In [1]:

```
# In this Notebook there is an Implementation
# of three Clustering Algorithms (K-Mean, K-Mode and K-Mediod)
# using built in library(sklearn) functions
# Data Sets
# Path.csv
# Artificial.csv
# Spiral.csv
```

In [2]:

```
# Importing important libraries in Python
import numpy as np
import pandas as pd
from matplotlib import pyplot as plt
from sklearn.cluster import KMeans
from kmodes.kmodes import KModes
from sklearn_extra.cluster import KMedoids
from sklearn.metrics import silhouette_samples, silhouette_score,rand_score
from sklearn.preprocessing import StandardScaler
from sklearn import metrics
from sklearn.metrics.cluster import rand_score
import random
import json
```

In [4]:

```
# this ftn would just load the provided data set as pandas frame
# return the data with actual labels in X and y respectively
def load_dataset(filepath):
    # loading Data as pandas frame
    X = pd.read_csv(filepath)
    y = X.iloc[:,2]     #actual values/ labels
    return X,y
```

In [5]:

```
# Path data set
X_path,y_path=load_dataset('/home/usman/Data_Sets/Path.csv')
print('Path Data Set')
X_path.head()
```

```
Path Data Set
```

Out[5]:

	11.25	5.05	1
0	10.95	4.70	1

	11.25	5.05	1
1	9.85	5.80	1
2	9.80	5.75	1
3	9.15	6.80	1
4	8.65	6.60	1

In [6]:

```
# Artificial data set
X_artf,y_artf=load_dataset('/home/usman/Data_Sets/Artificial.csv')
print('Artificial Data Set')
X_artf.head()
```

```
Artificial Data Set
```

Out[6]:

	8.04731	-4.88662	0
0	11.23750	3.017460	0
1	5.11050	0.269883	0
2	6.34456	-3.718320	0
3	9.09493	2.028360	0
4	8.01686	-2.264840	0

In [7]:

```
# Spiral data set
X_spir,y_spir=load_dataset('/home/usman/Data_Sets/Spiral.csv')
print('Spiral Data Set')
X_spir.head()
```

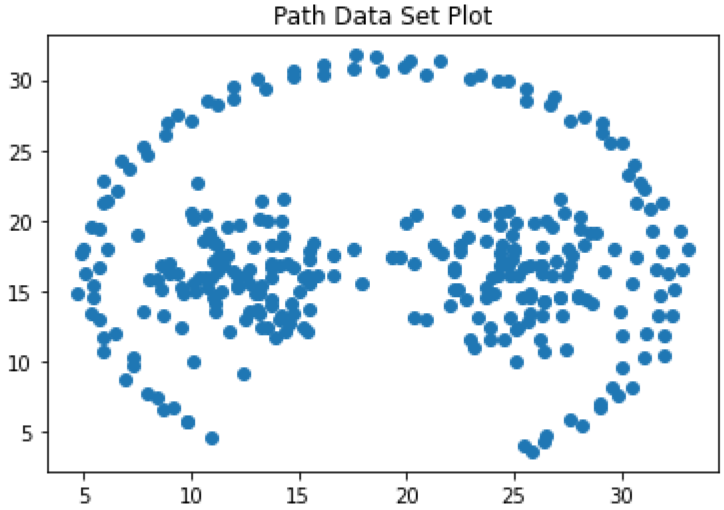
```
Spiral Data Set
```

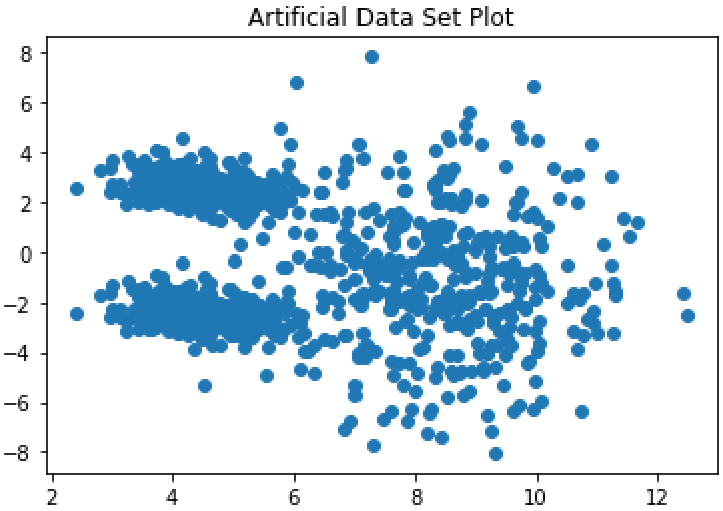
Out[7]:

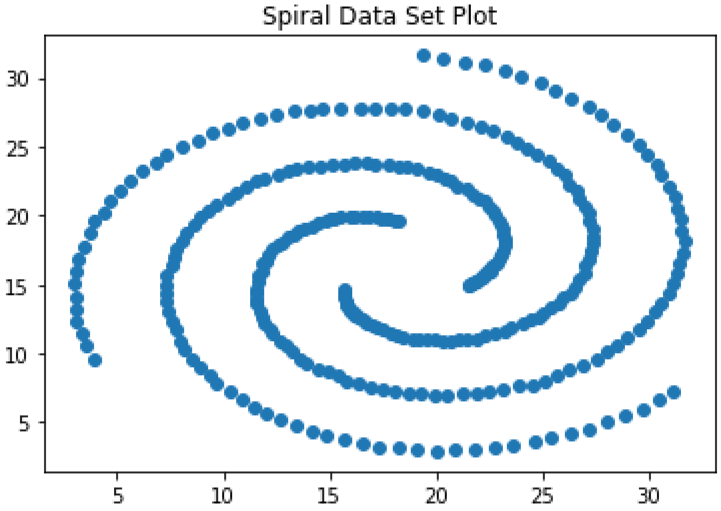
	31.95	7.95	3
0	31.15	7.30	3
1	30.45	6.65	3
2	29.70	6.00	3
3	28.90	5.55	3
4	28.05	5.00	3

In [8]:

```
# from IPython.core.display import display, HTML
# display(HTML("<style>.container { width:100% !important; }</style>"))
# display(HTML("<style>.output_result { max-width:100% !important; }</style>"))
# plotting the original data using Matplot lib

plt.title('Path Data Set Plot')
plt.scatter(X_path.iloc[:,0], X_path.iloc[:,1])
plt.show()


# plt.subplot(1,2,2)
plt.title('Artificial Data Set Plot')
plt.scatter(X_artf.iloc[:,0], X_artf.iloc[:,1])
plt.show()

plt.title('Spiral Data Set Plot')
plt.scatter(X_spir.iloc[:,0], X_spir.iloc[:,1])
plt.show()
```







K Mean

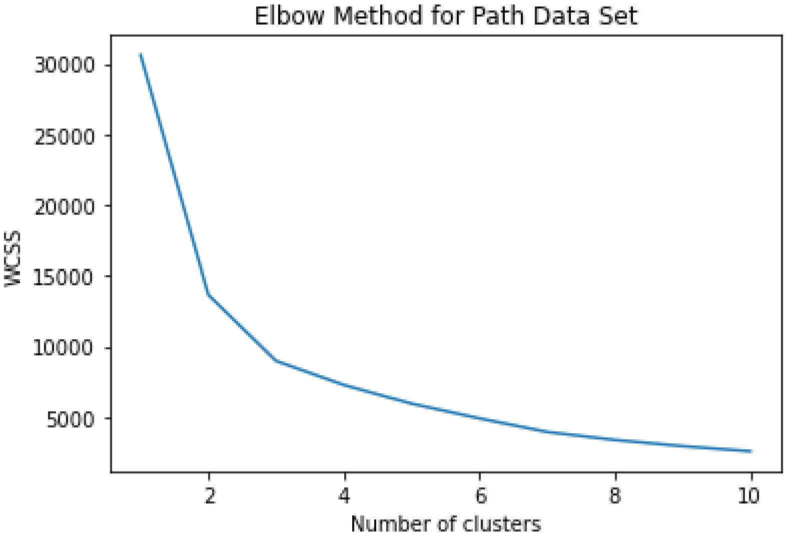
In [9]:

