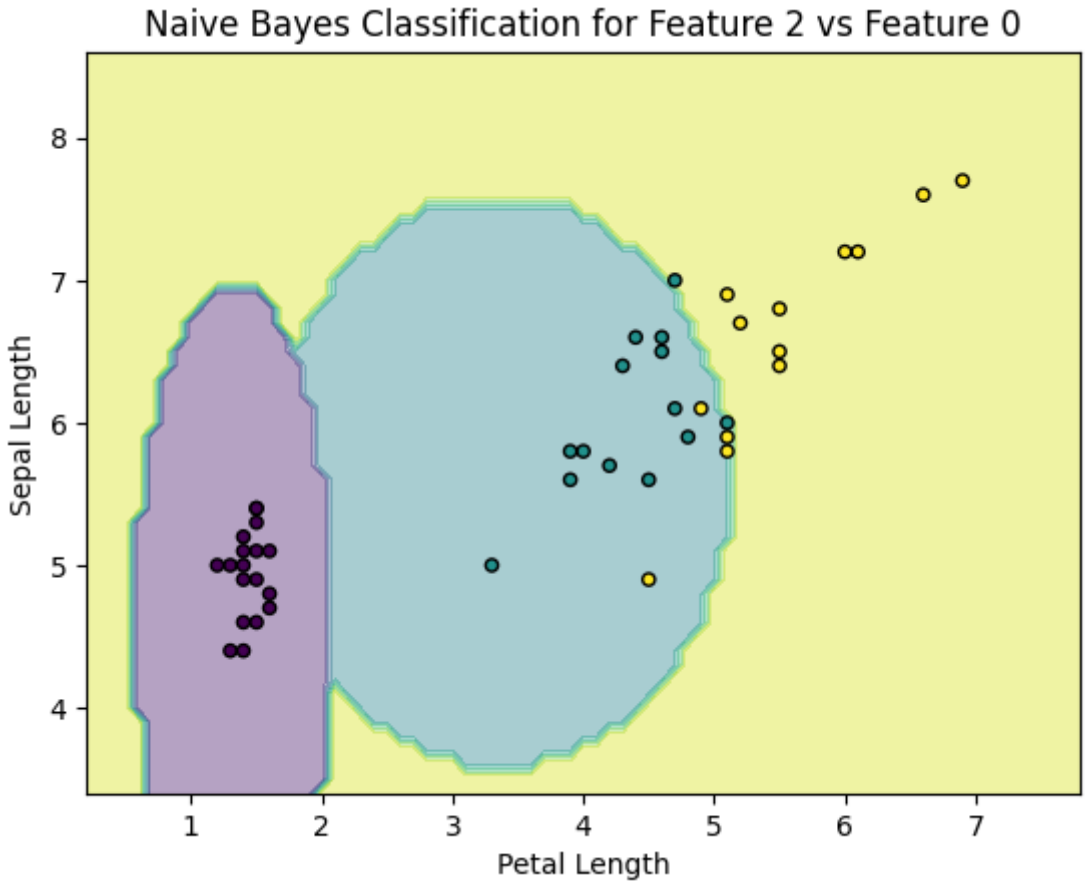


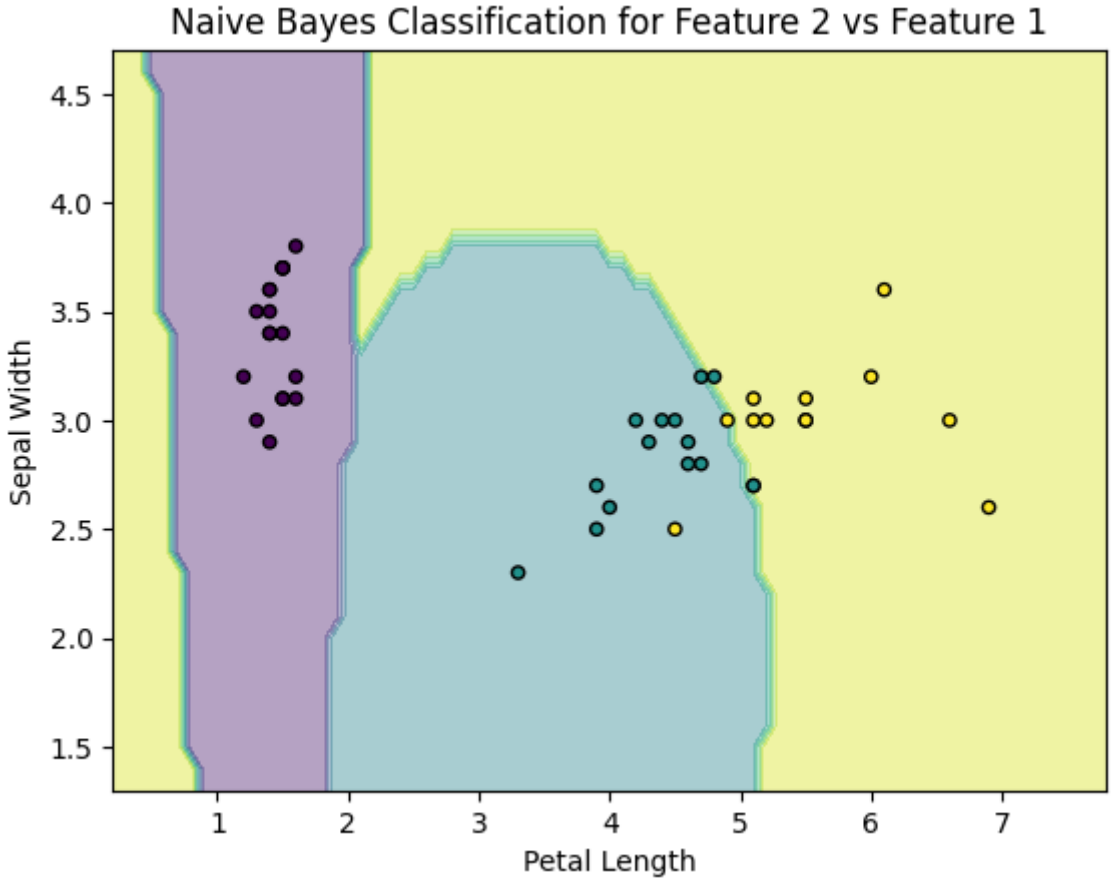
The Classification Report for the Gaussian Naive Bayes Model

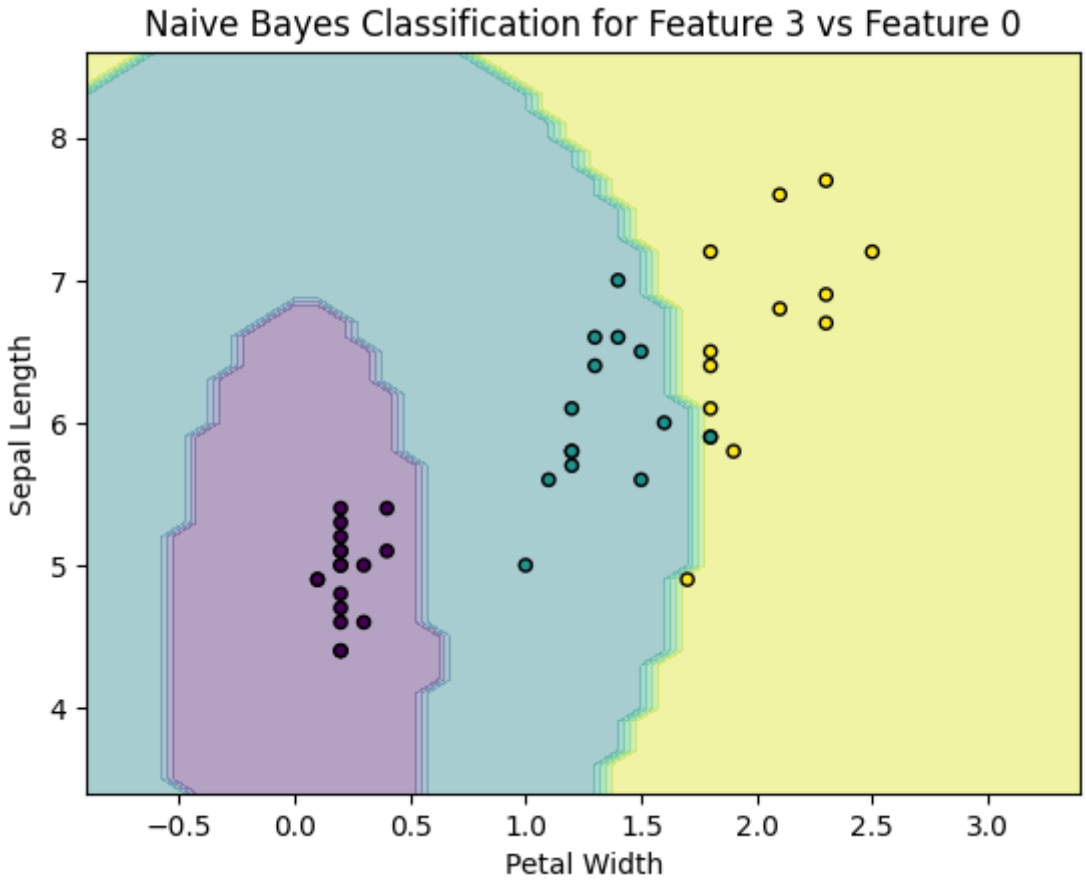
	precision	recall	f1-score	support
0	1.00	1.00	1.00	18
1	0.93	0.93	0.93	14
2	0.92	0.92	0.92	13
accuracy			0.96	45
macro avg	0.95	0.95	0.95	45
weighted avg	0.96	0.96	0.96	45

