## Problem Statement

Program to implement k-means clustering technique using any standard dataset available in the public domain

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## Dataset Description

In this project, we will be using the dataset holding the information of carbon dioxide emission from different car models.

The dataset includes 36 instances with 5 columns which can be briefed as:

| Column | Description |
|---|---|
| Car | Brand of the car |
| Model | Model of the car |
| Volume | Total space available inside the car (in $litres$) |
| Weight | Total weightof the car (in $kg$) |
| $CO_2$ | Total emission of carbon dioxide from the car |

**Note:** *(This is a manually created custom dataset for this project.*)

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## List of Activities

**Activity 1:** Import Modules and Read Data

**Activity 2:** Data Cleaning

**Activity 3:** Find Optimal Value of `K`

**Activity 4:** Plot Silhouette Scores

## Activity 1: Import Modules and Read Data

Import the necessary Python modules along with the following modules:

- `KMeans` - For clustering using K-means.
- `re` - To remove unwanted rows using regex.

Read the data from a CSV file to create a Pandas DataFrame and go through the necessary data-cleaning process (if required).

```
# Import the modules and Read the data.
import numpy as np
import pandas as pd
df=pd.read_csv('https://raw.githubusercontent.com/jiss-sngce/CO_3/main/jkcars.csv')

# Print the first five records
df.head()

```

| | Car | Model | Volume | Weight | CO2 |
|---|---|---|---|---|---|
| **0** | Mitsubishi | Space Star | 1200 | 1160 | 95 |
| **1** | Skoda | Citigo | 1000 | 929 | 95 |
| **2** | Fiat | 500 | 900 | 865 | 90 |
| **3** | Mini | Cooper | 1500 | 1140 | 105 |
| **4** | VW | Up! | 1000 | 929 | 105 |

```
# Get the total number of rows and columns, data types of columns and missing values (i
df.shape
df.dtypes
df.isnull().sum()
```

```
Car       0
Model     0
Volume    0
Weight    0
CO2       0
dtype: int64
```

## Activity 3: Find Optimal value of K

In this activity, you need to find the optimal value of `K` using the silhouette score.

1. Create a subset of the dataset consisting of three columns i.e `Volume`, `Weight`, and `CO2`.

```
# Create a new DataFrame consisting of three columns 'Volume', 'Weight', 'CO2'.
new_df = df[['Volume','Weight','CO2']]

# Print the first 5 rows of this new DataFrame.
new_df.head()
```

| | Volume | Weight | CO2 |
|---|---|---|---|
| **0** | 1200 | 1160 | 95 |
| **1** | 1000 | 929 | 95 |

2. Compute K-Means clustering for the 3D dataset `data_3d` by varying `K` from `2` to `10` clusters. Also, for each `K`, calculate silhouette score using `silhouette_score` function.

   **Steps to Follow**

   - Create an empty list to store silhouette scores obtained for each `K` (let's say `sil_scores`).
   - Initiate a `for` loop that ranges from 2 to 10.
   - Perform K-means clustering for the current value of `K` inside `for` loop.
   - Use `fit()` and `predict()` to create clusters.
   - Calculate silhouette score for current `K` value using `silhouette_score()` function and append it to the empty list `sil_scores`.
   - Create a DataFrame with two columns. The first column must contain `K` values from 2 to 10 and the second column must contain silhouette values obtained after the `for` loop.

```
#Calculate inertia for different values of 'K'.
from sklearn.metrics import silhouette_score
from sklearn.cluster import KMeans
# Create an empty list to store silhouette scores obtained for each 'K'
sil_scores = []
clusters = range(2,11)

for k in clusters:
  kmean_k = KMeans (n_clusters = k, random_state=10)
  kmean_k.fit(new_df)
  cluster_labels = kmean_k.predict(new_df)
  sil_scores.append(silhouette_score(new_df,cluster_labels))

sil_data = pd.DataFrame({'K value':clusters,'silhouette_score':sil_scores})
sil_data
#sil_scores
```

| | K value | silhouette_score |
|---|---|---|
| **0** | 2 | 0.466982 |
| **1** | 3 | 0.569304 |
| **2** | 4 | 0.506027 |
| **3** | 5 | 0.537547 |

**Q**: What are the maximum silhouette score and the corresponding cluster value?

**A**:

- Maximum silhouette score: 0.569304
- Corresponding cluster value: 3

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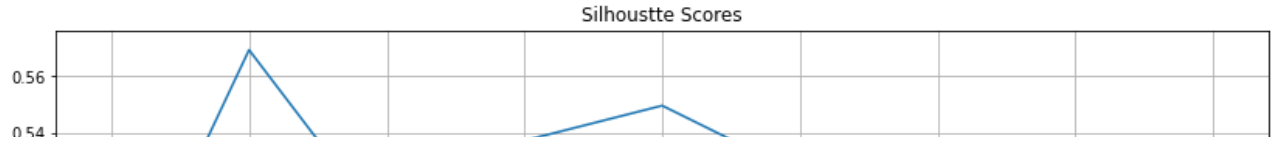
## Activity 4: Plot silhouette Scores & WCSS Scores to find optimal value for K

Create a line plot with `K` ranging from `2` to `10` on the $x$-axis and the silhouette scores stored in `sil_scores` list on the $y$-axis.

```
# Plot silhouette scores vs number of clusters.
import matplotlib.pyplot as plt
import numpy as np
plt.figure(figsize=(14,5))
plt.title('Silhoustte Scores')
x = np.arange(2,11)
plt.xlabel('K')
plt.ylabel('Silhoustte scores')
plt.grid()
y = (sil_scores)
plt.plot(x,y)
plt.show()

```




**Q:** Write your observations of the graph.

**A:** From the graph, we can conclude that the optimal value of `K` is 3.

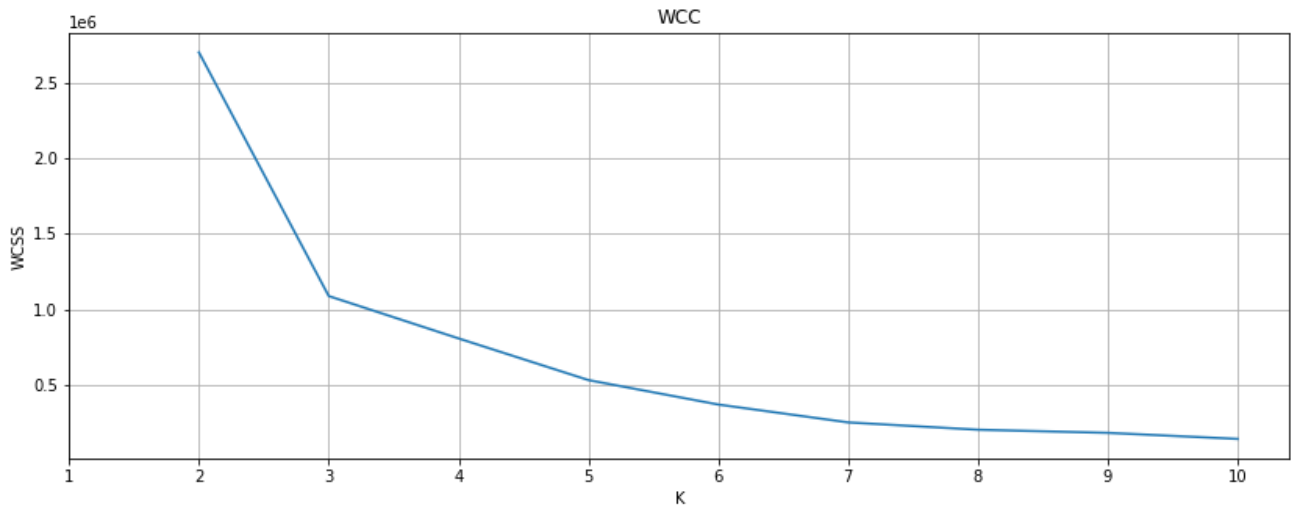

```
# S3.1: Determine 'K' using Elbow method.
from sklearn.metrics import silhouette_score
from sklearn.cluster import KMeans
wcss=[]
clusters=range(2,11)


# Initiate a for loop that ranges from 1 to 10.
for k in clusters:
    # Inside for loop, perform K-means clustering for current value of K. Use 'fit()' t
    kmean_k=KMeans(n_clusters=k,random_state=10)
    kmean_k.fit(new_df)

    # Find wcss for current K value using 'inertia_' attribute and append it to the emp
    wcss.append(kmean_k.inertia_)

# Plot WCSS vs number of clusters.
plt.figure(figsize=(14,5))
plt.title('WCC')
plt.plot(clusters,wcss)
plt.xlabel('K')
plt.ylabel("WCSS")
plt.grid()
plt.xticks(range(1,11))
plt.show()

```



```
# Clustering the dataset for K = 3
from sklearn.cluster import KMeans

# Perform K-Means clustering with n_clusters = 4 and random_state = 10
kmeans_model=KMeans(n_clusters=3,random_state=10)


# Fit the model to the scaled_df
kmeans_model.fit(new_df)


# Make a series using predictions by K-Means
cluster_labels=pd.Series(kmeans_model.predict(new_df))
cluster_labels.value_counts()
```

```
2    16
1     9
0     7
dtype: int64
```

```
# Create a DataFrame with cluster labels for cluster visualisation
km_df=pd.concat([df,cluster_labels],axis=1)
km_df.columns=list(df.columns)+['label']
km_df

```

| | Car | Model | Volume | Weight | CO2 | label |
|---|---|---|---|---|---|---|
| **0** | Mitsubishi | Space Star | 1200 | 1160 | 95 | 0 |
| **1** | Skoda | Citigo | 1000 | 929 | 95 | 0 |
| **2** | Fiat | 500 | 900 | 865 | 90 | 0 |
| **3** | Mini | Cooper | 1500 | 1140 | 105 | 2 |
| **4** | VW | Up! | 1000 | 929 | 105 | 0 |
| **5** | Skoda | Fabia | 1400 | 1109 | 90 | 2 |
| **6** | Ford | Fiesta | 1500 | 1112 | 98 | 2 |
| **7** | Audi | A1 | 1600 | 1150 | 99 | 2 |
| **8** | Hyundai | I20 | 1100 | 980 | 99 | 0 |
| **9** | Suzuki | Swift | 1300 | 990 | 101 | 0 |
| **10** | Ford | Fiesta | 1000 | 1112 | 99 | 0 |
| **11** | Honda | Civic | 1600 | 1252 | 94 | 2 |
| **12** | Hundai | I30 | 1600 | 1326 | 97 | 2 |
| **13** | Opel | Astra | 1600 | 1330 | 97 | 2 |
| **14** | BMW | 1 | 1600 | 1365 | 99 | 2 |
| **15** | Mazda | 3 | 2200 | 1280 | 104 | 1 |
| **17** | Ford | Focus | 2000 | 1328 | 105 | 1 |
| **18** | Ford | Mondeo | 1600 | 1584 | 94 | 2 |
| **19** | Mercedes | C-Class | 2100 | 1365 | 99 | 1 |
| **20** | Skoda | Octavia | 1600 | 1415 | 99 | 2 |
| **21** | Volvo | S60 | 2000 | 1415 | 99 | 1 |
| **22** | Mercedes | CLA | 1500 | 1465 | 102 | 2 |
| **23** | Audi | A4 | 2000 | 1490 | 104 | 1 |
| **24** | Audi | A6 | 2000 | 1725 | 114 | 1 |
| **25** | Volvo | V70 | 1600 | 1523 | 109 | 2 |
| **26** | BMW | 5 | 2000 | 1705 | 114 | 1 |
| **27** | Volvo | XC70 | 2000 | 1746 | 117 | 1 |
| **28** | Ford | B-Max | 1600 | 1235 | 104 | 2 |
| **29** | BMW | 216 | 1600 | 1390 | 108 | 2 |