In [ ]:

```
import warnings
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
from sklearn.cluster import KMeans
```

Exercise 1

Download the Iris dataset from UCI Machine Learning repository,
https:// archive.ics.uci.edu/ml/datasets/iris.
The data set contains 3 classes of 50 instances each, where each class refers to a type of iris plant.

In [ ]:

```
data = pd.read_csv('iris.data', names = ['sepal_L', 'sepal_W', 'petal_L', 'petal_W'
```

In [ ]:

```
data.head()
data['class'].unique()
```

Out[ ]:

```
array(['Iris-setosa', 'Iris-versicolor', 'Iris-virginica'], dtype=object)
```

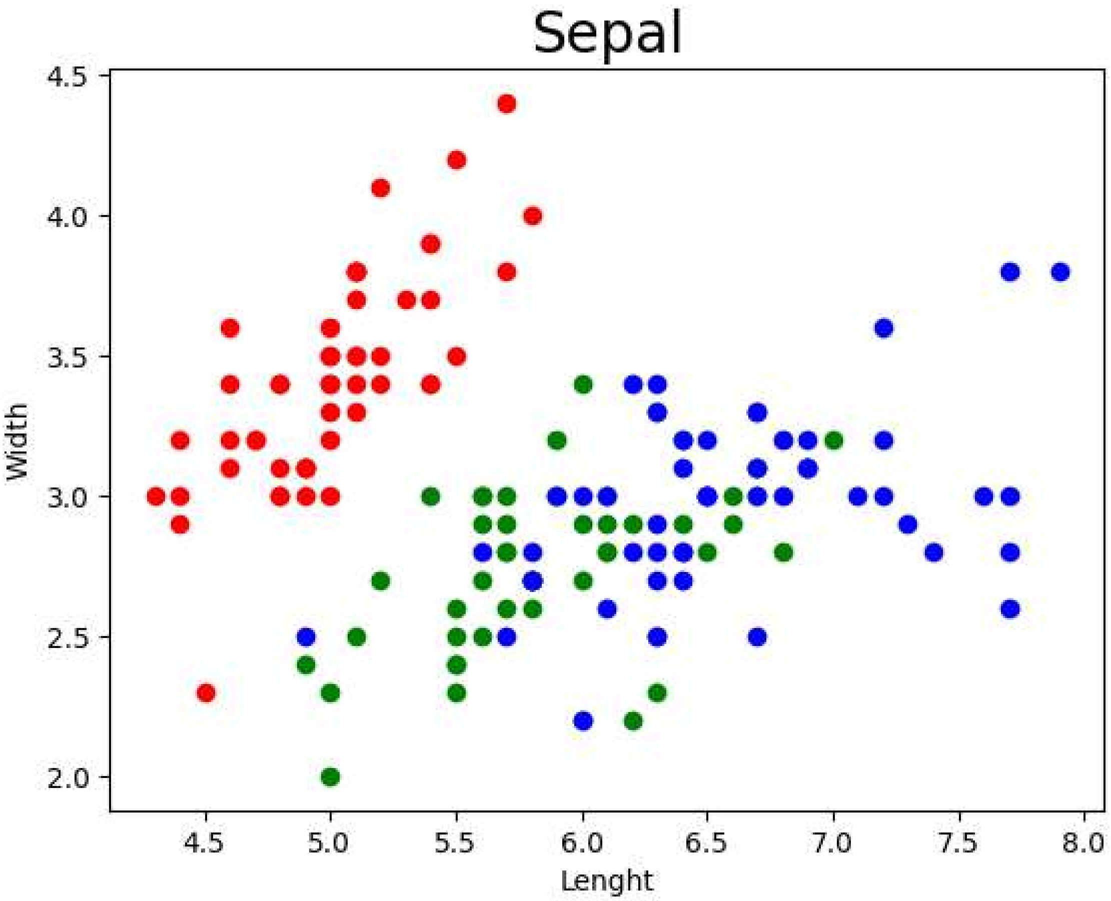
Exercise 2

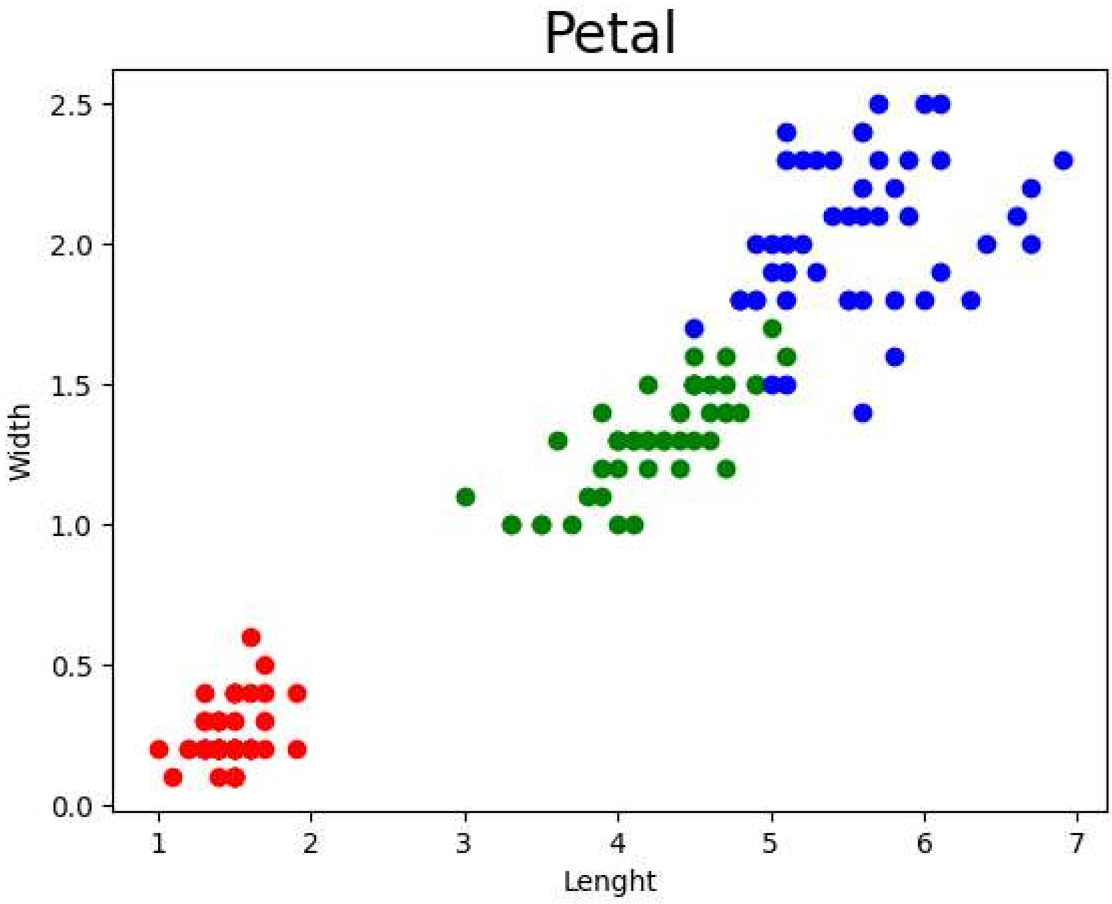
Visualize the data set in the 2D space of the first two features (sepal length and sepal width). Points from different classes should be visualized with different colors.

