21200889_assignment_2_task2

May 28, 2022

1 NOTE: Some warning messages take too much space. To traverse using ctrl-f and look for the word 'Apple'

Code Based on:

scikit-fuzzy (n.d.) Fuzzy c-means clustering. Available at: https://pythonhosted.org/scikit-fuzzy/auto_examples/plot_cmeans.html Accessed (18 March 2022)

scikit -learn (n.d.) Demo of DBSCAN clustering algorithm. Available at: https://scikit-learn.org/stable/auto_examples/cluster/plot_dbscan.html#sphx-glr-auto-examples-cluster-plot-dbscan-py Accessed (19 March 2022)

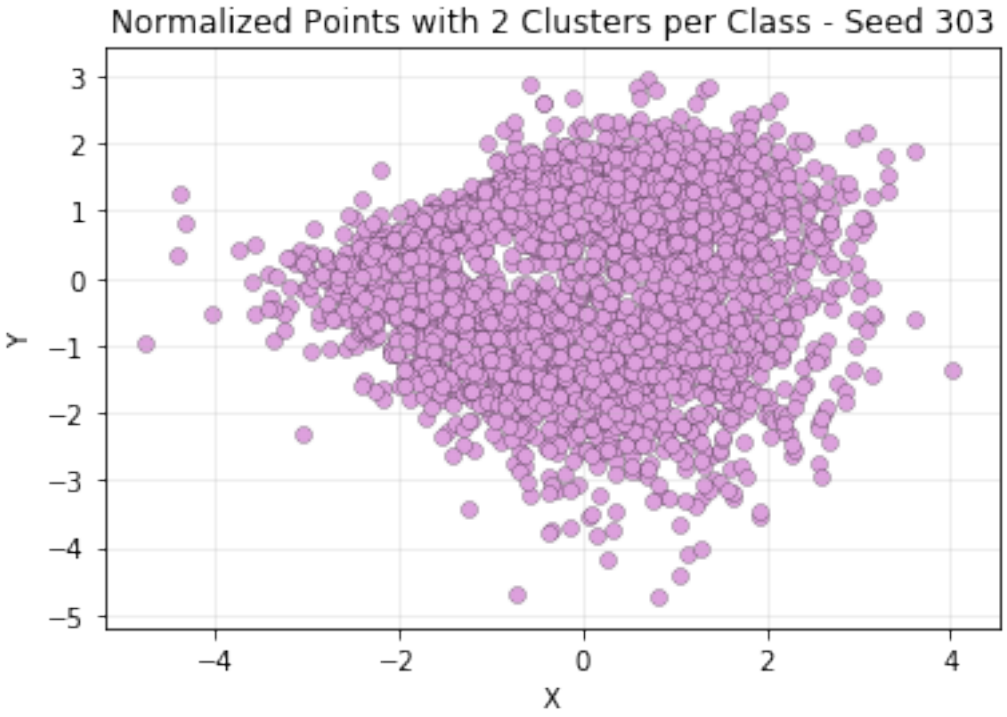
Ruane, E. (2022) assignment_2 Jupyter Notebook.

[3]:
```
#Apple
#Required for installing skfuzzy
#pip install -U scikit-fuzzy
```

[4]:
```
#Apple
#Imports based on Ruane (2022)
import numpy as np
from numpy import unique  # can also just use np.unique
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
from sklearn.cluster import KMeans
from sklearn.preprocessing import MinMaxScaler
from sklearn.datasets import make_classification
from sklearn.cluster import DBSCAN
import skfuzzy as fuzz
```

