In [1]:
```
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# Roll No.:11
# Practical No.:6
# Academic Year 2025-26
```

In [4]:
```
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.naive_bayes import GaussianNB
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.metrics import confusion_matrix,ConfusionMatrixDisplay,
classification_report,accuracy_score, precision_score, recall_score, f1_score
from sklearn.preprocessing import LabelEncoder
import warnings
warnings.filterwarnings("ignore")
```

In [5]:
```
df=pd.read_csv("/home/atharv/Downloads/iris.csv")
```

In [6]:
```
df
```

Out[6]:

	sepal.length	sepal.width	petal.length	petal.width	variety
0	5.1	3.5	1.4	0.2	Setosa
1	4.9	3.0	1.4	0.2	Setosa
2	4.7	3.2	1.3	0.2	Setosa
3	4.6	3.1	1.5	0.2	Setosa
4	5.0	3.6	1.4	0.2	Setosa
...	...	...	...	...	...
145	6.7	3.0	5.2	2.3	Virginica
146	6.3	2.5	5.0	1.9	Virginica
147	6.5	3.0	5.2	2.0	Virginica
148	6.2	3.4	5.4	2.3	Virginica
149	5.9	3.0	5.1	1.8	Virginica

150 rows × 5 columns

In [7]:
```
df.head(5)
```

Out[7]:

	sepal.length	sepal.width	petal.length	petal.width	variety
0	5.1	3.5	1.4	0.2	Setosa
1	4.9	3.0	1.4	0.2	Setosa
2	4.7	3.2	1.3	0.2	Setosa
3	4.6	3.1	1.5	0.2	Setosa
4	5.0	3.6	1.4	0.2	Setosa

In [8]:
```
df.tail()
```

Out[8]:

	sepal.length	sepal.width	petal.length	petal.width	variety
145	6.7	3.0	5.2	2.3	Virginica
146	6.3	2.5	5.0	1.9	Virginica
147	6.5	3.0	5.2	2.0	Virginica
148	6.2	3.4	5.4	2.3	Virginica
149	5.9	3.0	5.1	1.8	Virginica

In [9]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 150 entries, 0 to 149
Data columns (total 5 columns):
 #   Column        Non-Null Count  Dtype  
---  ------        --------------  -----  
 0   sepal.length  150 non-null    float64
 1   sepal.width   150 non-null    float64
 2   petal.length  150 non-null    float64
 3   petal.width   150 non-null    float64
 4   variety       150 non-null    object 
dtypes: float64(4), object(1)
memory usage: 6.0+ KB
```

In [10]:
```
print(df.shape)
```

