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Ministry of Higher Education and Scientific Research

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TD Project

In Information retrieval systems SRI

Specialty: *ISIL*

Theme

Clustering algorithms – K-Means

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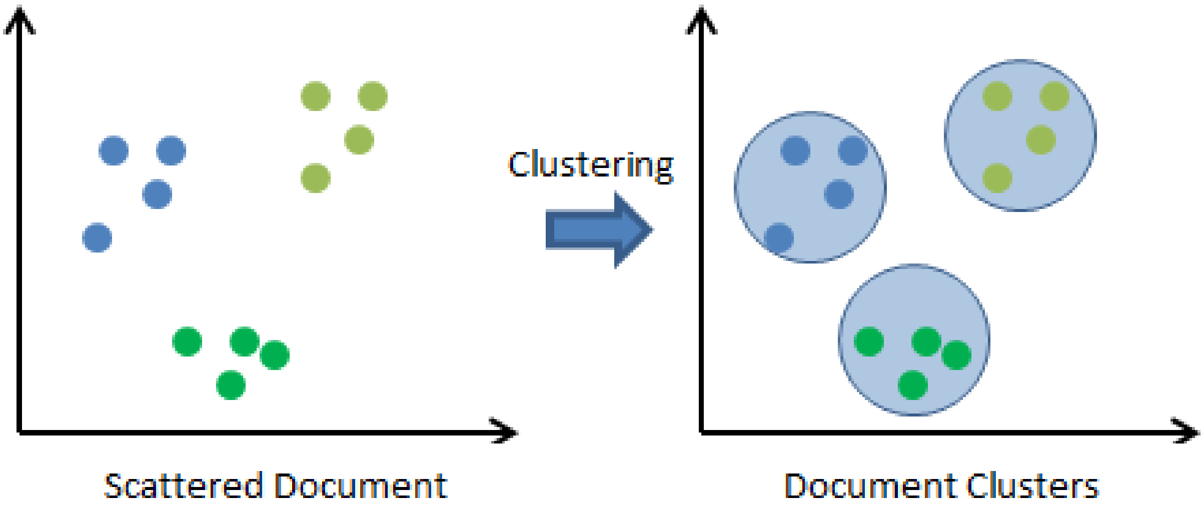
Contents

Introduction

Definition:

Clustering algorithms are a machine-learning technique that discovers patterns and groups together similar data points. It is used to group sets of data points into a number of clusters, which helps extract underlying patterns in data and transforms raw data into meaningful knowledge. [1]

Clustering algorithms are unsupervised learning approaches that group comparable data points into clusters based on their similarity. The identification of such clusters leads to segmentation of data points into a number of distinct groups. [1]



Types of clustering algorithms:

There are several types of clustering algorithms, like centroid-based, density-based, distribution-based, and hierarchical clustering. [1]

Each type of clustering algorithm is best suited to a particular data distribution and has its own advantages and disadvantages. [1]

Examples:

- **Centroid-based clustering** : This algorithm organizes data into non-hierarchical clusters. The most widely used centroid-based clustering algorithm is **k-means**. [1]
- **Density-based clustering** : This algorithm connects areas of high example density into clusters. It allows for arbitrary-shaped distributions as long as dense areas can be connected. [1]
- **Distribution-based clustering** : This algorithm assumes data is composed of distributions, such as Gaussian distributions. [1]
- **Hierarchical clustering** : This algorithm creates a tree of clusters. Hierarchical clustering is well suited to hierarchical data, such as taxonomies. [1]