In [ ]:

```
dfSet = data.loc[data['class'] == 'Iris-setosa']
dfVer = data.loc[data['class'] == 'Iris-versicolor']
dfVir = data.loc[data['class'] == 'Iris-virginica']

#Sepal
x, y = dfSet['sepal_L'].to_numpy(), dfSet['sepal_W'].to_numpy()
plt.scatter(x, y, color='red')
x, y = dfVer['sepal_L'].to_numpy(), dfVer['sepal_W'].to_numpy()
plt.scatter(x, y, color='green')
x, y = dfVir['sepal_L'].to_numpy(), dfVir['sepal_W'].to_numpy()
plt.scatter(x, y, color='blue')

plt.title('Sepal', fontsize=20)
plt.xlabel('Lenght', fontsize=10)
plt.ylabel('Width', fontsize=10)
plt.show()

#Petal
x, y = dfSet['petal_L'].to_numpy(), dfSet['petal_W'].to_numpy()
plt.scatter(x, y, color='red')
x, y = dfVer['petal_L'].to_numpy(), dfVer['petal_W'].to_numpy()
plt.scatter(x, y, color='green')
```

```
x, y = dfVir['petal_L'].to_numpy(), dfVir['petal_W'].to_numpy()
plt.scatter(x, y, color='blue')

plt.title('Petal', fontsize=20)
plt.xlabel('Lenght', fontsize=10)
plt.ylabel('Width', fontsize=10)
plt.show()
```





Exercise 3

Calculate the average sepal length for each of the three classes.

In [ ]:

```
print('avg sepal lenght for Iris-setosa', round(dfSet['sepal_L'].mean(), 3))
print('avg sepal lenght for Iris-versicolor', round(dfVer['sepal_L'].mean(), 3))
print('avg sepal lenght for Iris-virginica', round(dfVir['sepal_L'].mean(), 3))
```

```
avg sepal lenght for Iris-setosa 5.006
avg sepal lenght for Iris-versicolor 5.936
avg sepal lenght for Iris-virginica 6.588
```

Exercise 4

Calculate the variance of sepal length for each of the three classes. (It is advised to implement the variance calculation yourself rather than use built-in functions: this will give you some hands-on experience with the concept.)

In [ ]:

```
def calVar(df):
    val = 0
    mean = df['sepal_L'].mean()
    for elm in df['sepal_L']:
        val += (elm - mean) ** 2
    return val/(df.shape[0]-1)
calVar(dfSet)
print('var sepal lenght for Iris-setosa', round(calVar(dfSet), 3))
print('var sepal lenght for Iris-versicolor', round(calVar(dfVer), 3))
print('var sepal lenght for Iris-virginica', round(calVar(dfVir), 3))
print()
print('var sepal lenght for Iris-setosa', round(dfSet['sepal_L'].var(), 3))
print('var sepal lenght for Iris-versicolor', round(dfVer['sepal_L'].var(), 3))
print('var sepal lenght for Iris-virginica', round(dfVir['sepal_L'].var(), 3))
```

```
var sepal lenght for Iris-setosa 0.124
var sepal lenght for Iris-versicolor 0.266
var sepal lenght for Iris-virginica 0.404

var sepal lenght for Iris-setosa 0.124
var sepal lenght for Iris-versicolor 0.266
var sepal lenght for Iris-virginica 0.404
```

Exercise 5

Python is an interpreter language (as opposed to a compiled language) and, therefore, in terms of run-time efficiency it is highly recommended to use precompiled functions instead of for-loops whenever possible. Use matrix-vector multiplications and other built-in functions to compute the Euclidean distance between the first data point and all the remaining data points without using any for-loops! Report the average distance and its variance.

In [ ]:

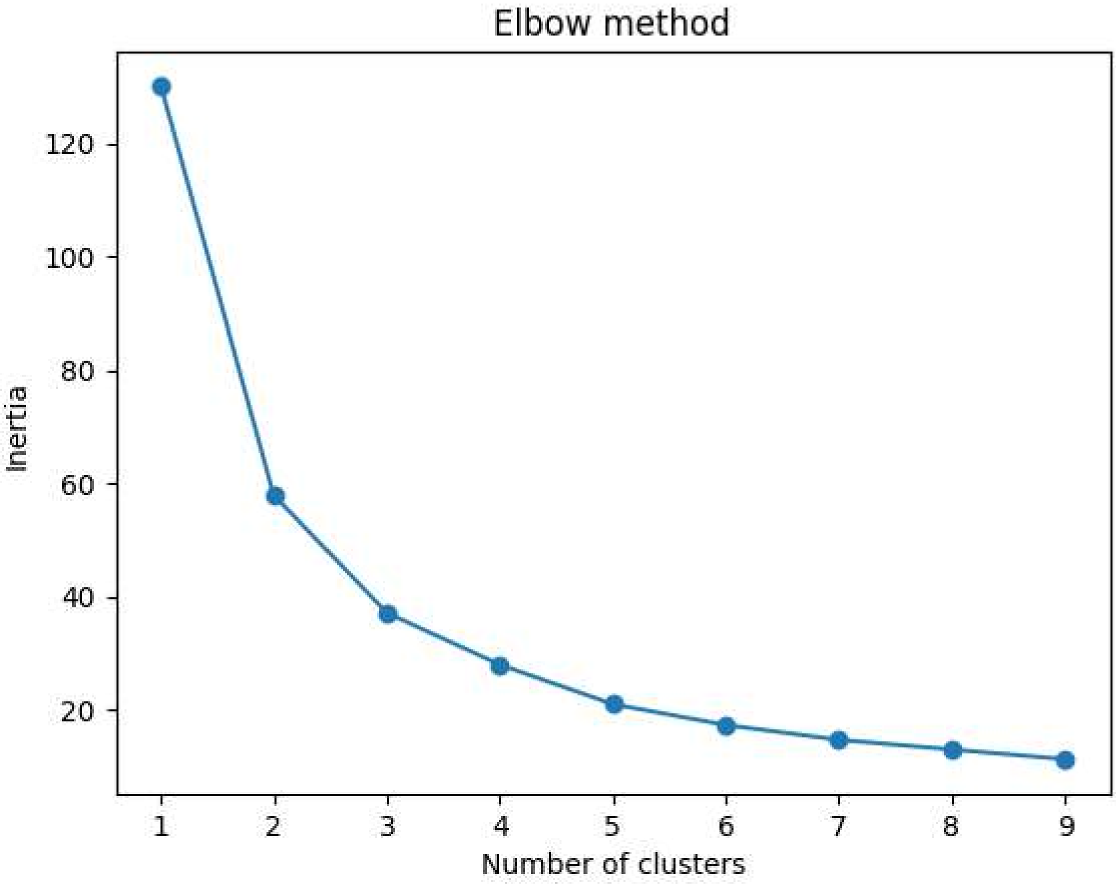
```
from sklearn.metrics.pairwise import euclidean_distances
def fromFirstEntry(col):
    lenghts_arr = data[col].to_numpy()
    fstVal_arr = np.array(data[col].iloc[0])
    lenghts_arr = lenghts_arr.reshape(-1, 1)
    fstVal_arr = fstVal_arr.reshape(-1, 1)

    distance = euclidean_distances(lenghts_arr, fstVal_arr)
    return np.mean(distance), np.var(distance)

print('avg =', round(fromFirstEntry('sepal_L')[0], 3))
print('var =', round(fromFirstEntry('sepal_L')[1], 3))
```