```
(150, 5)
```

In [11]:
```
df['variety'].unique()
```

Out[11]:
```
array(['Setosa', 'Versicolor', 'Virginica'], dtype=object)
```

In [12]:
```
df.isnull().sum()
```

Out[12]:
```
sepal.length    0
sepal.width     0
petal.length    0
petal.width     0
variety         0
dtype: int64
```

In [14]:
```
x = df.iloc[:,1:4]
y = df.iloc[:,4:5]
```

In [15]:
```
encode = LabelEncoder()
y_encoded = encode.fit_transform(y)
```

In [16]:
```
x_train,x_test,y_train,y_test = train_test_split(x,y_encoded,test_size = 0.3,
                                                 random_state = 0)
```

In [17]:
```
naive_bayes = GaussianNB()
naive_bayes.fit(x_train,y_train)
pred = naive_bayes.predict(x_test)
```

In [18]:
```
pred
```

Out[18]:
```
array([2, 1, 0, 2, 0, 2, 0, 1, 1, 1, 2, 1, 1, 1, 1, 0, 1, 1, 0, 0, 2, 1,
       0, 0, 2, 0, 0, 1, 1, 0, 2, 1, 0, 2, 2, 1, 0, 2, 1, 1, 2, 0, 2, 0,
       0])
```

In [19]:
```
y_test
```

Out[19]:
```
array([2, 1, 0, 2, 0, 2, 0, 1, 1, 1, 2, 1, 1, 1, 1, 0, 1, 1, 0, 0, 2, 1,
       0, 0, 2, 0, 0, 1, 1, 0, 2, 1, 0, 2, 2, 1, 0, 1, 1, 1, 2, 0, 2, 0,
       0])
```

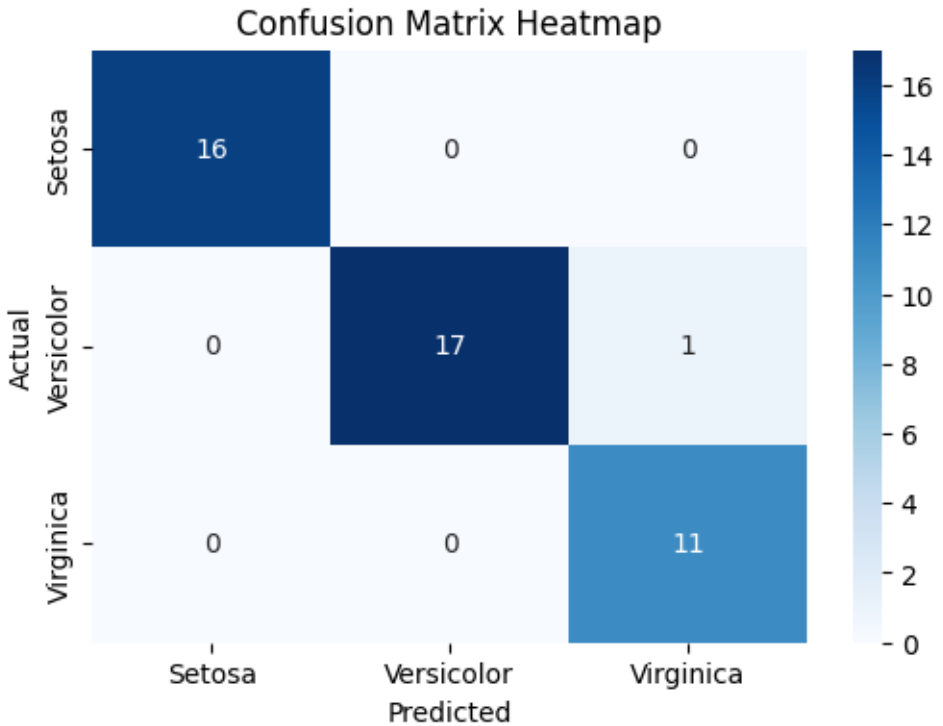
In [20]:
```
matrix =  confusion_matrix(y_test,pred,labels = naive_bayes.classes_)
print(matrix)

tp, fn, fp, tn = confusion_matrix(y_test,pred,labels=[1,0]).reshape(-1)
```

```
[[16  0  0]
 [ 0 17  1]
 [ 0  0 11]]
```

In [21]:
```
accuracy = accuracy_score(y_test, pred)
precision = precision_score(y_test, pred, average='micro')
recall = recall_score(y_test, pred, average='micro')
print(f"Accuracy: {accuracy:.2f}")
print(f"Precision: {precision:.2f}")
print(f"Recall: {recall:.2f}")
```

```
Accuracy: 0.98
Precision: 0.98
Recall: 0.98
```

In [22]:
```
plt.figure(figsize=(6,4))
sns.heatmap(matrix, annot=True, fmt='d', cmap='Blues', xticklabels=['Setosa',
                                                    'Versicolor','Virginica'],
                yticklabels=['Setosa', 'Versicolor', 'Virginica'])
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.title('Confusion Matrix Heatmap')
plt.show()
```



In [23]:
```
print(classification_report(y_test,pred))
```

```
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        16
           1       1.00      0.94      0.97        18
           2       0.92      1.00      0.96        11

    accuracy                           0.98        45
   macro avg       0.97      0.98      0.98        45
weighted avg       0.98      0.98      0.98        45
```

In [24]:
```
print('\nAccuracy: {:.2f}'.format(accuracy_score(y_test,pred)))
print('Error Rate: ',(fp+fn)/(tp+tn+fn+fp))
print('Sensitivity (Recall or True positive rate) :',tp/(tp+fn))
print('Specificity (True negative rate) :',tn/(fp+tn))
print('Precision (Positive predictive value) :',tp/(tp+fp))
print('False Positive Rate :',fp/(tn+fp))
```

```
Accuracy: 0.98
Error Rate:  0.0
Sensitivity (Recall or True positive rate) : 1.0
Specificity (True negative rate) : 1.0
Precision (Positive predictive value) : 1.0
False Positive Rate : 0.0
```

In [ ]:

In [ ]: