In [1]:

```python
import pyforest
from sklearn.cluster import KMeans
import warnings
warnings.filterwarnings('ignore')
%matplotlib inline
```

In [2]:

```python
# Create a dictionary with the data
data = {
    'X': [2, 3, 5, 8, 10, 12,  18, 20],
    'Y': [3, 4, 6, 8, 10, 12,  18, 20]
}

# Create a DataFrame from the dictionary
df = pd.DataFrame(data)

# Display the DataFrame
df
```

Out[2]:

	X	Y
0	2	3
1	3	4
2	5	6
3	8	8
4	10	10
5	12	12
6	18	18
7	20	20

Find K Value (No. Of Clusters):

$$\text{WCSS} = \sum_{C_k}^{C_n} \left(\sum_{d_i \, in \, C_i}^{d_m} distance(d_i, C_k)^2 \right)$$

Where,

C is the cluster centroids and d is the data point in each Cluster.

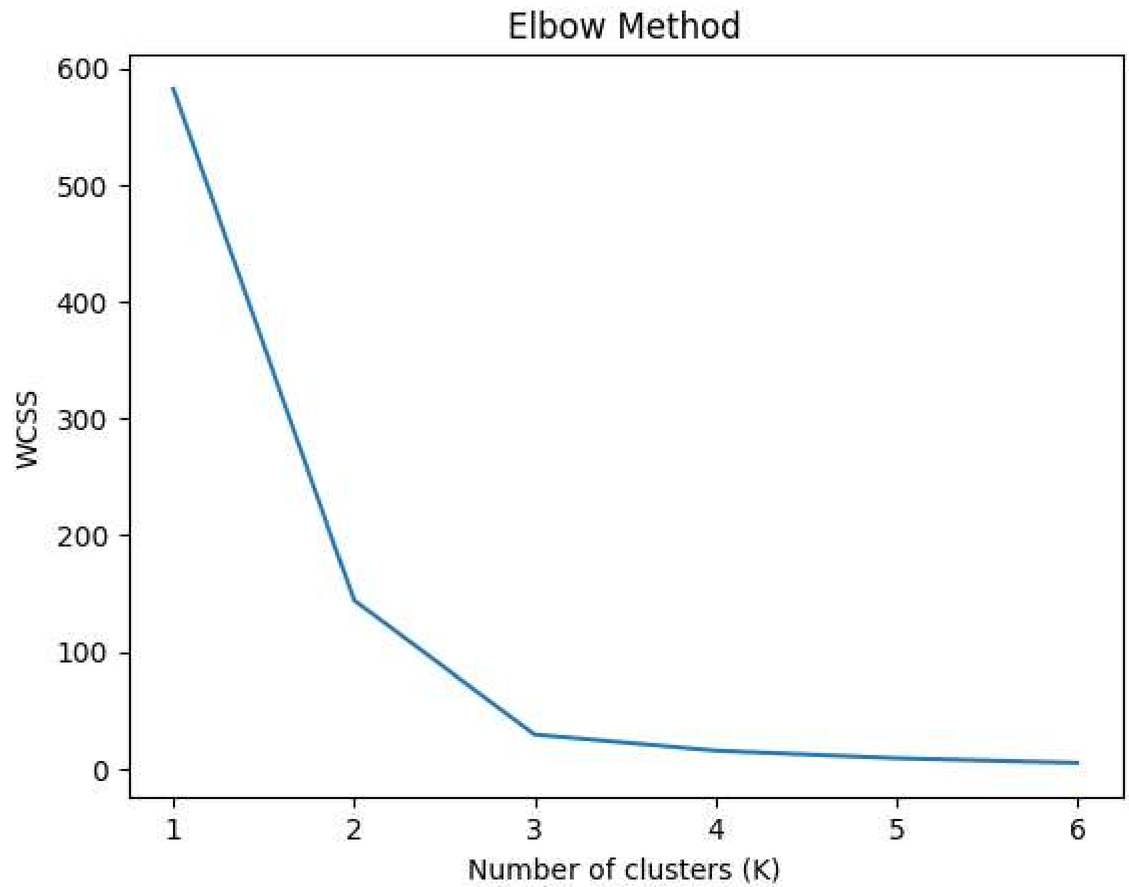
In [ ]:
```
wcss= []
for k in range(1,7):
    kmeans= KMeans(n_clusters=k,init='k-means++')
    kmeans.fit(df)
    wcss.append(kmeans.inertia_)
```

In [4]:
```
WCSS_Values=pd.DataFrame({'K Value': [1,2,3,4,5,6], 'WCSS':wcss})
WCSS_Values
```

Out[4]:

	K Value	WCSS
0	1	582.375000
1	2	144.166667
2	3	29.333333
3	4	15.500000
4	5	9.000000
5	6	5.000000

In [5]:
```
plt.plot(range(1,7), wcss)
plt.title('Elbow Method')
plt.xlabel('Number of clusters (K)')
plt.ylabel('WCSS')
plt.show()
```



Calculate Centroid and Eucliden Distance for Clustering:

$$d(x, y) = \sqrt{\sum_{i=1}^{n} (y_i - x_i)^2}$$

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

Out[6]:

	X	Y
0	2	3
1	3	4
2	5	6
3	8	8
4	10	10
5	12	12
6	18	18
7	20	20

In [7]:
```
# Random Centroids For Initialize: df index 0 and 7
c1= (3,4)
c2= (10,10)
```