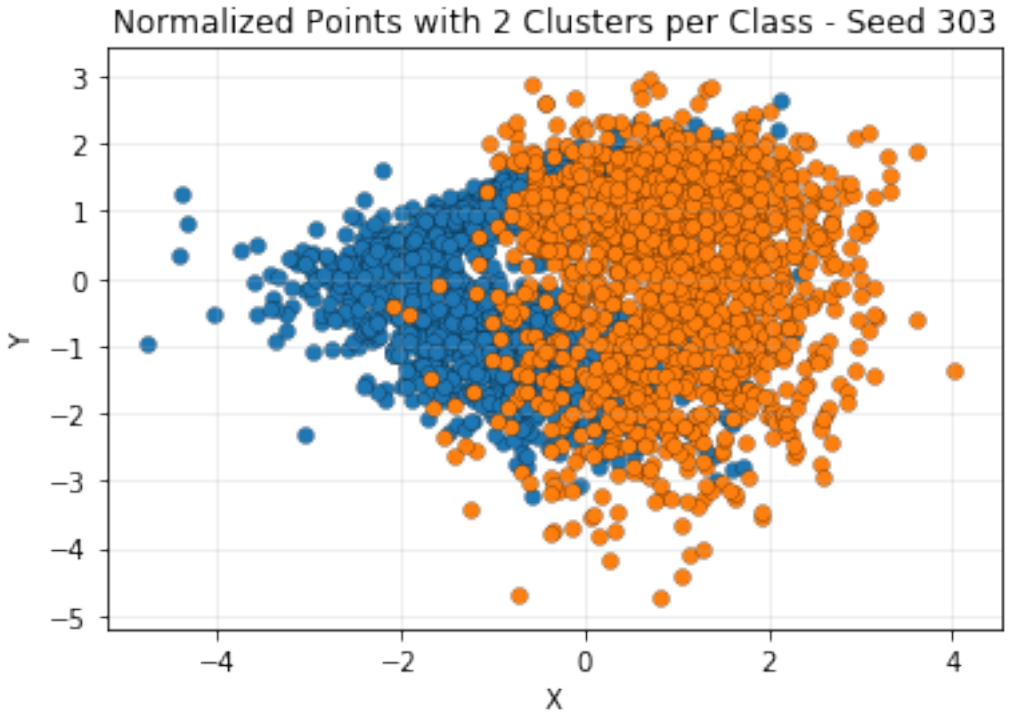
[5]:
```
#Apple
# Define dataset. Based on Ruane(2022)
data_values, class_labels = make_classification(n_samples=3000, n_features=2,
                                                n_informative=2, n_redundant=0,
                                                n_classes = 2,␣
 ↪n_clusters_per_class=2,
                                                random_state= 303)
```

[6]:
```
#Apple
# Scatter plot without showing clusters
# Create scatter plot for samples from each class. Based on Ruane (2022)
for class_value in range(len(unique(class_labels))):
    # get row indexes for samples with this class
    row_ix = np.where(class_labels == class_value)
    # create scatter of these samples
    plt.scatter(data_values[row_ix, 0], data_values[row_ix, 1], c = "plum",␣
 ↪linewidths = 0.2, edgecolors = "black")
# show the plot
plt.xlabel("X")
plt.ylabel("Y")
plt.title("Normalized Points with 2 Clusters per Class - Seed 303")
plt.grid(True, alpha = 0.25)
plt.show()
```



[7]:
```
#Apple
# Scatter plot showing clusters
# Create scatter plot for samples from each class. Based on Ruane (2022)
for class_value in range(len(unique(class_labels))):
    # get row indexes for samples with this class
    row_ix = np.where(class_labels == class_value)
    # create scatter of these samples
```

```
    plt.scatter(data_values[row_ix, 0], data_values[row_ix, 1], linewidths = 0.
↪2, edgecolors = "black")
# show the plot
plt.xlabel("X")
plt.ylabel("Y")
plt.title("Normalized Points with 2 Clusters per Class - Seed 303")
plt.grid(True, alpha = 0.25)
plt.show()
```



[8]:
```
#Apple
#Creating a DataFrame for later purposes
k_frame = pd.DataFrame(data_values, columns = ["x", "y"])
k_frame.sort_values(by = "x")
```

[8]:

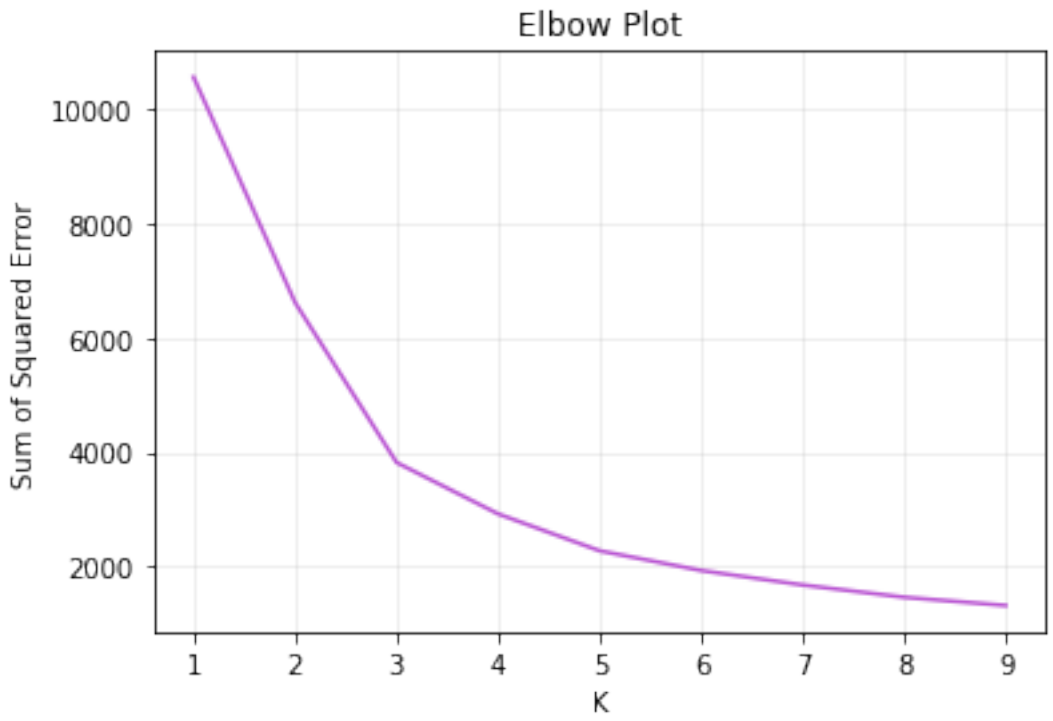
	x	y
1694	-4.733662	-0.973050
2202	-4.409129	0.328300
2154	-4.358334	1.261389
58	-4.321743	0.826715
2273	-4.024949	-0.521945
…	…	…
64	3.306552	1.290013
2193	3.323652	1.551523

```
2472  3.609009  1.889647
156   3.621020 -0.599586
2428  4.019805 -1.380379

[3000 rows x 2 columns]
```