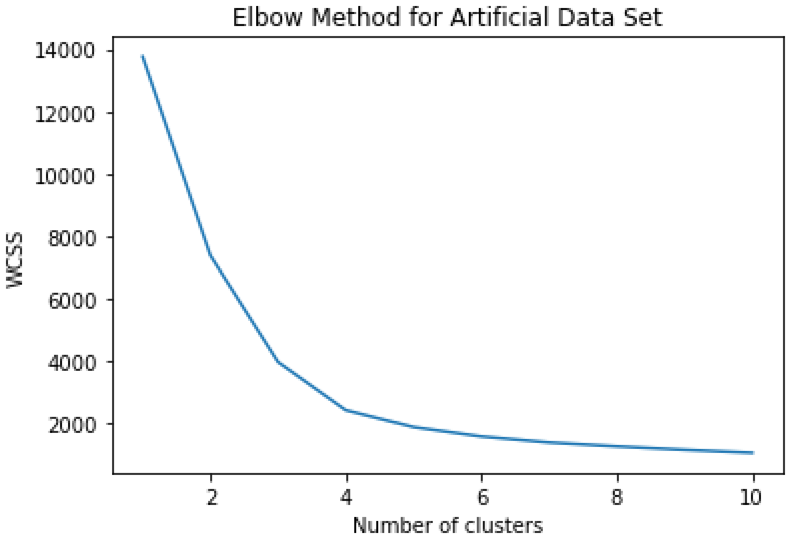
```
# to Choose the right number of clusters / optimal value for K used Elbow Method
# if we didn't know about the centers, then we could use Elbow Method
# it works fine in some of the cases. to determine the correct number of clusters.
# In this cell i have visualize the relationship between the number of clusters and
# Within Cluster Sum of Squares (WCSS) then we select the number
# of clusters where the change in WCSS begins to level off i.e 3/4 in our case
```

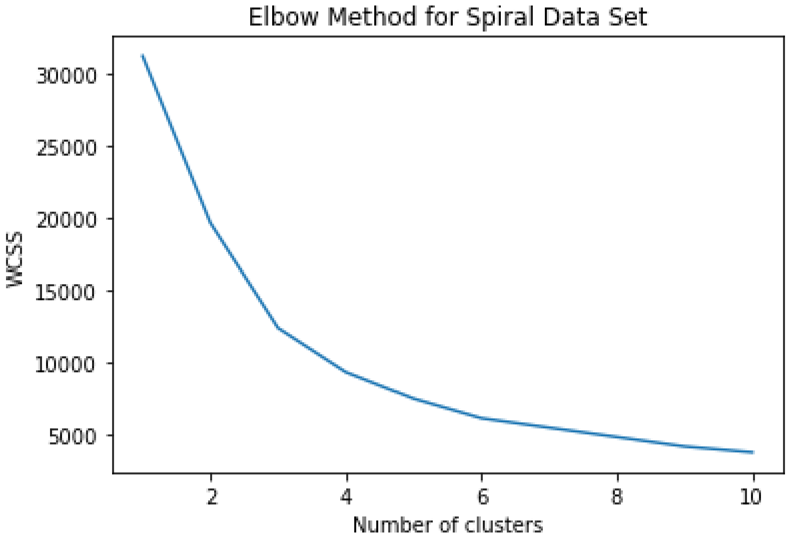
```
def elbow_method_kmean(X,title):

    wcss = []
    for i in range(1, 11):
        kmeans = KMeans(n_clusters=i, init='k-means++', max_iter=300, n_init=10, random_state=0)
        kmeans.fit(X)
        wcss.append(kmeans.inertia_)
    plt.plot(range(1, 11), wcss)
    plt.title('Elbow Method for '+title)
    plt.xlabel('Number of clusters')
    plt.ylabel('WCSS')
    plt.show()
```

In [10]:

```
elbow_method_kmean(X_path,'Path Data Set')
elbow_method_kmean(X_artf,'Artificial Data Set')
elbow_method_kmean(X_spir,'Spiral Data Set')
```







In [11]:

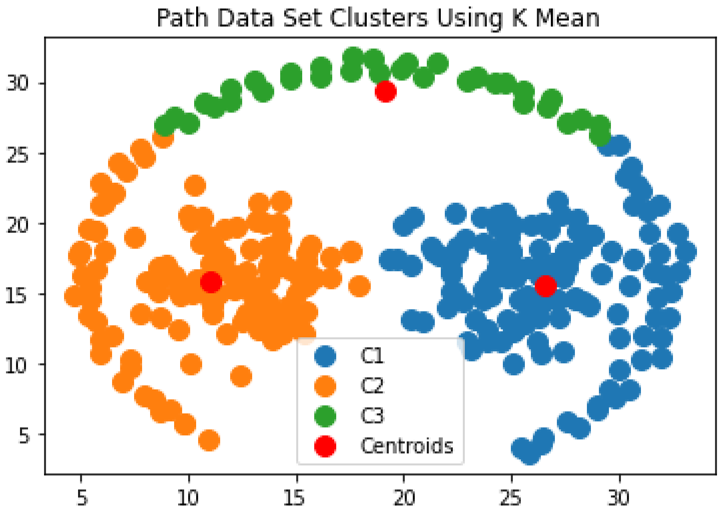
```
# We can see a major bend at K=3 in all of the above graphs indicating 3 is the optimal number of clusters.
K=3
```

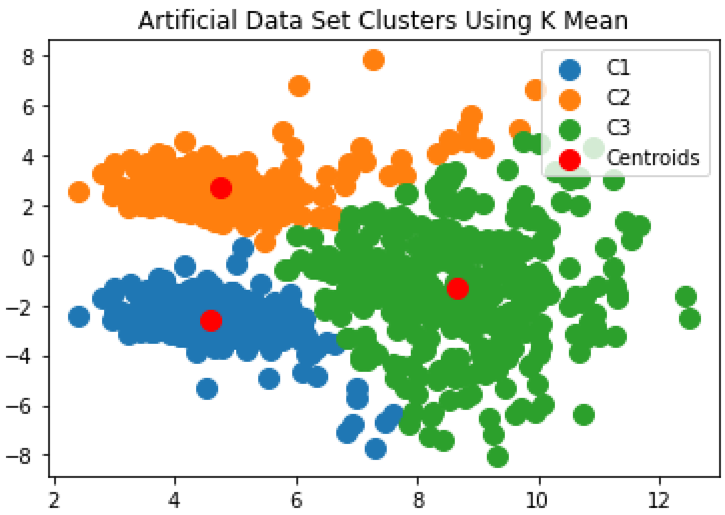
In [12]:

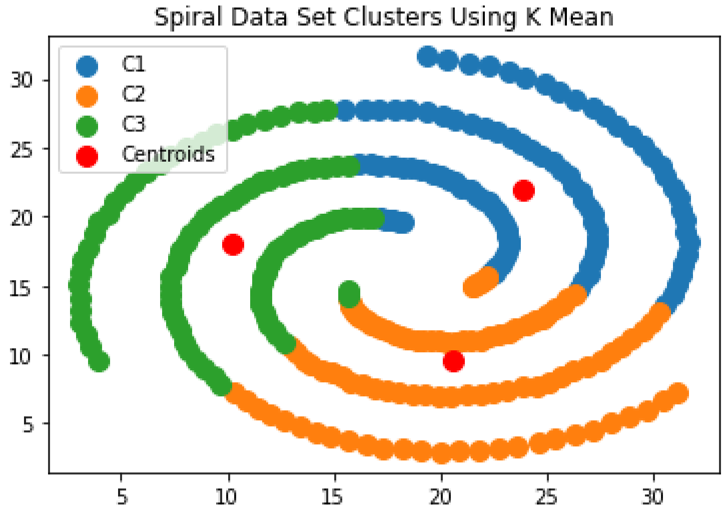
```
# this function is used to implement k means on using sklearn library
def kmean_sklearn(K,X,label):
    # k-means++ ensures that you get don’t fall into the random initialization trap.
    kmeans = KMeans(n_clusters=K, init='k-means++', max_iter=300, n_init=10, random_state=0)
    pred_y = kmeans.fit_predict(X)
    for i in range(K):
        plt.scatter(X.iloc[pred_y==i,0], X.iloc[pred_y==i,1], s = 100, label = 'C'+str(i+1))


    plt.title(label+' Data Set Clusters Using K Mean')
    plt.scatter(kmeans.cluster_centers_[:, 0], kmeans.cluster_centers_[:, 1], s=100, c='red',label = 'Centroid
    plt.legend()
    plt.show()
    return kmeans.cluster_centers_,pred_y
```

In [13]:

```
center_path,ykmean_path = kmean_sklearn(K,X_path,'Path')
center_artf,ykmean_artf = kmean_sklearn(K,X_artf,'Artificial')
center_spir,ykmean_spir = kmean_sklearn(K,X_spir,'Spiral')
```







K Mode

In [14]:

```
# Elbow curve to find optimal K in case of K-Mode
def elbow_method_kmode(X,title):
    cost = []
    k_list = range(1,11)
    for i in list(k_list):
        kmode = KModes(n_clusters=i, init = "random", n_init = 5, verbose=1)
        kmode.fit_predict(X)
        cost.append(kmode.cost_)

    plt.plot(k_list, cost, 'bx-')
    plt.xlabel('No. of clusters')
    plt.ylabel('Cost')
    plt.title('Elbow Method For Optimal k '+title)
    plt.show()
```