In [8]:
```
#Euclidean Distance Each Data Point to Each(2) centoids:

# c1 and c2 to all data points euclidean distance:
df['Distance_to_c1']= np.sqrt((df['X']-c1[0])**2+(df['Y']-c1[1])**2)
df['Distance_to_c2'] = np.sqrt((df['X'] - c2[0])**2 + (df['Y'] - c2[1])**2)
```

In [9]:
```
df
```

Out[9]:

	X	Y	Distance_to_c1	Distance_to_c2
0	2	3	1.414214	10.630146
1	3	4	0.000000	9.219544
2	5	6	2.828427	6.403124
3	8	8	6.403124	2.828427
4	10	10	9.219544	0.000000
5	12	12	12.041595	2.828427
6	18	18	20.518285	11.313708
7	20	20	23.345235	14.142136

In [10]:
```
# Assign each data point to the cluster with the minimum distance
df['Cluster'] = np.where(df['Distance_to_c1'] < df['Distance_to_c2'], 'Cluster 1', 'Cluster 2')
```

In [11]:
```
df
```

Out[11]:

	X	Y	Distance_to_c1	Distance_to_c2	Cluster
0	2	3	1.414214	10.630146	Cluster 1
1	3	4	0.000000	9.219544	Cluster 1
2	5	6	2.828427	6.403124	Cluster 1
3	8	8	6.403124	2.828427	Cluster 2
4	10	10	9.219544	0.000000	Cluster 2
5	12	12	12.041595	2.828427	Cluster 2
6	18	18	20.518285	11.313708	Cluster 2
7	20	20	23.345235	14.142136	Cluster 2

Update Centroids by Calculating Average:

In [12]:
```
new1_c1 = (df[df['Cluster'] == 'Cluster 1']['X'].mean(), df[df['Cluster'] == 'Cluster 1']['Y'].mean())
new1_c2 = (df[df['Cluster'] == 'Cluster 2']['X'].mean(), df[df['Cluster'] == 'Cluster 2']['Y'].mean())
```

In [13]:
```
new1_c1,new1_c2
```

Out[13]:
```
((3.3333333333333335, 4.333333333333333), (13.6, 13.6))
```

In [14]:
```
#Euclidean Distance Each Data Point to Each(2) new_centoids:

# new_c1 and new_c2 to all data points euclidean distance:
df['Distance_to_new1_c1']= np.sqrt((df['X']-new1_c1[0])**2+(df['Y']-new1_c1[1])**2)
df['Distance_to_new1_c2'] = np.sqrt((df['X'] - new1_c2[0])**2 + (df['Y'] - new1_c2[1])**2)
```

In [15]:
```
df
```

Out[15]:

	X	Y	Distance_to_c1	Distance_to_c2	Cluster	Distance_to_new1_c1	Distance_to_new1_c2
0	2	3	1.414214	10.630146	Cluster 1	1.885618	15.713688
1	3	4	0.000000	9.219544	Cluster 1	0.471405	14.301049
2	5	6	2.828427	6.403124	Cluster 1	2.357023	11.476933
3	8	8	6.403124	2.828427	Cluster 2	5.934831	7.919596
4	10	10	9.219544	0.000000	Cluster 2	8.749603	5.091169
5	12	12	12.041595	2.828427	Cluster 2	11.571037	2.262742
6	18	18	20.518285	11.313708	Cluster 2	20.047167	6.222540
7	20	20	23.345235	14.142136	Cluster 2	22.874051	9.050967

In [16]:

```
# Assign each data point to the cluster with the minimum distance
df['new_Cluster'] = np.where(df['Distance_to_new1_c1'] < df['Distance_to_new1_c2'], 'Cluster 1', 'Cluster 2')
```

In [17]:

```
df
```

Out[17]:

	X	Y	Distance_to_c1	Distance_to_c2	Cluster	Distance_to_new1_c1	Distance_to_new1_c2	new_Cluster
0	2	3	1.414214	10.630146	Cluster 1	1.885618	15.713688	Cluster 1
1	3	4	0.000000	9.219544	Cluster 1	0.471405	14.301049	Cluster 1
2	5	6	2.828427	6.403124	Cluster 1	2.357023	11.476933	Cluster 1
3	8	8	6.403124	2.828427	Cluster 2	5.934831	7.919596	Cluster 1
4	10	10	9.219544	0.000000	Cluster 2	8.749603	5.091169	Cluster 2
5	12	12	12.041595	2.828427	Cluster 2	11.571037	2.262742	Cluster 2
6	18	18	20.518285	11.313708	Cluster 2	20.047167	6.222540	Cluster 2
7	20	20	23.345235	14.142136	Cluster 2	22.874051	9.050967	Cluster 2

In [18]:

```
# Create a scatter plot for the data points in each cluster
plt.scatter(df[df['new_Cluster'] == 'Cluster 1']['X'], df[df['new_Cluster'] == 'Cluster 1']['Y'], label='Cluster 1',
plt.scatter(df[df['new_Cluster'] == 'Cluster 2']['X'], df[df['new_Cluster'] == 'Cluster 2']['Y'], label='Cluster 2',

# Plot the centroids as well
plt.scatter(new1_c1[0], new1_c1[1], label='Centroid 1', marker='x', c='black', s=100)
plt.scatter(new1_c2[0], new1_c2[1], label='Centroid 2', marker='x', c='green', s=100)

# Add labels and a legend
plt.xlabel('X')
plt.ylabel('Y')
plt.legend()

# Show the scatter plot
plt.show()
```