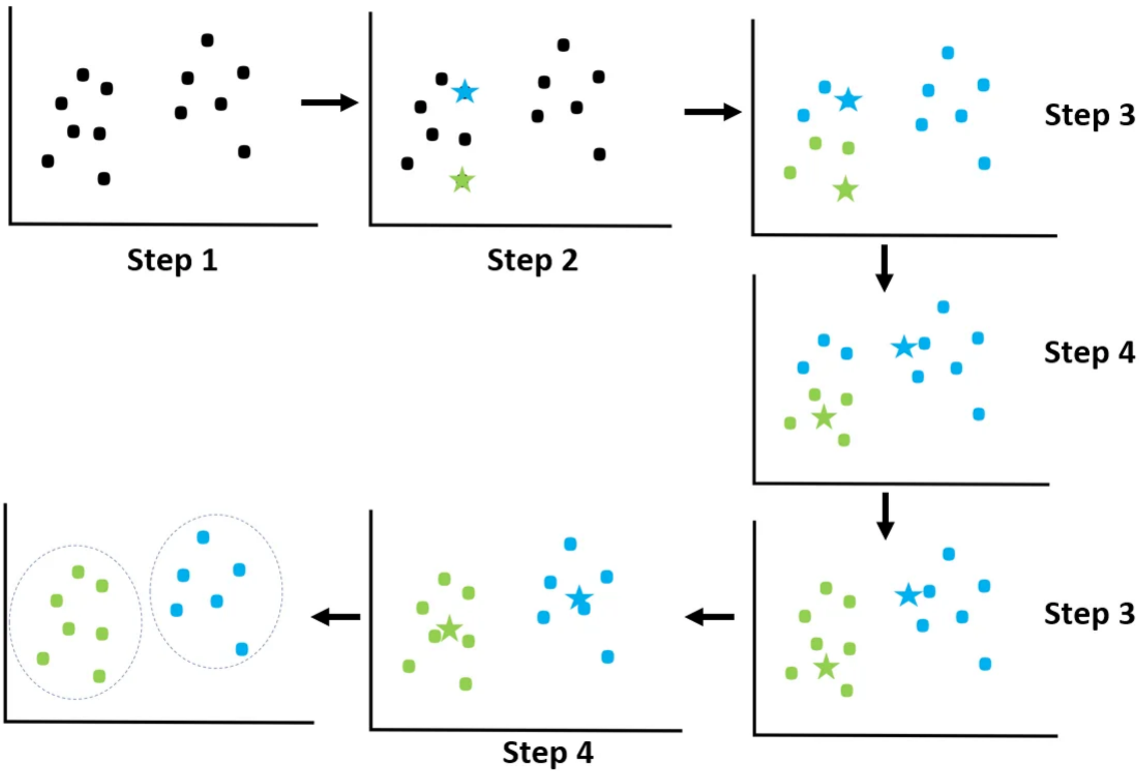
K-Means

The K-Means Clustering is an Unsupervised Learning algorithm, which groups the unlabeled dataset into different clusters. [1]

Were K defines the number of pre-defined clusters that need to be created in the process, so if K=5, there will be five clusters, and so on. [1]

K-Means Steps:

1. Select the number of clusters K.
2. Select random K points or centroids.
3. Assign each data point to their closest centroid.
4. Calculate the variance and place a new centroid of each cluster.
5. Repeat Step 3 and Step 4 for N number of times.
6. Stop if you loop N times or if the values of Step 4 do not change.



Optimal Value of K (Elbow Method):