K-means++

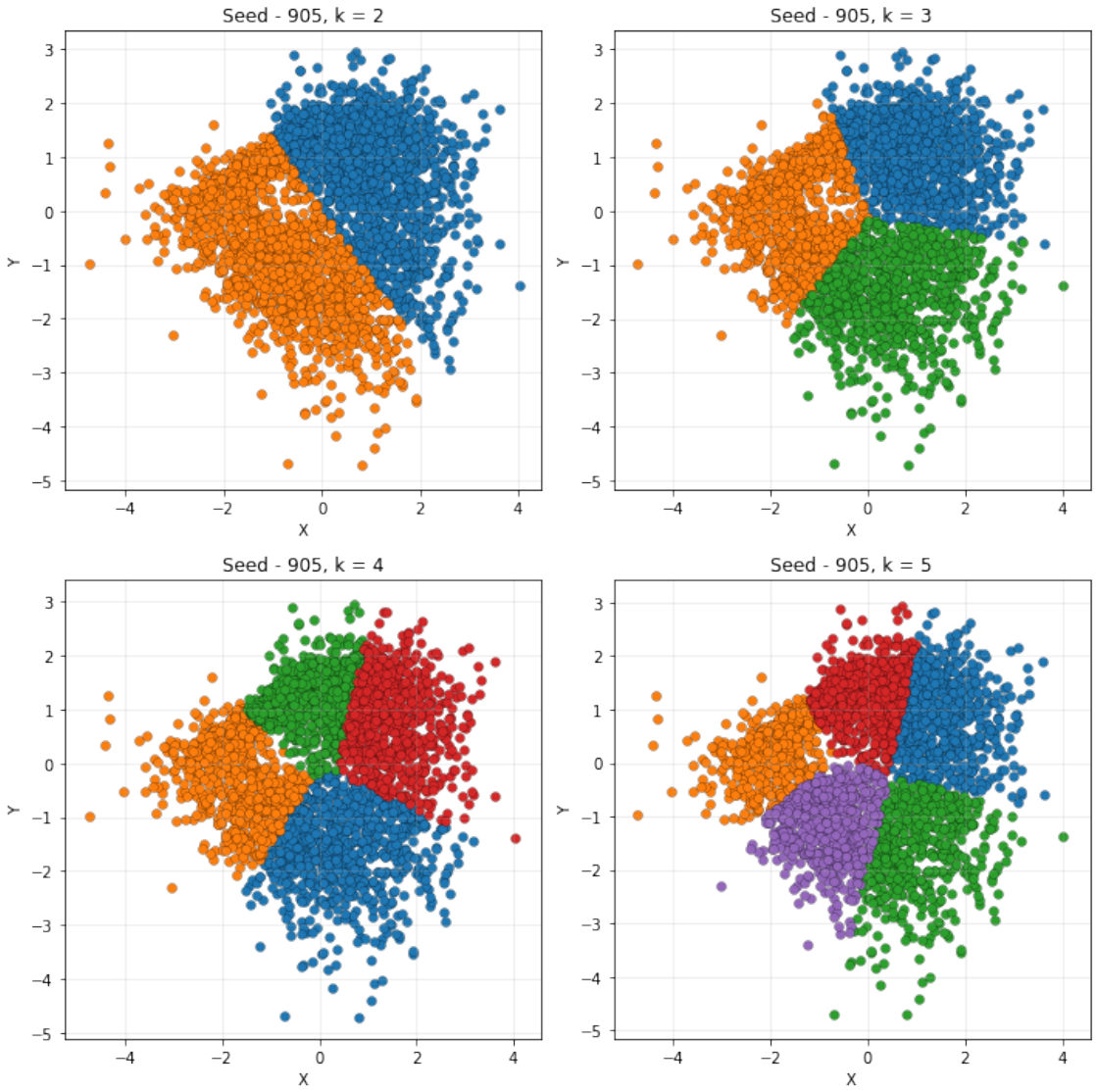
[9]:
```
#Apple
#Elbow Plot Function from Ruane (2022)
def get_elbow_plot(dataset, x_col='', y_col='', min_k=1, max_k=10):

    # for what values of k do we want to run
    k_range = range(min_k, max_k)

    # calculate sum of squared error for each value of k
    sse = [] # initialze empty list

    for k in k_range:
        km = KMeans(n_clusters=k) # set whatever other parameters you want here
        km.fit(dataset)
        sse.append(km.inertia_)

    plt.xlabel('K')
    plt.ylabel('Sum of Squared Error')
    plt.plot(k_range, sse, color = "mediumorchid")
    plt.grid(True, alpha = 0.25)
    plt.title("Elbow Plot")
    plt.show()
```

[10]:
```
#Apple
#Getting the elbow plot for k-means
get_elbow_plot(k_frame, x_col='x', y_col='y')
```



[11]:
```
#Apple
#Running k-means++. Based on Ruane (2022)
k_values = [[2,3],[4,5]]
fig1, axes1 = plt.subplots(2, 2, figsize = (10, 10))
row = 0

for i in range(2):
    for j in range(2):
        kmeans_model = KMeans(n_clusters= k_values[i][j], init='k-means++',␣
↪n_init=10,
                              random_state = 905) # set k to whatever makes␣
↪sense for your data
        kmeans_model.fit(data_values)
        kmeans_clusters = kmeans_model.predict(data_values)

# create scatter plot for samples from each cluster.
        for cluster in unique(kmeans_clusters):
            # get row indexes for samples with this cluster
            row_ix = np.where(kmeans_clusters == cluster)
            # create scatter of these samples.
            axes1[i,j].scatter(data_values[row_ix, 0], data_values[row_ix, 1],␣
↪linewidths = 0.2, edgecolors = "black")
            axes1[i,j].set_xlabel("X")
```

```
            axes1[i,j].set_ylabel("Y")
            axes1[i,j].set_title("Seed - 905, k = {}".format(k_values[i][j]))
            axes1[i,j].grid(True, alpha = 0.25)
# show the plot
fig1.tight_layout()
plt.show()
```



DBSCAN

[15]:
```
#Apple
#Plotting DBSCAN. Based on Ruane (2022) and sci-kit(n.d.). No color repetition
epsilon = [0.05, 0.15, 0.30]
samples = [5, 8, 10]
```

```
fig2, axes2 = plt.subplots(3, 3, figsize = (12, 12))
row = 0

for e in epsilon:
    col = 0
    for s in samples:
        dbscan_model = DBSCAN(eps= e, min_samples= s)
        dbscan_clusters = dbscan_model.fit_predict(data_values)



        colors = [plt.cm.Spectral(each) for each in np.linspace(0, 1,␣
 ↪len(unique(dbscan_clusters)))]

        #for k, color in zip(unique_labels, colors):
         #   if k == -1:
                # Black used for noise.
          #      color = [0, 0, 0, 1]


        # create scatter plot for samples from each cluster
        for cluster in unique(dbscan_clusters):

            # get row indexes for samples with this cluster
            row_ix = np.where(dbscan_clusters == cluster)
            # create scatter of these samples
            axes2[row,col].scatter(data_values[row_ix, 0], data_values[row_ix,␣
 ↪1], c = colors[cluster], linewidths = 0.2, edgecolors = "black")
            axes2[row,col].set_xlabel("X")
            axes2[row,col].set_ylabel("Y")
            axes2[row,col].set_title("No. Clusters: {},  : {}, MinPts: {}".
 ↪format(len(unique(dbscan_clusters))-1,e,s))
            axes2[row,col].grid(True, alpha = 0.25)
        col += 1
    row += 1
# show the plot
fig2.tight_layout()
plt.show()
```