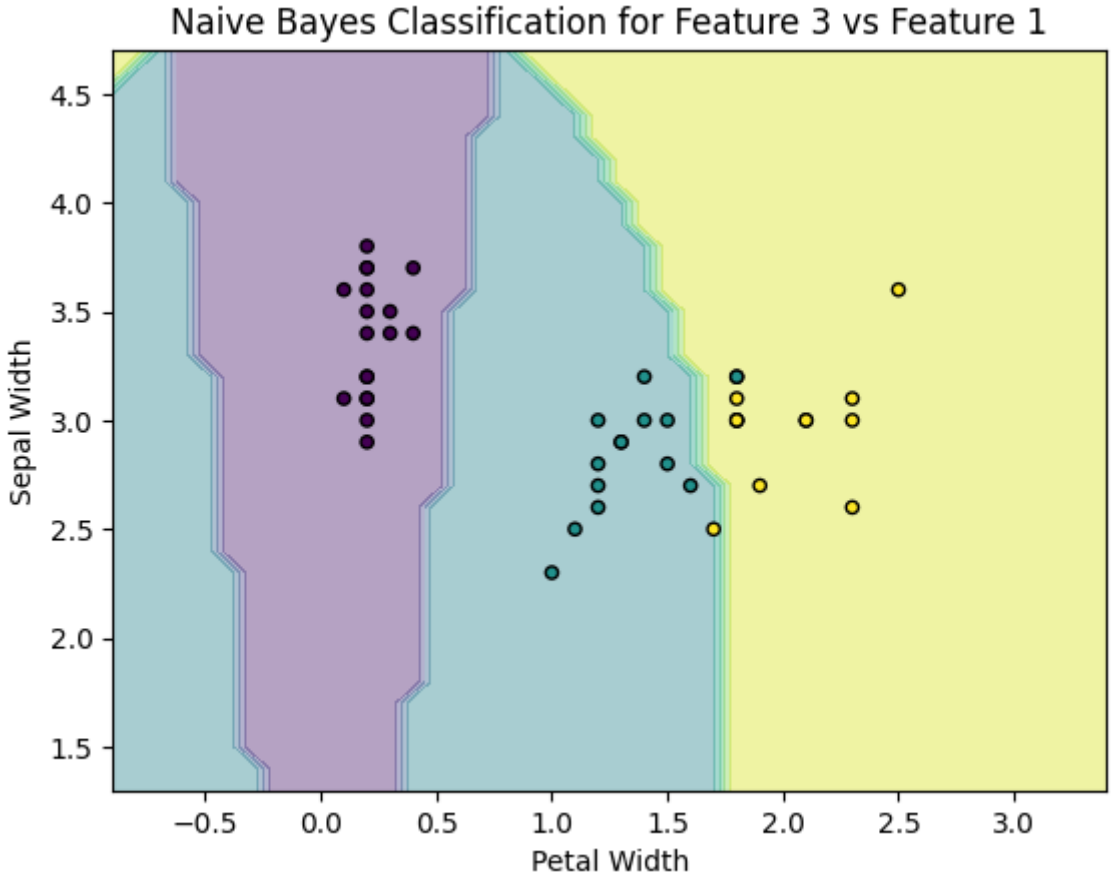
PLOTS OF GAUSSIAN NAIVE BAYES MODEL WITH ANY TWO ATTRIBUTES

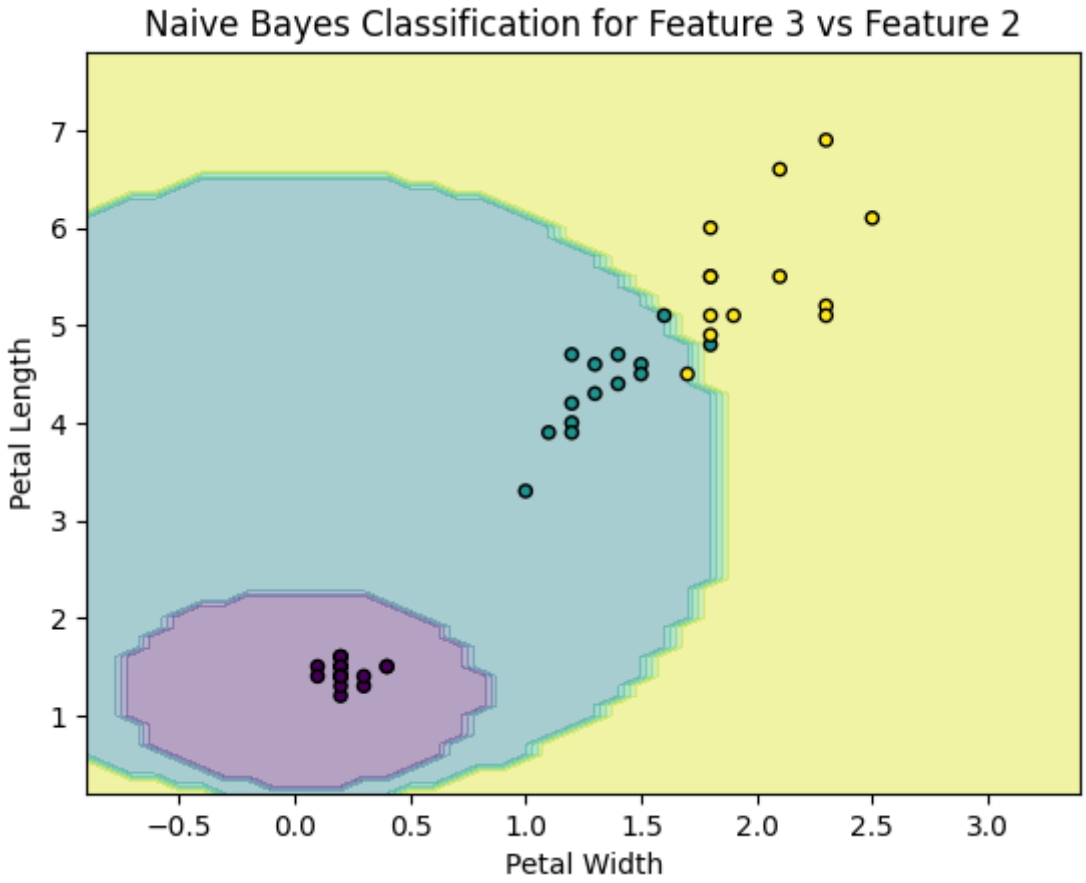

Naive Bayes Classification for Feature 1 vs Feature 0
Sepal Length
Sepal Width
8
7
6
5
4
1.5
2.0
2.5
3.0
3.5
4.0
4.5


Naive Bayes Classification for Feature 2 vs Feature 0
Sepal Length
Petal Length
8
7
6
5
4
1
2
3
4
5
6
7


Naive Bayes Classification for Feature 2 vs Feature 1
Sepal Width
Petal Length
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1
2
3
4
5
6
7


Naive Bayes Classification for Feature 3 vs Feature 0
Sepal Length
Petal Width
8
7
6
5
4
−0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0





To implement the Naive Bayes Classification Algorithm, Gaussian Naive Bayes was used over Iris Dataset with Train-Test Split of 70:30. The model gives an accuracy of 93.33% and is a good fit to predict the classes for the given Dataset.

The plot for the trained Gaussian Naive Bayes Model was plotted for taking any two attributes in consideration. It can be concluded from the plots that the results predicted

by the model are satisfactory.