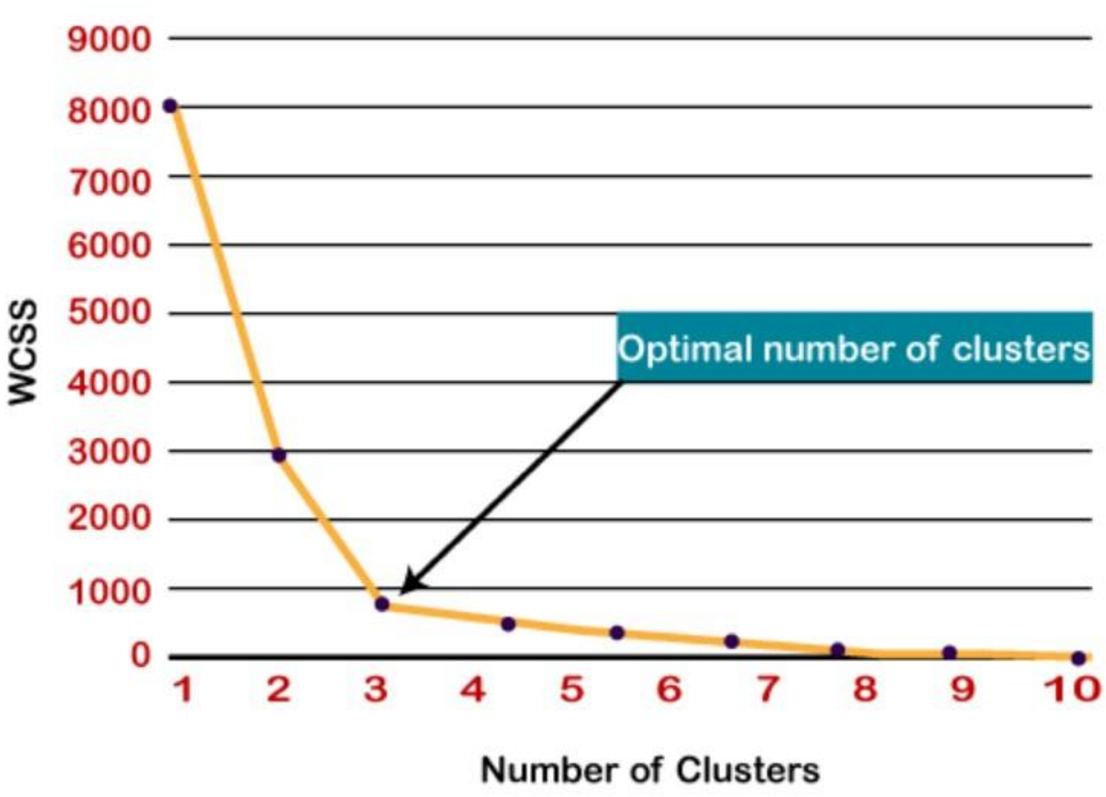
The Elbow method is one of the most popular ways to find the optimal number of clusters. This method uses the concept of WCSS (Within Cluster Sum of Squares) value. [1]

- WCSS= $\sum_{\text{Pi in Cluster1}}$ distance(P_i C_1)^2 +$\sum_{\text{Pi in Cluster2}}$distance($P_i$ C_2)^2 with k=2.

We executes the K-means clustering on a given dataset for different K values (ranges from 1-15).

For each value of K, we calculates the WCSS value.

Plots a curve between calculated WCSS values and the number of clusters K.



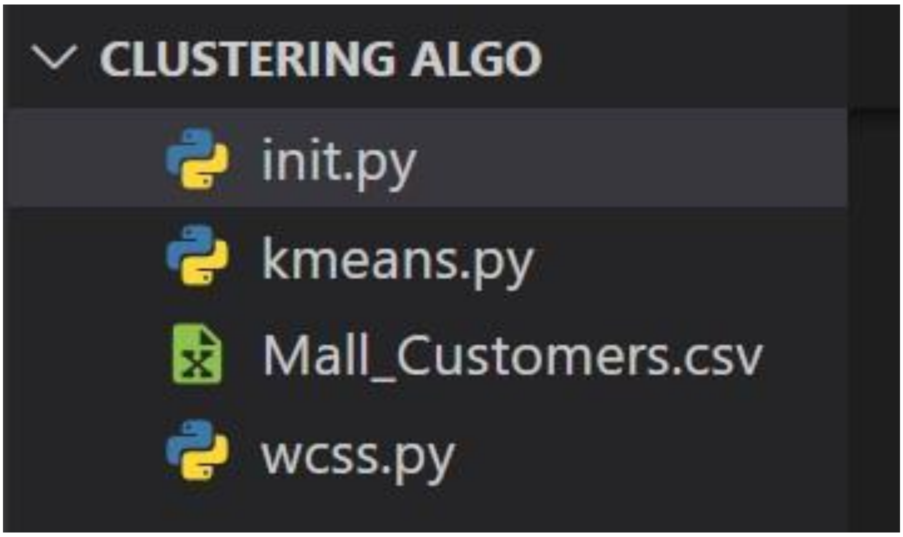
In this graph, the optimal k is Three.

Implementation

Prerequisite:

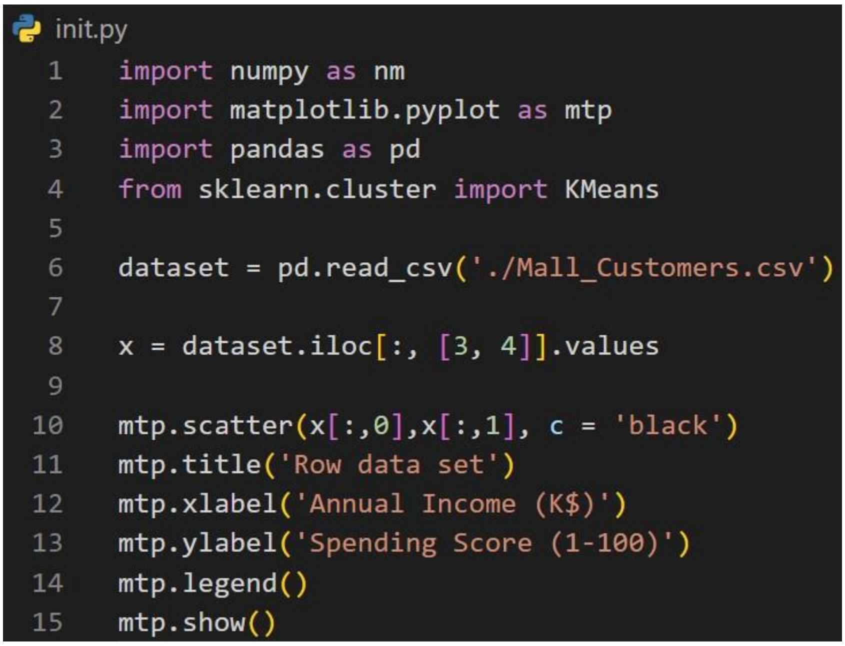
- Python 3.10
- pip install numpy
- pip install matplotlib
- pip install pandas
- pip install sklearn

We will use the free **mall customer csv [2]**, after extracting the .csv file, you can drop it in your working directory, and then we will need three new files.



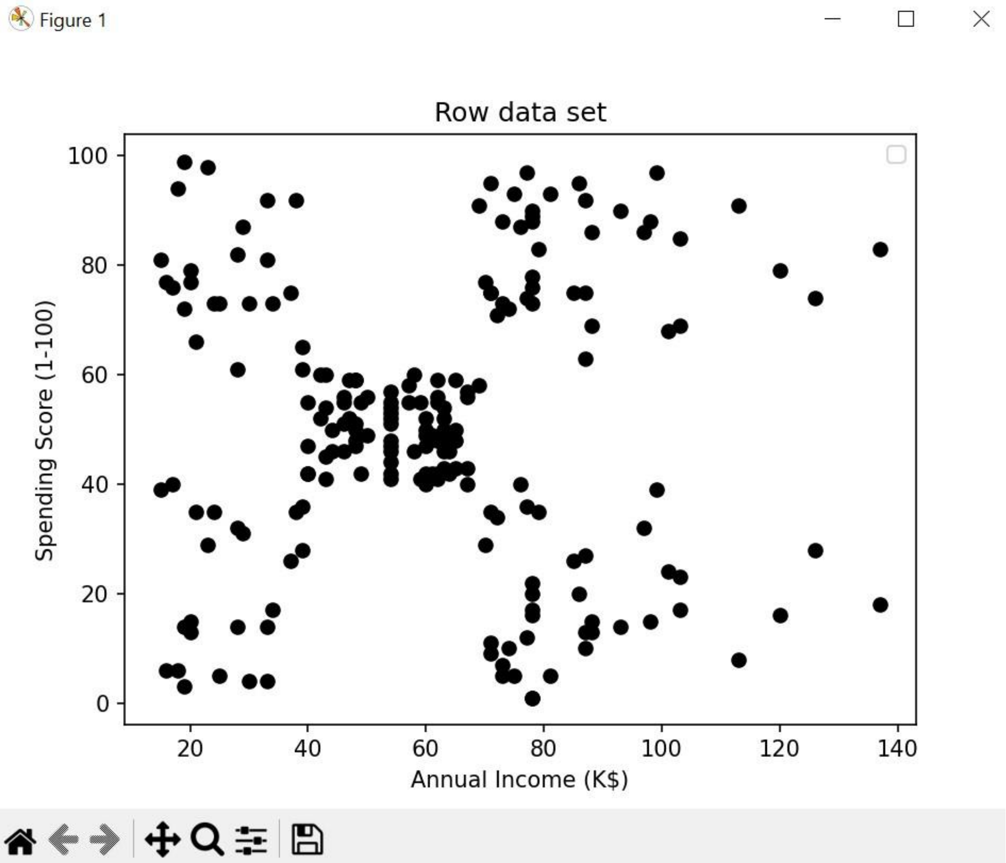
```
CLUSTERING ALGO
    init.py
    kmeans.py
    Mall_Customers.csv
    wcss.py
```

init.py: This file is mandatory, it serve to help us visualize how we transformed the data into a graph.

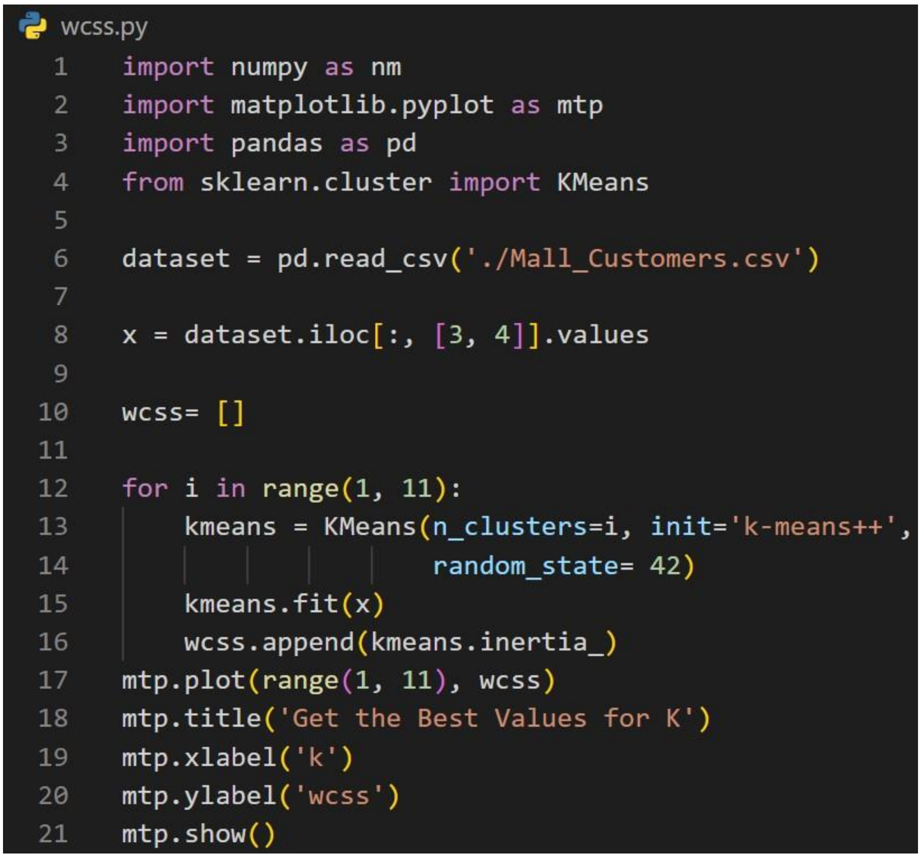


init.py

```python
import numpy as nm
import matplotlib.pyplot as mtp
import pandas as pd
from sklearn.cluster import KMeans

dataset = pd.read_csv('./Mall_Customers.csv')

x = dataset.iloc[:, [3, 4]].values

mtp.scatter(x[:,0],x[:,1], c = 'black')
mtp.title('Row data set')
mtp.xlabel('Annual Income (K$)')
mtp.ylabel('Spending Score (1-100)')
mtp.legend()
mtp.show()
```

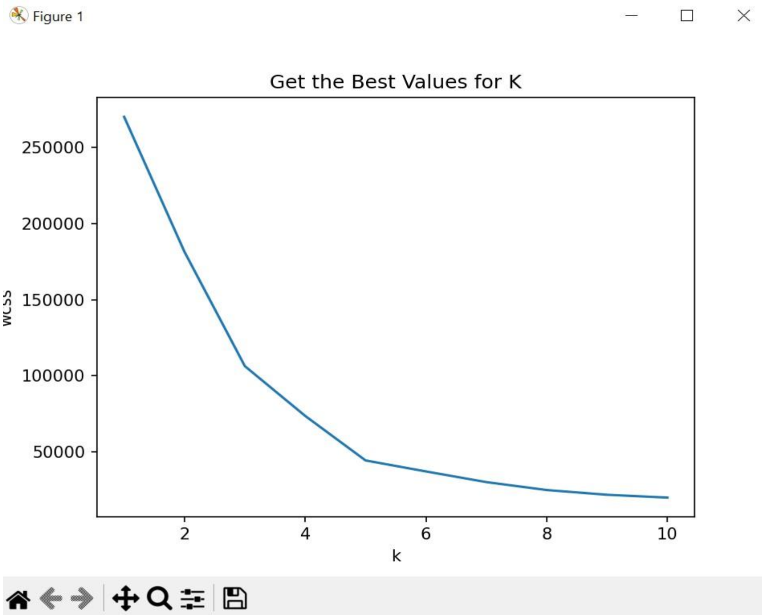


wcss.py: This file is responsible for finding the optimal K using the WSCC method. Is our example the optimal K = 5.

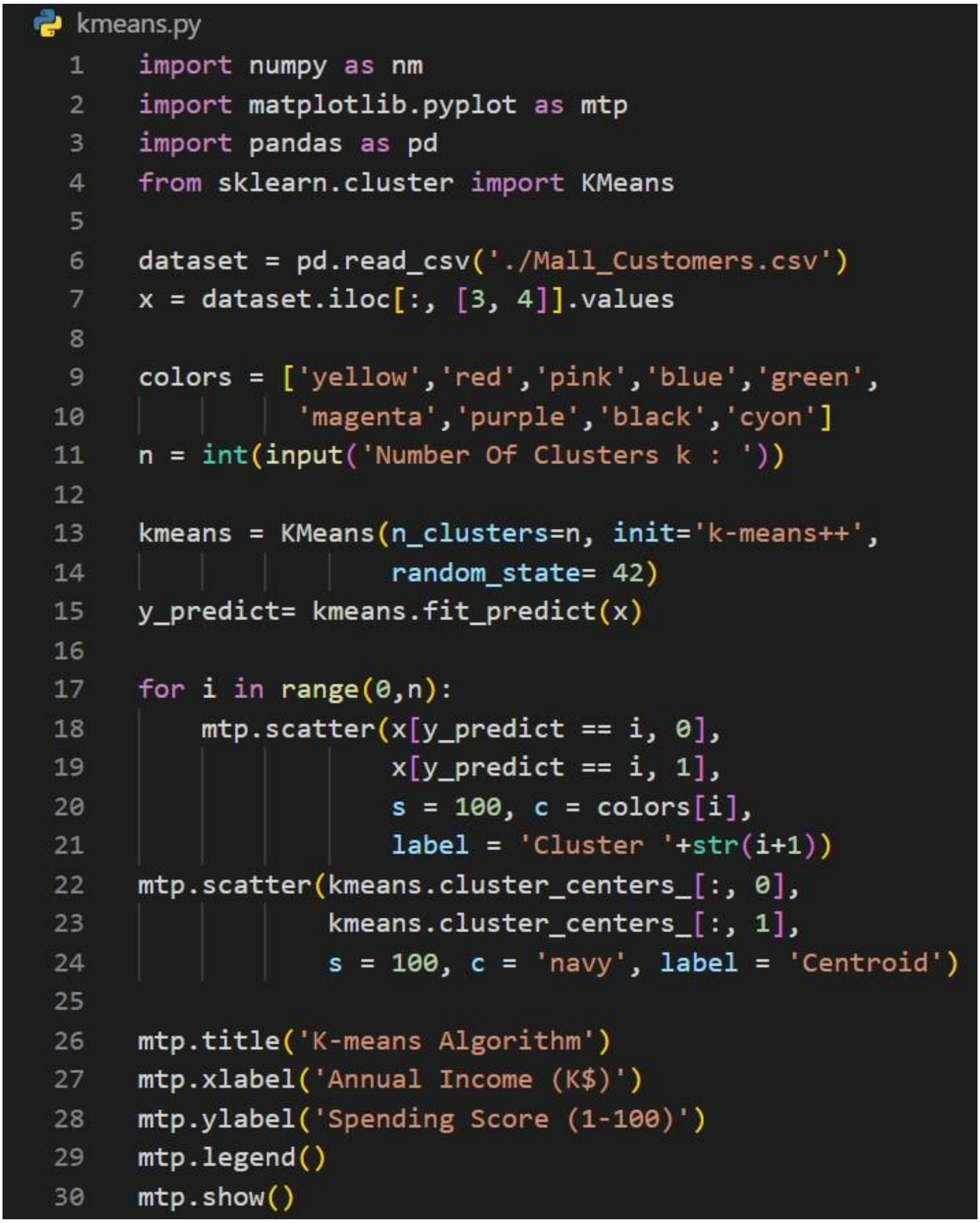


wcss.py

```python
import numpy as nm
import matplotlib.pyplot as mtp
import pandas as pd
from sklearn.cluster import KMeans

dataset = pd.read_csv('./Mall_Customers.csv')

x = dataset.iloc[:, [3, 4]].values

wcss= []

for i in range(1, 11):
    kmeans = KMeans(n_clusters=i, init='k-means++',
                    random_state= 42)
    kmeans.fit(x)
    wcss.append(kmeans.inertia_)
mtp.plot(range(1, 11), wcss)
mtp.title('Get the Best Values for K')
mtp.xlabel('k')
mtp.ylabel('wcss')
mtp.show()
```

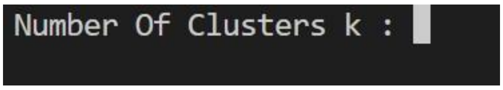


kmeans.py: This file is our main algorithm for transforming the date into relevant clusters.



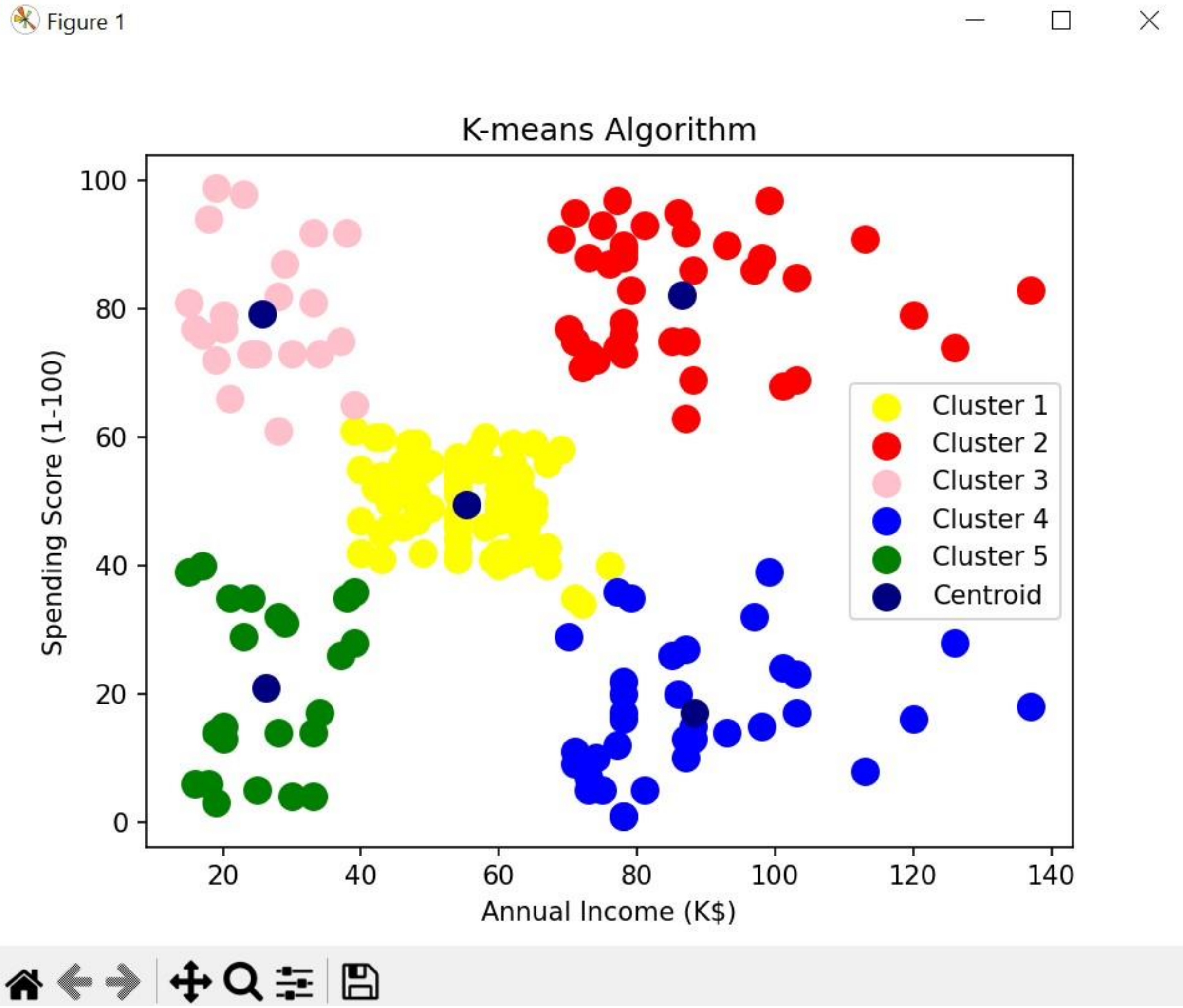
```python
import numpy as nm
import matplotlib.pyplot as mtp
import pandas as pd
from sklearn.cluster import KMeans

dataset = pd.read_csv('./Mall_Customers.csv')
x = dataset.iloc[:, [3, 4]].values

colors = ['yellow','red','pink','blue','green',
     'magenta','purple','black','cyon']
n = int(input('Number Of Clusters k : '))

kmeans = KMeans(n_clusters=n, init='k-means++',
        random_state= 42)
y_predict= kmeans.fit_predict(x)

for i in range(0,n):
  mtp.scatter(x[y_predict == i, 0],
        x[y_predict == i, 1],
        s = 100, c = colors[i],
        label = 'Cluster '+str(i+1))
mtp.scatter(kmeans.cluster_centers_[:, 0],
      kmeans.cluster_centers_[:, 1],
      s = 100, c = 'navy', label = 'Centroid')

mtp.title('K-means Algorithm')
mtp.xlabel('Annual Income (K$)')
mtp.ylabel('Spending Score (1-100)')
mtp.legend()
mtp.show()
```

You will be prompted for the K values, which is 5.



```
Number Of Clusters k : 
```

Type 5 and then hit enter.



As you can see, we have five different clusters.

Bibliography

[1] ChatGPT , https://www.javatpoint.com/k-means-clustering-algorithm-in-machine-learning

[2] https://gist.github.com/pravalliyaram/5c05f43d2351249927b8a3f3cc3e5ecf