In [15]:

```
# We can see a bend at K=3 in the above graph indicating 3 is the optimal number of clusters.
```

In [16]:

```
elbow_method_kmode(X_path,'Path Data Set')
elbow_method_kmode(X_artf,'Artificial Data Set')
elbow_method_kmode(X_spir,'Spiral Data Set')
```

```
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 0, cost: 778.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 0, cost: 778.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 0, cost: 778.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 0, cost: 778.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 0, cost: 778.0
Best run was number 1
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 0, cost: 677.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
```

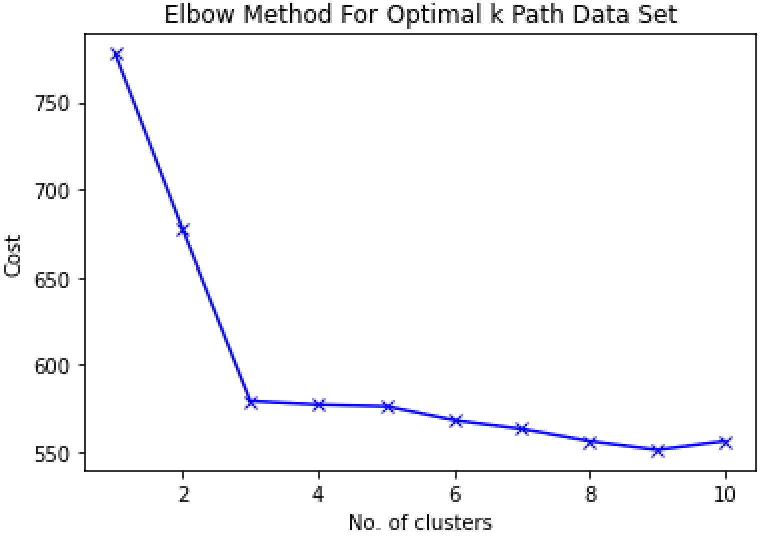
```
Run 2, iteration: 1/100, moves: 1, cost: 776.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 0, cost: 677.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 0, cost: 677.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 87, cost: 682.0
Run 5, iteration: 2/100, moves: 1, cost: 682.0
Best run was number 1
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 0, cost: 579.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 0, cost: 677.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 89, cost: 679.0
Run 3, iteration: 2/100, moves: 0, cost: 679.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 0, cost: 579.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 85, cost: 581.0
Run 5, iteration: 2/100, moves: 0, cost: 581.0
Best run was number 1
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 85, cost: 580.0
Run 1, iteration: 2/100, moves: 0, cost: 580.0
Init: initializing centroids
Init: initializing clusters
```

```
Starting iterations...
Run 2, iteration: 1/100, moves: 81, cost: 579.0
Run 2, iteration: 2/100, moves: 0, cost: 579.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 0, cost: 672.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 0, cost: 577.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 0, cost: 577.0
Best run was number 4
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 0, cost: 667.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 0, cost: 672.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 2, cost: 576.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 84, cost: 580.0
Run 4, iteration: 2/100, moves: 1, cost: 580.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 1, cost: 665.0
Run 5, iteration: 2/100, moves: 1, cost: 665.0
Best run was number 3
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 0, cost: 569.0
Init: initializing centroids
Init: initializing clusters
```

```
Starting iterations...
Run 2, iteration: 1/100, moves: 2, cost: 569.0
Run 2, iteration: 2/100, moves: 0, cost: 569.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 86, cost: 573.0
Run 3, iteration: 2/100, moves: 0, cost: 573.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 0, cost: 570.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 88, cost: 568.0
Run 5, iteration: 2/100, moves: 0, cost: 568.0
Best run was number 5
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 4, cost: 563.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 0, cost: 564.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 89, cost: 568.0
Run 3, iteration: 2/100, moves: 1, cost: 568.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 1, cost: 571.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 85, cost: 574.0
Run 5, iteration: 2/100, moves: 0, cost: 574.0
Best run was number 1
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 1, cost: 558.0
```

```
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 3, cost: 562.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 1, cost: 567.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 85, cost: 556.0
Run 4, iteration: 2/100, moves: 0, cost: 556.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 0, cost: 564.0
Best run was number 4
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 105, cost: 562.0
Run 1, iteration: 2/100, moves: 2, cost: 562.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 104, cost: 562.0
Run 2, iteration: 2/100, moves: 0, cost: 562.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 0, cost: 565.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 1, cost: 560.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 163, cost: 551.0
Run 5, iteration: 2/100, moves: 0, cost: 551.0
Best run was number 5
Init: initializing centroids
Init: initializing clusters
Starting iterations...
```

```
Run 1, iteration: 1/100, moves: 0, cost: 561.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 105, cost: 556.0
Run 2, iteration: 2/100, moves: 0, cost: 556.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 1, cost: 557.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 1, cost: 558.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 2, cost: 556.0
Best run was number 2
```



```
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 0, cost: 2598.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 0, cost: 2598.0
Init: initializing centroids
```

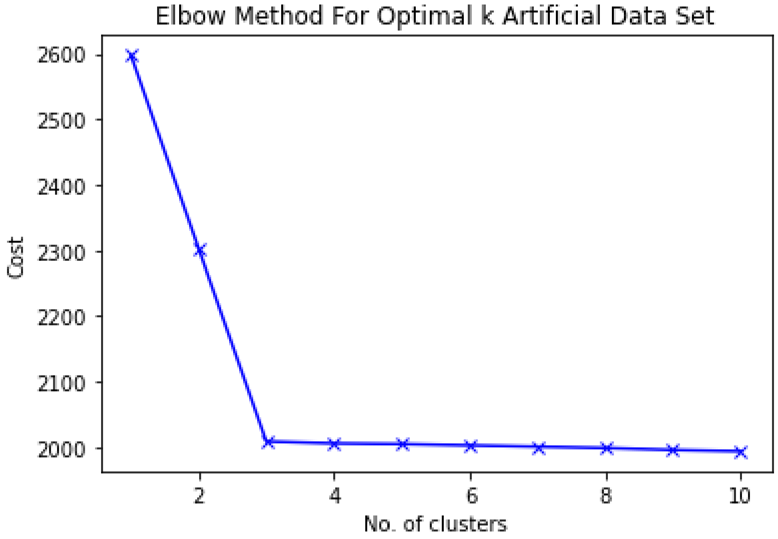
```
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 0, cost: 2598.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 0, cost: 2598.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 0, cost: 2598.0
Best run was number 1
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 0, cost: 2303.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 0, cost: 2303.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 2, cost: 2304.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 0, cost: 2596.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 0, cost: 2596.0
Best run was number 1
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 0, cost: 2009.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 0, cost: 2009.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 0, cost: 2594.0
```

```
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 0, cost: 2009.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 3, cost: 2300.0
Best run was number 1
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 0, cost: 2007.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 0, cost: 2007.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 289, cost: 2298.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 417, cost: 2297.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 1, cost: 2006.0
Best run was number 5
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 0, cost: 2005.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 0, cost: 2005.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 0, cost: 2005.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
```

```
Run 4, iteration: 1/100, moves: 0, cost: 2005.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 2, cost: 2297.0
Best run was number 1
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 0, cost: 2003.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 0, cost: 2003.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 0, cost: 2003.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 291, cost: 2004.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 0, cost: 2003.0
Best run was number 1
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 0, cost: 2001.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 0, cost: 2001.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 0, cost: 2001.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 0, cost: 2001.0
Init: initializing centroids
Init: initializing clusters
```

```
Starting iterations...
Run 5, iteration: 1/100, moves: 287, cost: 2002.0
Best run was number 1
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 292, cost: 2001.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 0, cost: 1999.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 0, cost: 1999.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 288, cost: 1999.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 0, cost: 1999.0
Best run was number 2
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 0, cost: 1997.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 0, cost: 1997.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 1, cost: 1996.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 0, cost: 1997.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 0, cost: 1997.0
Best run was number 3
```

```
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 0, cost: 1995.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 0, cost: 1995.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 0, cost: 1995.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 0, cost: 1995.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 1, cost: 1994.0
Best run was number 5
```



```
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 0, cost: 818.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
```