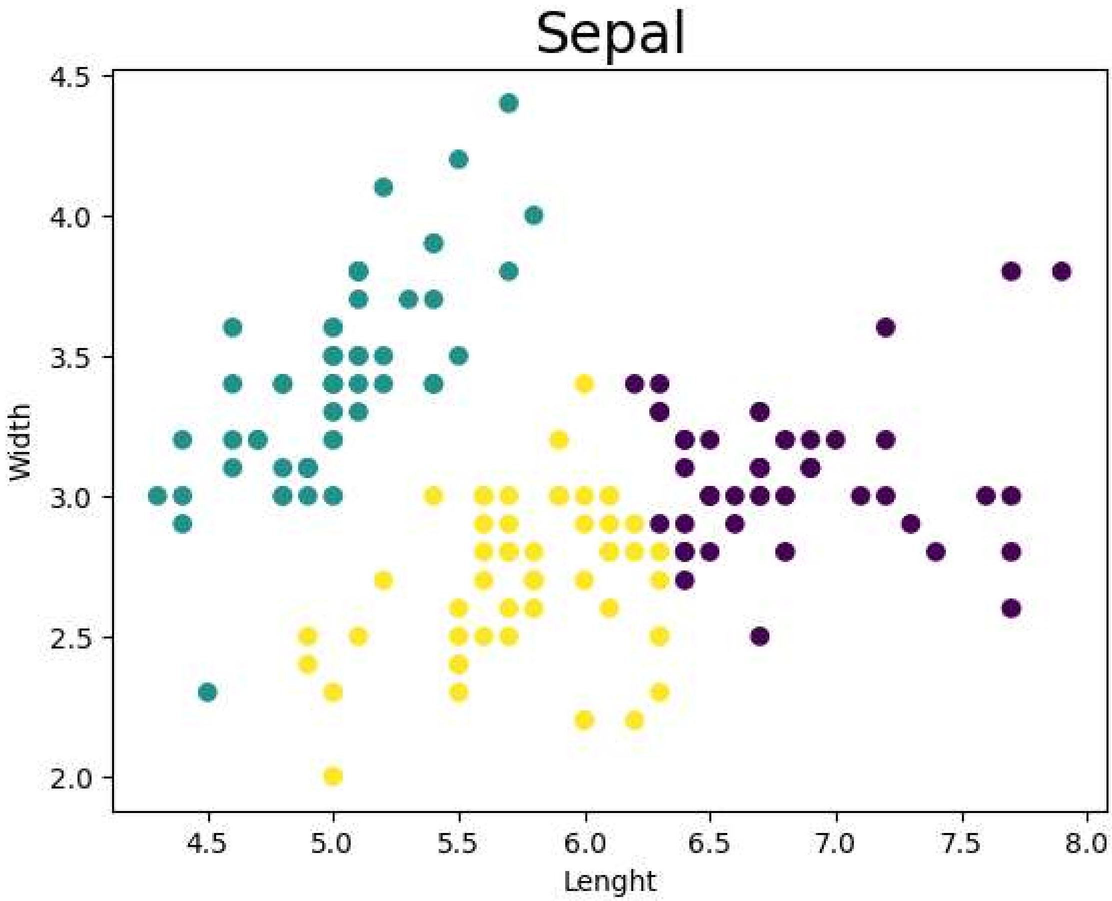
```
avg = 0.877
var = 0.465
```

K-means clustering

In [ ]:

```
def kMeans_plotSepalLW():
    x, y = data['sepal_L'].to_numpy(), data['sepal_W'].to_numpy()
    data_samples = list(zip(x,y))
    inertias = []
    for i in range (1, 10):
        kmeans = KMeans(n_clusters=i)
        kmeans.fit(data_samples)
        inertias.append(kmeans.inertia_)
    plt.plot(range(1,10), inertias, marker='o')
    plt.title('Elbow method')
    plt.xlabel('Number of clusters')
    plt.ylabel('Inertia')
    plt.show()

    ''' We can see that the "elbow" on the graph is at K=3 '''
    kmeans = KMeans(n_clusters=3)
    kmeans.fit(data_samples)

    plt.scatter(x, y, c=kmeans.labels_)
    plt.title('Sepal', fontsize=20)
    plt.xlabel('Lenght', fontsize=10)
    plt.ylabel('Width', fontsize=10)
    plt.show()
warnings.filterwarnings('ignore')
kMeans_plotSepalLW()
warnings.filterwarnings('default')
```




Sepal
4.5
4.0
3.5
3.0
2.5
2.0
Width
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
Lenght