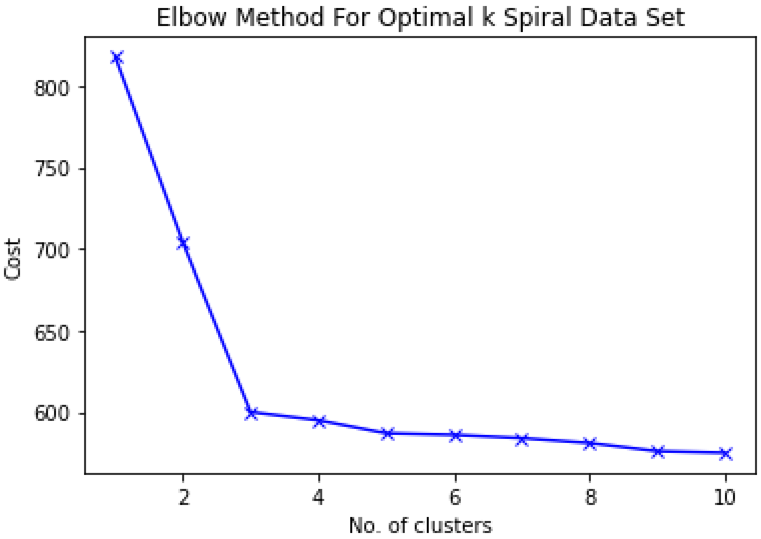
```
Run 2, iteration: 1/100, moves: 0, cost: 818.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 0, cost: 818.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 0, cost: 818.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 0, cost: 818.0
Best run was number 1
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 1, cost: 708.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 104, cost: 704.0
Run 2, iteration: 2/100, moves: 0, cost: 704.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 91, cost: 720.0
Run 3, iteration: 2/100, moves: 0, cost: 720.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 1, cost: 708.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 0, cost: 704.0
Best run was number 2
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 2, cost: 704.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 1, cost: 702.0
```

```
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 90, cost: 606.0
Run 3, iteration: 2/100, moves: 1, cost: 606.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 103, cost: 600.0
Run 4, iteration: 2/100, moves: 0, cost: 600.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 102, cost: 600.0
Run 5, iteration: 2/100, moves: 0, cost: 600.0
Best run was number 4
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 102, cost: 597.0
Run 1, iteration: 2/100, moves: 0, cost: 597.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 96, cost: 602.0
Run 2, iteration: 2/100, moves: 1, cost: 601.0
Run 2, iteration: 3/100, moves: 0, cost: 601.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 2, cost: 595.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 100, cost: 597.0
Run 4, iteration: 2/100, moves: 0, cost: 597.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 89, cost: 595.0
Run 5, iteration: 2/100, moves: 12, cost: 595.0
Best run was number 3
Init: initializing centroids
Init: initializing clusters
Starting iterations...
```

```
Run 1, iteration: 1/100, moves: 0, cost: 591.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 0, cost: 593.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 3, cost: 592.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 94, cost: 588.0
Run 4, iteration: 2/100, moves: 1, cost: 587.0
Run 4, iteration: 3/100, moves: 0, cost: 587.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 3, cost: 593.0
Best run was number 4
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 78, cost: 588.0
Run 1, iteration: 2/100, moves: 19, cost: 588.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 97, cost: 596.0
Run 2, iteration: 2/100, moves: 0, cost: 596.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 1, cost: 589.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 95, cost: 587.0
Run 4, iteration: 2/100, moves: 1, cost: 586.0
Run 4, iteration: 3/100, moves: 0, cost: 586.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 0, cost: 591.0
Best run was number 4
```

```
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 2, cost: 586.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 3, cost: 584.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 99, cost: 585.0
Run 3, iteration: 2/100, moves: 0, cost: 585.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 90, cost: 598.0
Run 4, iteration: 2/100, moves: 1, cost: 598.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 3, cost: 588.0
Best run was number 2
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 3, cost: 582.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 87, cost: 581.0
Run 2, iteration: 2/100, moves: 2, cost: 581.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 1, cost: 585.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 1, cost: 586.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 1, cost: 584.0
Best run was number 2
```

```
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 2, cost: 581.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 86, cost: 586.0
Run 2, iteration: 2/100, moves: 0, cost: 586.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 1, cost: 579.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 3, cost: 576.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 2, cost: 585.0
Best run was number 4
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 1, cost: 578.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 1, cost: 575.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 2, cost: 581.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 2, cost: 579.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 3, cost: 581.0
Best run was number 2
```



In [17]:

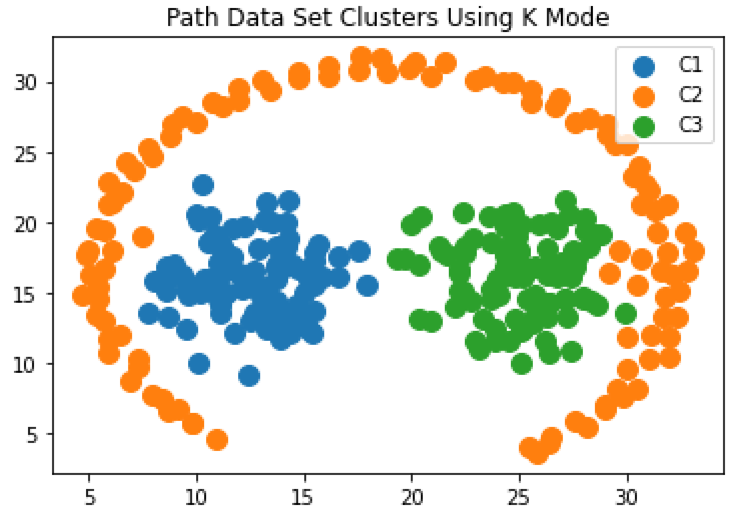
```
def kmode_sklearn(K,X,label='Default'):

    kmode = KModes(n_clusters=K, init = "random", n_init = 10, verbose=1)
    pred_y = kmode.fit_predict(X)

    for i in range(K):
        plt.scatter(X.iloc[pred_y==i,0], X.iloc[pred_y==i,1], s = 100, label = 'C'+str(i+1))
    plt.title(label+' Data Set Clusters Using K Mode')
    plt.legend()
    plt.show()
    return pred_y
```

In [18]:

```
ykmode_path = kmode_sklearn(K,X_path,'Path')
ykmode_artf = kmode_sklearn(K,X_artf,'Artificial')
ykmode_spir = kmode_sklearn(K,X_spir,'Spiral')
```

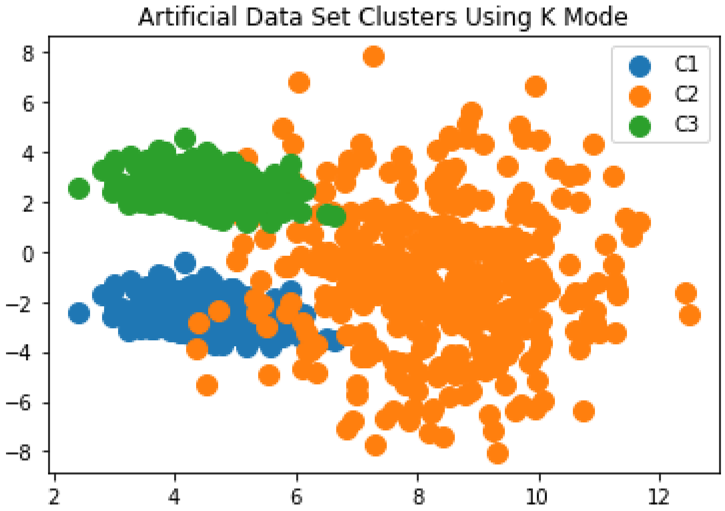
```
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 0, cost: 675.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 87, cost: 585.0
Run 2, iteration: 2/100, moves: 0, cost: 585.0
```

```
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 83, cost: 582.0
Run 3, iteration: 2/100, moves: 0, cost: 582.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 0, cost: 673.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 0, cost: 675.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 6, iteration: 1/100, moves: 0, cost: 673.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 7, iteration: 1/100, moves: 0, cost: 579.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 8, iteration: 1/100, moves: 2, cost: 670.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 9, iteration: 1/100, moves: 1, cost: 579.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 10, iteration: 1/100, moves: 105, cost: 673.0
Run 10, iteration: 2/100, moves: 0, cost: 673.0
Best run was number 7
```



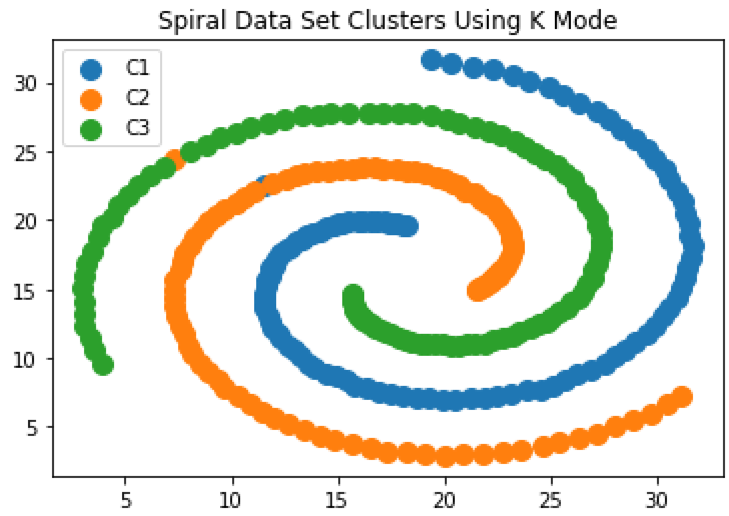
```
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 3, cost: 2300.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 0, cost: 2009.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 0, cost: 2009.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 2, cost: 2302.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 0, cost: 2009.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 6, iteration: 1/100, moves: 3, cost: 2299.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 7, iteration: 1/100, moves: 2, cost: 2302.0
Init: initializing centroids
```

```
Init: initializing clusters
Starting iterations...
Run 8, iteration: 1/100, moves: 0, cost: 2300.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 9, iteration: 1/100, moves: 0, cost: 2009.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 10, iteration: 1/100, moves: 0, cost: 2594.0
Best run was number 2
```



```
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 1, iteration: 1/100, moves: 0, cost: 702.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 2, iteration: 1/100, moves: 1, cost: 704.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 3, iteration: 1/100, moves: 89, cost: 712.0
Run 3, iteration: 2/100, moves: 1, cost: 712.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 4, iteration: 1/100, moves: 1, cost: 703.0
```

```
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 5, iteration: 1/100, moves: 2, cost: 597.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 6, iteration: 1/100, moves: 1, cost: 597.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 7, iteration: 1/100, moves: 195, cost: 606.0
Run 7, iteration: 2/100, moves: 0, cost: 606.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 8, iteration: 1/100, moves: 27, cost: 604.0
Run 8, iteration: 2/100, moves: 72, cost: 603.0
Run 8, iteration: 3/100, moves: 0, cost: 603.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 9, iteration: 1/100, moves: 96, cost: 603.0
Run 9, iteration: 2/100, moves: 1, cost: 603.0
Init: initializing centroids
Init: initializing clusters
Starting iterations...
Run 10, iteration: 1/100, moves: 102, cost: 600.0
Run 10, iteration: 2/100, moves: 0, cost: 600.0
Best run was number 5
```



K Mediod

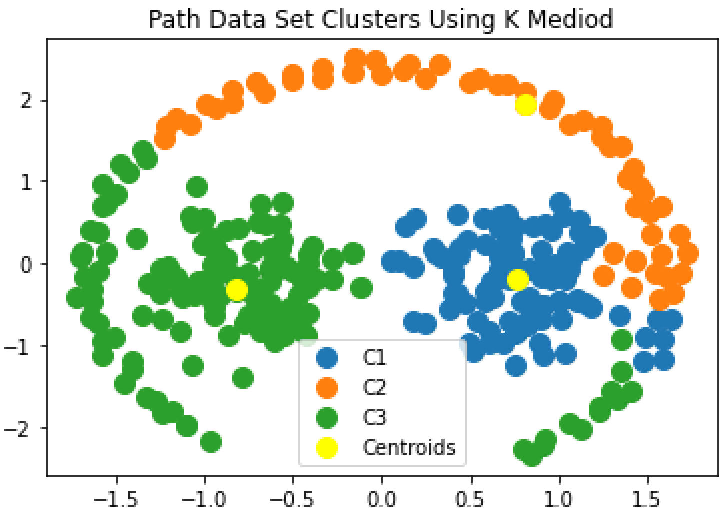
In [19]:
```
# Installing sklearn Extra
!pip install https://github.com/scikit-learn-contrib/scikit-learn-extra/archive/master.zip
```

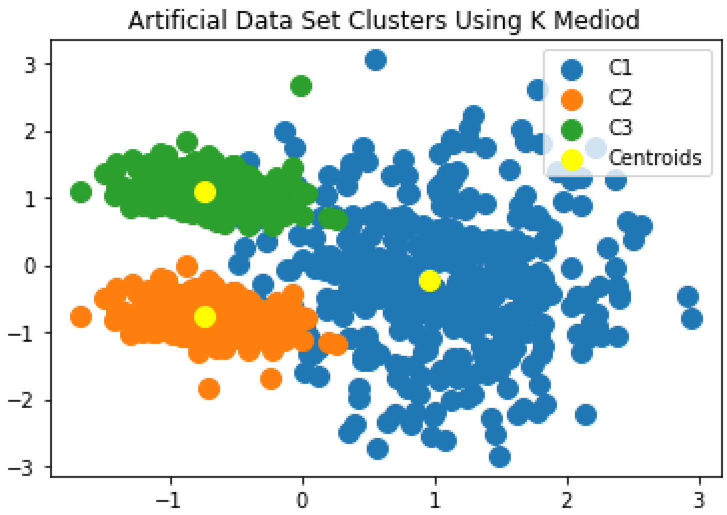
```
Collecting https://github.com/scikit-learn-contrib/scikit-learn-extra/archive/master.zip
  Using cached https://github.com/scikit-learn-contrib/scikit-learn-extra/archive/master.zip
  Installing build dependencies ... done
  Getting requirements to build wheel ... done
    Preparing wheel metadata ... done
Requirement already satisfied: scikit-learn>=0.23.0 in /home/usman/anaconda3/lib/python3.9/site-packages (from
scikit-learn-extra==0.3.0.dev0) (0.24.2)
Requirement already satisfied: numpy>=1.13.3 in /home/usman/anaconda3/lib/python3.9/site-packages (from scikit-
learn-extra==0.3.0.dev0) (1.20.3)
Requirement already satisfied: scipy>=0.19.1 in /home/usman/anaconda3/lib/python3.9/site-packages (from scikit-
learn-extra==0.3.0.dev0) (1.7.1)
Requirement already satisfied: threadpoolctl>=2.0.0 in /home/usman/anaconda3/lib/python3.9/site-packages (from
scikit-learn>=0.23.0->scikit-learn-extra==0.3.0.dev0) (2.2.0)
Requirement already satisfied: joblib>=0.11 in /home/usman/anaconda3/lib/python3.9/site-packages (from scikit-l
earn>=0.23.0->scikit-learn-extra==0.3.0.dev0) (1.1.0)
```

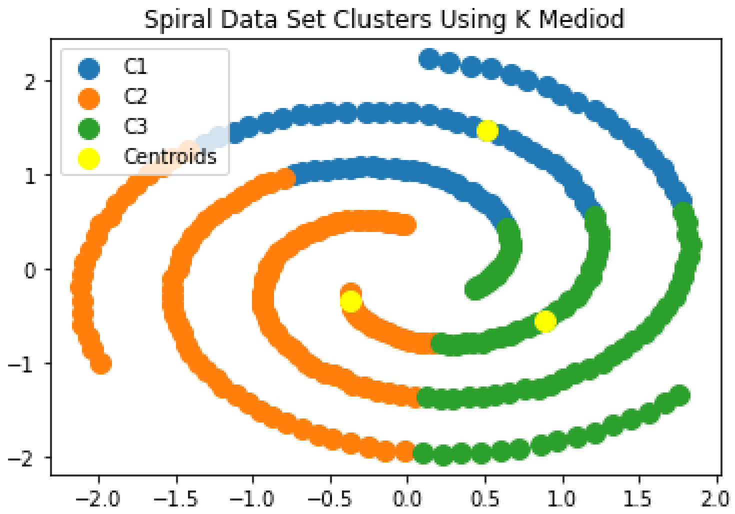
In [20]:
```
# Scaling and Fitting KMedoids
def kmediod_sklearn(K,X,label='Default'):
    scaler = StandardScaler().fit(X)
    x_scaled = scaler.transform(X)
    kmedoids = KMedoids(n_clusters = K, random_state = 0)
    kmedoids.fit(x_scaled)
#     print(kmedoids.inertia_)
    y_kmed = kmedoids.fit_predict(x_scaled)

    # plotting the data with appropriate clusters assigned to data
    for i in range(K):
        plt.scatter(x_scaled[y_kmed == i, 0], x_scaled[y_kmed == i, 1], s = 100, label = 'C'+str(i+1))

    plt.scatter(kmedoids.cluster_centers_[:, 0], kmedoids.cluster_centers_[:,1], s = 100, c = 'yellow', label =
    plt.title(label+' Data Set Clusters Using K Mediod')
    plt.legend()
    plt.show()
    return y_kmed,x_scaled
```

In [21]:

```
ykmed_path,x_scaled_path = kmediod_sklearn(K,X_path,'Path')
ykmed_artf,x_scaled_artf = kmediod_sklearn(K,X_artf,'Artificial')
ykmed_spir,x_scaled_spir = kmediod_sklearn(K,X_spir,'Spiral')
```







Evaluations Metrics

Uses the following Methods for Evaluations

1. Silhouette Coefficient
2. Purity
3. Rand Index
4. Calinski-Harabasz Index

5. Davies-Bouldin Index

In [22]:

```
# Creating Nested Dictionaries for tracking the records of different Evaluations
eval_kmean   = {'path':{},'artf':{},'spir':{}}
eval_kmode   = {'path':{},'artf':{},'spir':{}}
eval_kmediod = {'path':{},'artf':{},'spir':{}}
```

In [23]:

```
# 1.Silhouette Coefficient:
# Silhouette Coefficient is bounded between -1 for incorrect clustering and +1 for highly dense clustering.
# Scores around zero indicate overlapping clusters. The score is higher when clusters are dense
# and well separated, which relates to a standard concept of a cluster.

def sihouette_calc(X,y_pred):
    sihouette_avg = sihouette_score(X, y_pred)
#     print(sihouette_avg)
    return sihouette_avg
```

In [24]:

```
eval_kmean['path']['sihouette']   = sihouette_calc(X_path,ykmean_path)
eval_kmode['path']['sihouette']   = sihouette_calc(X_path,ykmode_path)
eval_kmediod['path']['sihouette'] = sihouette_calc(x_scaled_path,ykmed_path)

eval_kmean['artf']['sihouette']   = sihouette_calc(X_artf,ykmean_artf)
eval_kmode['artf']['sihouette']   = sihouette_calc(X_artf,ykmode_artf)
eval_kmediod['artf']['sihouette'] = sihouette_calc(x_scaled_artf,ykmed_artf)

eval_kmean['spir']['sihouette']   = sihouette_calc(X_spir,ykmean_spir)
eval_kmode['spir']['sihouette']   = sihouette_calc(X_spir,ykmode_spir)
eval_kmediod['spir']['sihouette'] = sihouette_calc(x_scaled_spir,ykmed_spir)
```

In [25]:

```
# 2.Computing Purity Score

def purity_score(y_true, y_pred):
    # compute contingency matrix (also called confusion matrix)
    contingency_matrix = metrics.cluster.contingency_matrix(y_true, y_pred)
    # return purity
#     print(np.sum(np.amax(contingency_matrix, axis=0)) / np.sum(contingency_matrix))
    return np.sum(np.amax(contingency_matrix, axis=0)) / np.sum(contingency_matrix)
```

In [26]:

```
eval_kmean['path']['purity']   = purity_score(y_path,ykmean_path)
```

```
eval_kmode['path']['purity']   = purity_score(y_path,ykmode_path)
eval_kmediod['path']['purity'] = purity_score(y_path,ykmed_path)

eval_kmean['artf']['purity']   = purity_score(y_artf,ykmean_artf)
eval_kmode['artf']['purity']   = purity_score(y_artf,ykmode_artf)
eval_kmediod['artf']['purity'] = purity_score(y_artf,ykmed_artf)

eval_kmean['spir']['purity']   = purity_score(y_spir,ykmean_spir)
eval_kmode['spir']['purity']   = purity_score(y_spir,ykmode_spir)
eval_kmediod['spir']['purity'] = purity_score(y_spir,ykmed_spir)
```

In [27]:

```
# 3.Rand Index
# It computes a similarity measure between two clusters by considering all
# pairs of samples and counting pairs that are assigned in the same or different
# clusters in the predicted and true clusterings.
# The RI can range from zero to 1, a perfect match.
```

In [28]:

```
def rand_index(y_true,y_pred):
    from sklearn.metrics.cluster import rand_score
    rand_score = rand_score(y_true, y_pred)
#     print(rand_score)
    return rand_score
```

In [29]:

```
eval_kmean['path']['rand_index']   = rand_index(y_path,ykmean_path)
eval_kmode['path']['rand_index']   = rand_index(y_path,ykmode_path)
eval_kmediod['path']['rand_index'] = rand_index(y_path,ykmed_path)


eval_kmean['artf']['rand_index']   = rand_index(y_artf,ykmean_artf)
eval_kmode['artf']['rand_index']   = rand_index(y_artf,ykmode_artf)
eval_kmediod['artf']['rand_index'] = rand_index(y_artf,ykmed_artf)

eval_kmean['spir']['rand_index']   = rand_index(y_spir,ykmean_spir)
eval_kmode['spir']['rand_index']   = rand_index(y_spir,ykmode_spir)
eval_kmediod['spir']['rand_index'] = rand_index(y_spir,ykmed_spir)
```

In [30]:

```
# 4.Calinski-Harabasz Index
# The score is defined as the ratio between the within-cluster dispersion and the
# between-cluster dispersion.
# The C-H Index is a great way to evaluate the performance of a Clustering algorithm as it does
# not require information on the ground truth labels.
# The higher the Index, the better the performance.
```

In [31]:

```
def calinski_score(X,y_pred):
    from sklearn.metrics.cluster import calinski_harabasz_score
    ch_index = calinski_harabasz_score(X, y_pred)
#     print(ch_index)
    return ch_index
```

In [32]:

```
eval_kmean['path']['calinski_score']   = calinski_score(X_path,ykmean_path)
eval_kmode['path']['calinski_score']   = calinski_score(X_path,ykmode_path)
eval_kmediod['path']['calinski_score'] = calinski_score(x_scaled_path,ykmed_path)


eval_kmean['artf']['calinski_score']   = calinski_score(X_artf,ykmean_artf)
eval_kmode['artf']['calinski_score']   = calinski_score(X_artf,ykmode_artf)
eval_kmediod['artf']['calinski_score'] = calinski_score(x_scaled_artf,ykmed_artf)

eval_kmean['spir']['calinski_score']   = calinski_score(X_spir,ykmean_spir)
eval_kmode['spir']['calinski_score']   = calinski_score(X_spir,ykmode_spir)
eval_kmediod['spir']['calinski_score'] = calinski_score(x_scaled_spir,ykmed_spir)
```

In [33]:

```
# 5.Davies-Bouldin Index
# The minimum score is zero, and differently from most performance metrics,
# the lower values the better clustering performance.
```

In [34]:

```
def davies_score(X,y_pred):

    from sklearn.metrics.cluster import davies_bouldin_score
    db_index = davies_bouldin_score(X, y_pred)
#     print(db_index)
    return db_index
```

In [35]:

```
eval_kmean['path']['davies_score']   = davies_score(X_path,ykmean_path)
eval_kmode['path']['davies_score']   = davies_score(X_path,ykmode_path)
eval_kmediod['path']['davies_score'] = davies_score(x_scaled_path,ykmed_path)
```

```
eval_kmean['artf']['davies_score']   = davies_score(X_artf,ykmean_artf)
eval_kmode['artf']['davies_score']   = davies_score(X_artf,ykmode_artf)
eval_kmediod['artf']['davies_score'] = davies_score(x_scaled_artf,ykmed_artf)

eval_kmean['spir']['davies_score']   = davies_score(X_spir,ykmean_spir)
eval_kmode['spir']['davies_score']   = davies_score(X_spir,ykmode_spir)
eval_kmediod['spir']['davies_score'] = davies_score(x_scaled_spir,ykmed_spir)
```

In [36]:

```
# scaling down the calinski_score by dividing 150 scalar values so that the graph could be visualized properly
eval_kmean['path']['calinski_score']   = eval_kmean['path']['calinski_score']/150
eval_kmode['path']['calinski_score']   = eval_kmode['path']['calinski_score']/150
eval_kmediod['path']['calinski_score'] = eval_kmediod['path']['calinski_score']/150

eval_kmean['artf']['calinski_score']   = eval_kmean['artf']['calinski_score']/150
eval_kmode['artf']['calinski_score']   = eval_kmode['artf']['calinski_score']/150
eval_kmediod['artf']['calinski_score'] = eval_kmediod['artf']['calinski_score']/150

eval_kmean['spir']['calinski_score']   = eval_kmean['spir']['calinski_score']/150
eval_kmode['spir']['calinski_score']   = eval_kmode['spir']['calinski_score']/150
eval_kmediod['spir']['calinski_score'] = eval_kmediod['spir']['calinski_score']/150
```

In [37]:

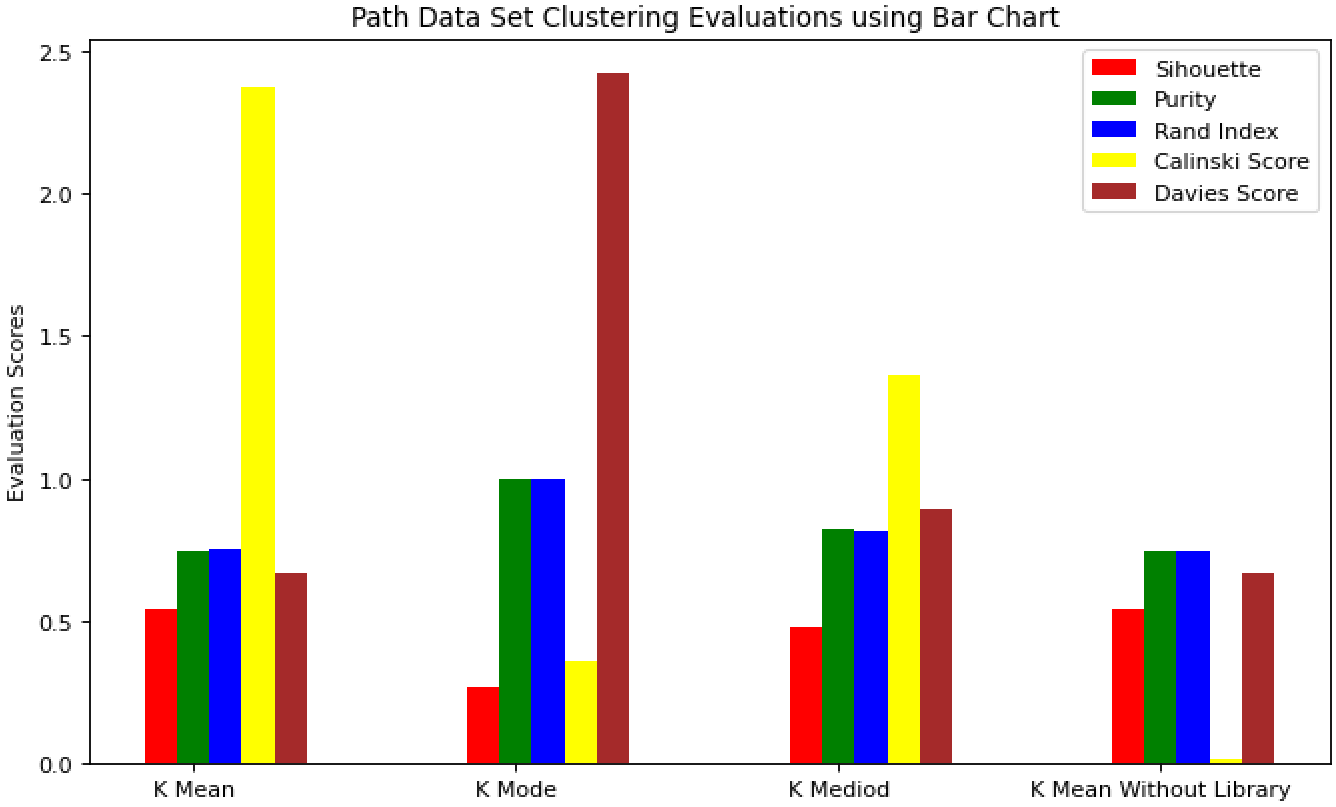
```
# reading evaluations got using K mean without library function in another notebook
with open('convert.txt') as f:
    data = f.read()


# reconstructing the data as a dictionary
w_eval = json.loads(data)

w_eval
```

Out[37]:

```
{'path': {'sihouette': 0.5420275543619765,
  'purity': 0.7433333333333333,
  'rand_index': 0.7477814938684504,
  'calinski_score': 0.01595704857846857,
  'davies_score': 0.6662412952246745},
 'artf': {'sihouette': 0.5492679494658761,
  'rand_index': 0.8593255934683091,
  'calinski_score': 0.05641706432730371,
  'davies_score': 0.6986488218381682,
  'purity': 0.8870168483647175},
 'spir': {'sihouette': 0.36141515270397445,
  'rand_index': 0.5541058619836755,
  'calinski_score': 0.010556675439449131,
  'davies_score': 0.8892926294746718,
  'purity': 0.34615384615384615}}
```

In [41]:

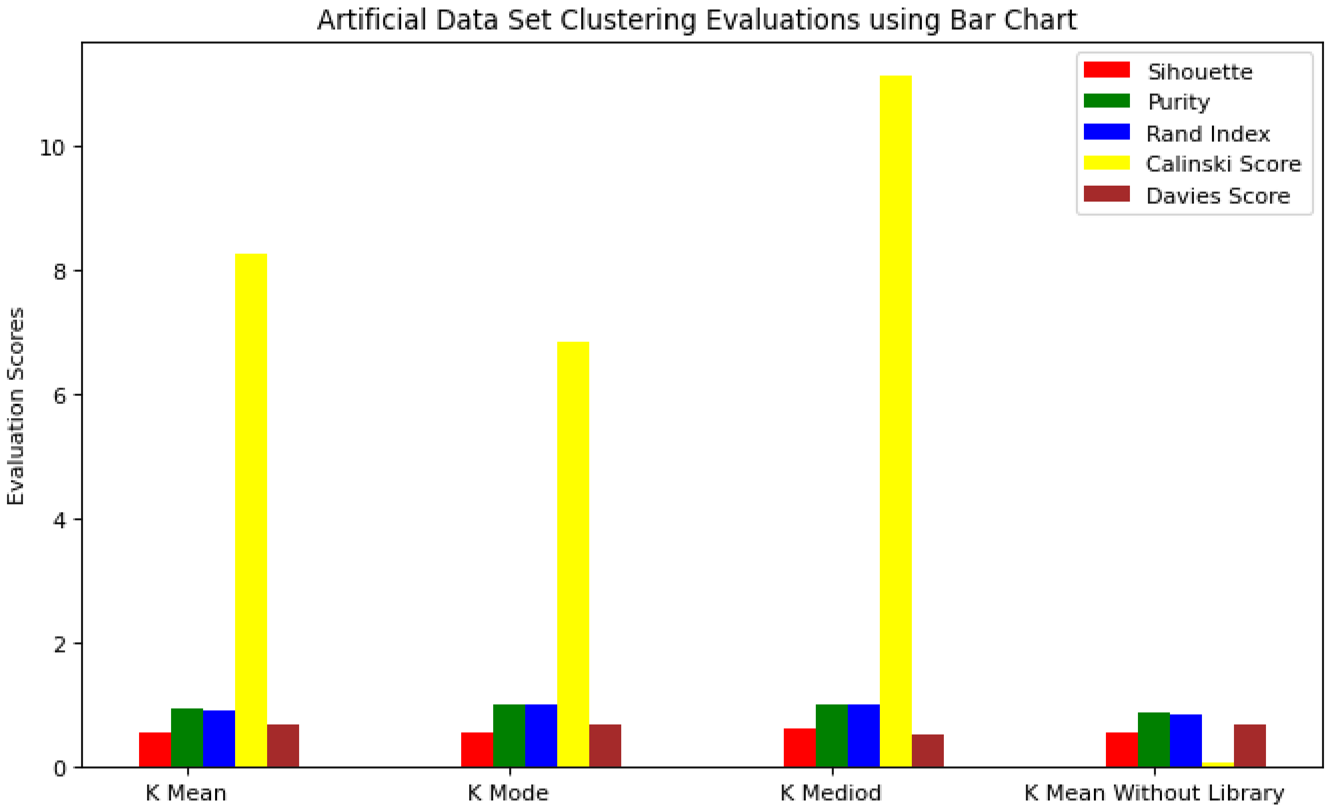
```
# Path Data Set Evaluation Bar Chart
N = 4
ind = np.arange(N)
width = 0.1

avals = []
avals.append(eval_kmean['path']['sihouette'])
avals.append(eval_kmode['path']['sihouette'])
avals.append(eval_kmediod['path']['sihouette'])
avals.append(w_eval['path']['sihouette'])

bar1 = plt.bar(ind, avals, width, color = 'r')

bvals = []
bvals.append(eval_kmean['path']['purity'])
bvals.append(eval_kmode['path']['purity'])
bvals.append(eval_kmediod['path']['purity'])
bvals.append(w_eval['path']['purity'])


bar2 = plt.bar(ind+width, bvals, width, color='g')

cvals = []
cvals.append(eval_kmean['path']['rand_index'])
cvals.append(eval_kmode['path']['rand_index'])
cvals.append(eval_kmediod['path']['rand_index'])
cvals.append(w_eval['path']['rand_index'])

bar3 = plt.bar(ind+width*2, cvals, width, color = 'b')

dvals = []
dvals.append(eval_kmean['path']['calinski_score'])
dvals.append(eval_kmode['path']['calinski_score'])
dvals.append(eval_kmediod['path']['calinski_score'])
dvals.append(w_eval['path']['calinski_score'])

bar4 = plt.bar(ind+width*3, dvals, width, color = 'yellow')

evals = []
evals.append(eval_kmean['path']['davies_score'])
evals.append(eval_kmode['path']['davies_score'])
evals.append(eval_kmediod['path']['davies_score'])
evals.append(w_eval['path']['davies_score'])

bar5 = plt.bar(ind+width*4, evals, width, color = 'brown')


# plt.xlabel("Algorithms")
plt.ylabel('Evaluation Scores')
plt.title("Path Data Set Clustering Evaluations using Bar Chart ")

plt.xticks(ind+width,['K Mean', 'K Mode', 'K Mediod','K Mean Without Library'])
plt.legend((bar1, bar2, bar3,bar4,bar5), ('Sihouette', 'Purity', 'Rand Index','Calinski Score','Davies Score')
plt.rcParams.update({'figure.figsize':(10,6), 'figure.dpi':80})
plt.show()
```



```
In [43]:
# Artificial Data Set Evaluation Bar Chart
N = 4
```

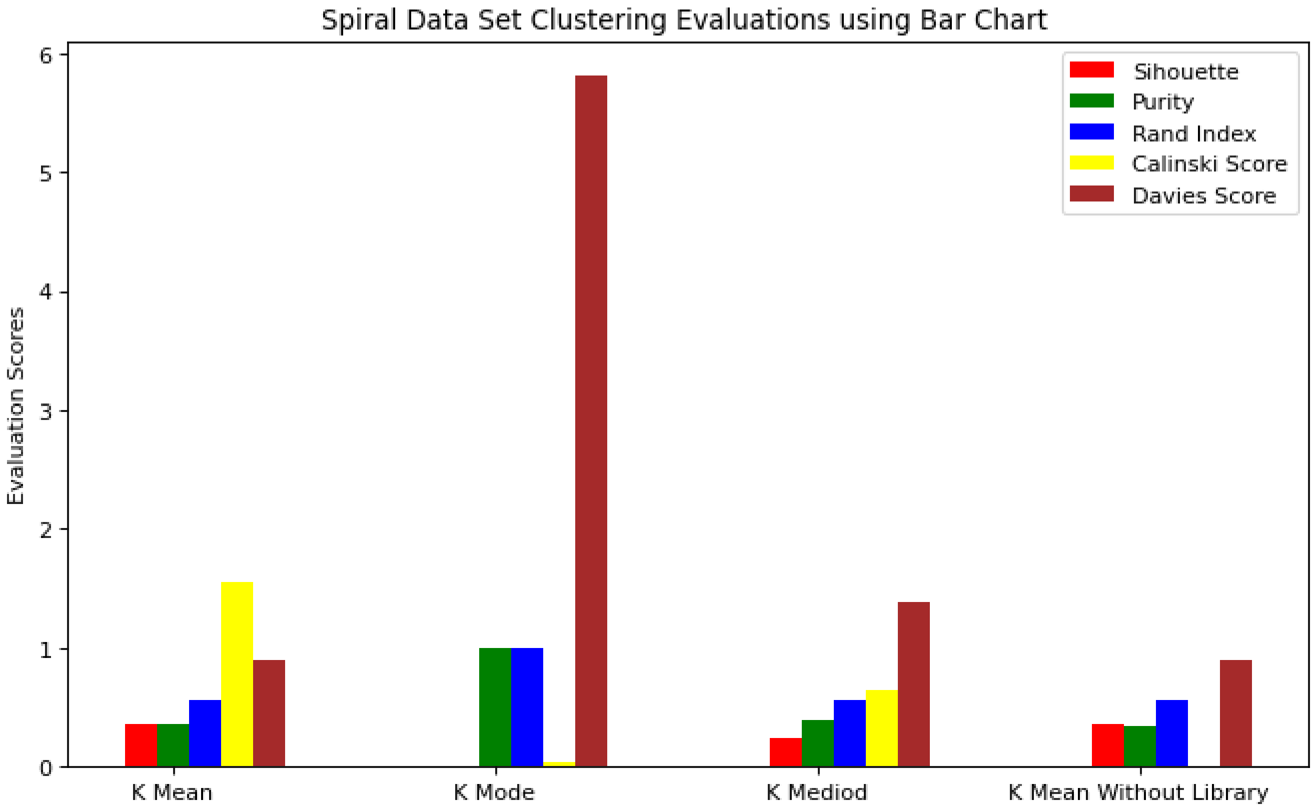
```
ind = np.arange(N)
width = 0.1

avals = []
avals.append(eval_kmean['artf']['sihouette'])
avals.append(eval_kmode['artf']['sihouette'])
avals.append(eval_kmediod['artf']['sihouette'])
avals.append(w_eval['artf']['sihouette'])

bar1 = plt.bar(ind, avals, width, color = 'r')

bvals = []
bvals.append(eval_kmean['artf']['purity'])
bvals.append(eval_kmode['artf']['purity'])
bvals.append(eval_kmediod['artf']['purity'])
bvals.append(w_eval['artf']['purity'])


bar2 = plt.bar(ind+width, bvals, width, color='g')

cvals = []
cvals.append(eval_kmean['artf']['rand_index'])
cvals.append(eval_kmode['artf']['rand_index'])
cvals.append(eval_kmediod['artf']['rand_index'])
cvals.append(w_eval['artf']['rand_index'])

bar3 = plt.bar(ind+width*2, cvals, width, color = 'b')

dvals = []
dvals.append(eval_kmean['artf']['calinski_score'])
dvals.append(eval_kmode['artf']['calinski_score'])
dvals.append(eval_kmediod['artf']['calinski_score'])
dvals.append(w_eval['artf']['calinski_score'])

bar4 = plt.bar(ind+width*3, dvals, width, color = 'yellow')

evals = []
evals.append(eval_kmean['artf']['davies_score'])
evals.append(eval_kmode['artf']['davies_score'])
evals.append(eval_kmediod['artf']['davies_score'])
evals.append(w_eval['artf']['davies_score'])

bar5 = plt.bar(ind+width*4, evals, width, color = 'brown')
```

```
# plt.xlabel("Algorithms")
plt.ylabel('Evaluation Scores')
plt.title("Artificial Data Set Clustering Evaluations using Bar Chart ")


plt.xticks(ind+width,['K Mean', 'K Mode', 'K Mediod','K Mean Without Library'])
plt.legend((bar1, bar2, bar3,bar4,bar5), ('Sihouette', 'Purity', 'Rand Index','Calinski Score','Davies Score')
plt.rcParams.update({'figure.figsize':(10,6), 'figure.dpi':80})
plt.show()
```



In [40]:

```
# Spiral Data Set Evaluation Bar Chart
N = 4
ind = np.arange(N)
width = 0.1

avals = []
avals.append(eval_kmean['spir']['sihouette'])
avals.append(eval_kmode['spir']['sihouette'])
avals.append(eval_kmediod['spir']['sihouette'])
avals.append(w_eval['spir']['sihouette'])

bar1 = plt.bar(ind, avals, width, color = 'r')

bvals = []
bvals.append(eval_kmean['spir']['purity'])
bvals.append(eval_kmode['spir']['purity'])
bvals.append(eval_kmediod['spir']['purity'])
bvals.append(w_eval['spir']['purity'])


bar2 = plt.bar(ind+width, bvals, width, color='g')

cvals = []
cvals.append(eval_kmean['spir']['rand_index'])
cvals.append(eval_kmode['spir']['rand_index'])
cvals.append(eval_kmediod['spir']['rand_index'])
cvals.append(w_eval['spir']['rand_index'])

bar3 = plt.bar(ind+width*2, cvals, width, color = 'b')

dvals = []
dvals.append(eval_kmean['spir']['calinski_score'])
dvals.append(eval_kmode['spir']['calinski_score'])
dvals.append(eval_kmediod['spir']['calinski_score'])
dvals.append(w_eval['spir']['calinski_score'])

bar4 = plt.bar(ind+width*3, dvals, width, color = 'yellow')

evals = []
evals.append(eval_kmean['spir']['davies_score'])
evals.append(eval_kmode['spir']['davies_score'])
evals.append(eval_kmediod['spir']['davies_score'])
evals.append(w_eval['spir']['davies_score'])

bar5 = plt.bar(ind+width*4, evals, width, color = 'brown')


# plt.xlabel("Algorithms")
plt.ylabel('Evaluation Scores')
plt.title("Spiral Data Set Clustering Evaluations using Bar Chart ")
plt.xticks(ind+width,['K Mean', 'K Mode', 'K Mediod','K Mean Without Library'])
plt.legend((bar1, bar2, bar3,bar4,bar5), ('Sihouette', 'Purity', 'Rand Index','Calinski Score','Davies Score'))
plt.rcParams.update({'figure.figsize':(10,6), 'figure.dpi':80})
plt.show()
```



In [48]:

```
eval_kmediod
```

Out[48]:

```
{'path': {'sihouette': 0.479262149547105,
  'purity': 0.822742474916388,
  'rand_index': 0.8121927678391058,
  'calinski_score': 1.3627150656615774,
  'davies_score': 0.8946031887902232},
 'artf': {'sihouette': 0.621183442371943,
  'purity': 0.9940476190476191,
  'rand_index': 0.9916201667691241,
  'calinski_score': 11.135531590084328,
  'davies_score': 0.5322085412775556},
 'spir': {'sihouette': 0.23832972009069942,
  'purity': 0.39228295819935693,
  'rand_index': 0.5516855098018878,
  'calinski_score': 0.6502060708239539,
  'davies_score': 1.3828544796908826}}
```

```
In [ ]:
```