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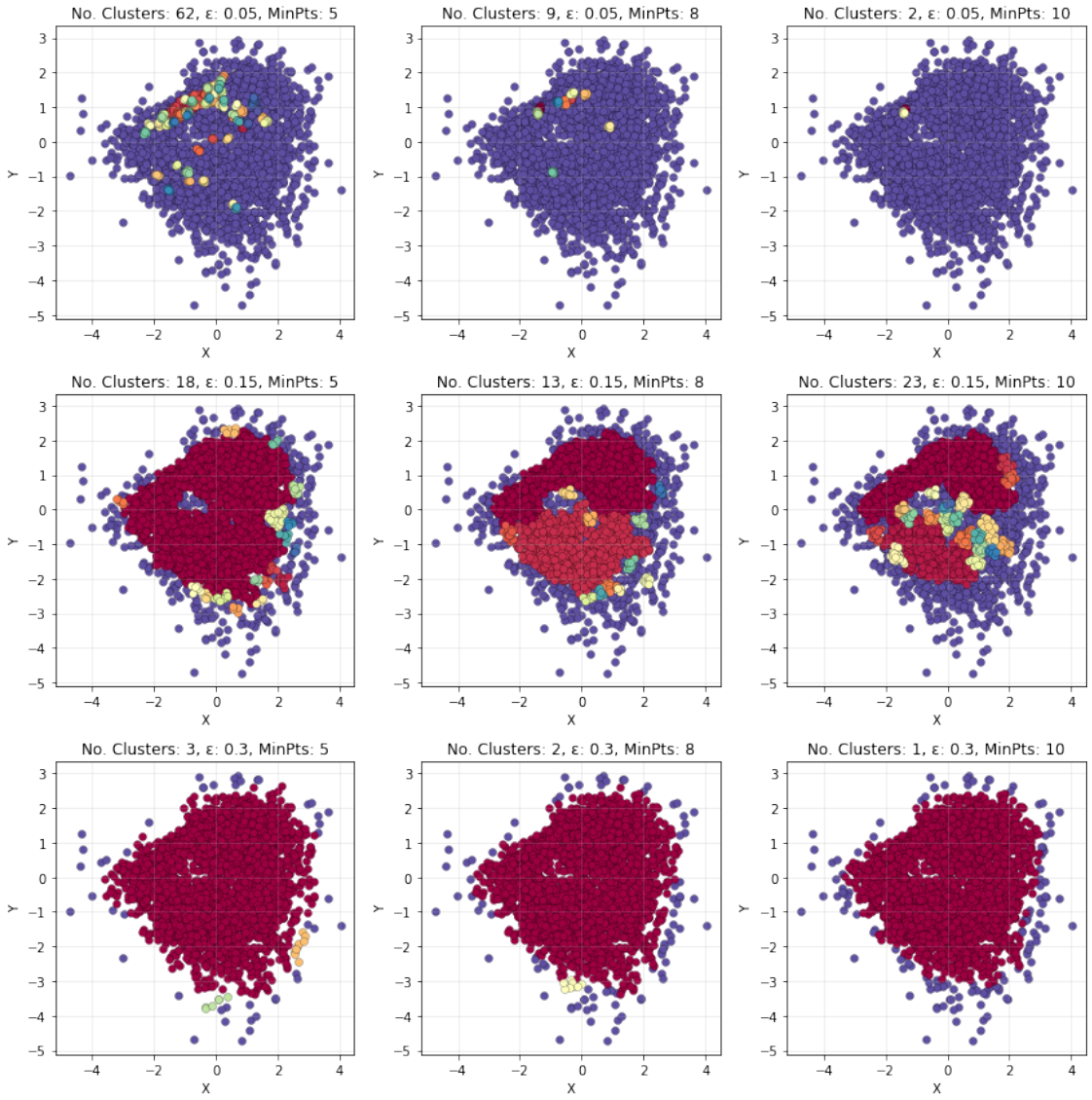
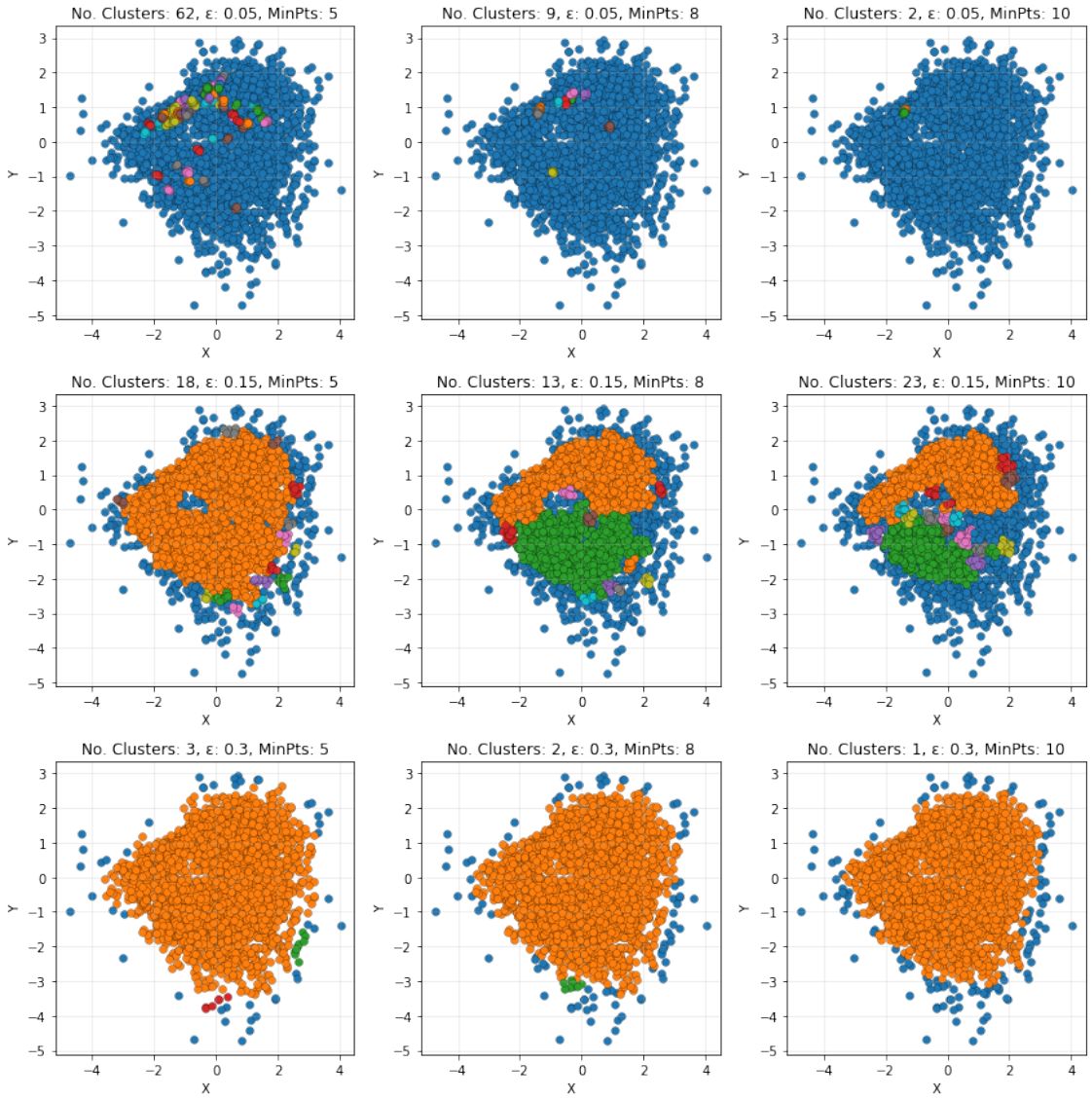


[16]:
```
#Apple
#Plotting DBSCAN. Based on Ruane (2022). With color repetition for comparison␣
 ↪sake
epsilon = [0.05, 0.15, 0.30]
samples = [5, 8, 10]
fig2, axes2 = plt.subplots(3, 3, figsize = (12, 12))
row = 0

for e in epsilon:
    col = 0
    for s in samples:
        dbscan_model = DBSCAN(eps= e, min_samples= s)
```

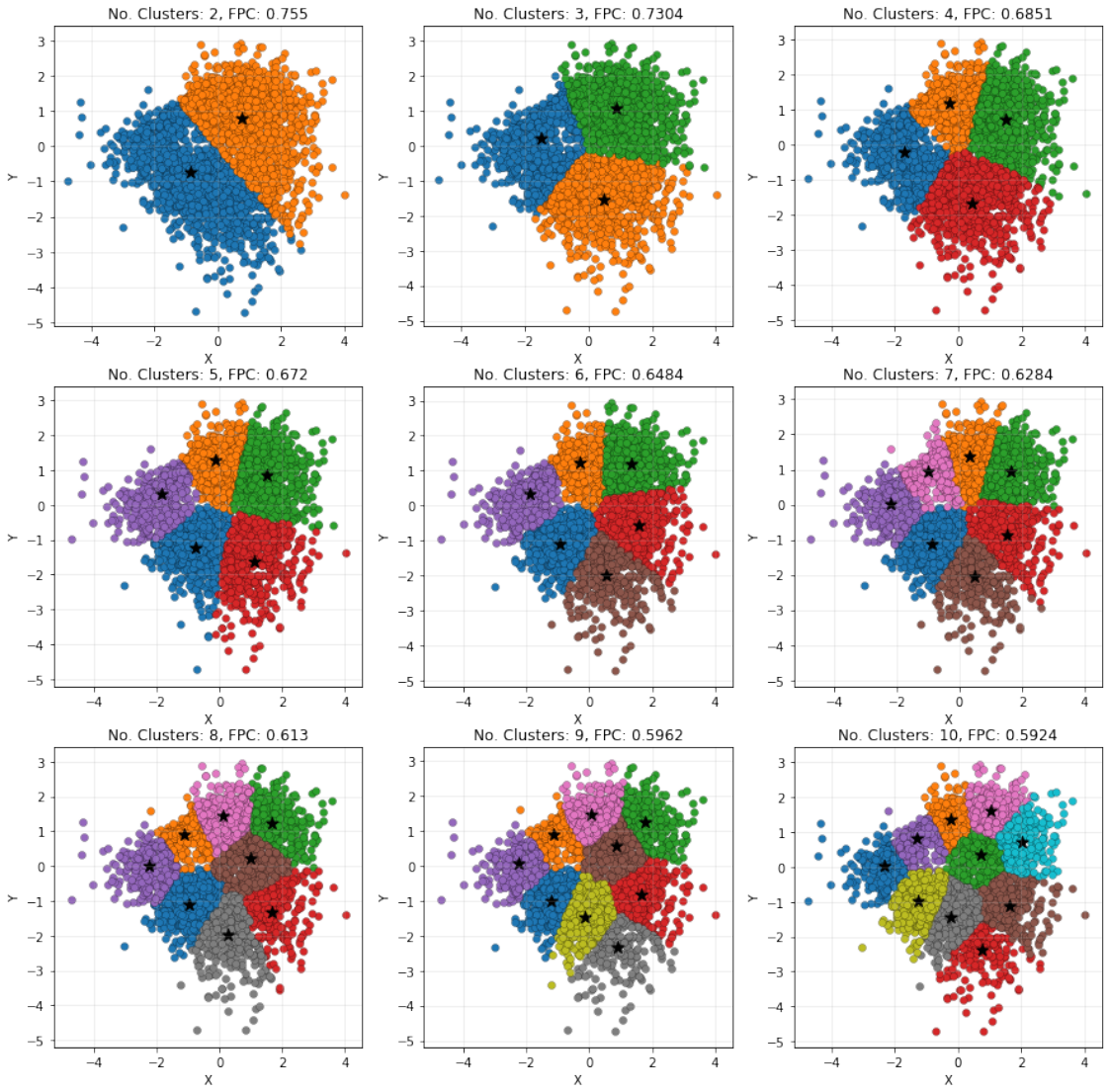
```
        dbscan_clusters = dbscan_model.fit_predict(data_values)


        # create scatter plot for samples from each cluster
        for cluster in unique(dbscan_clusters):
            # get row indexes for samples with this cluster
            row_ix = np.where(dbscan_clusters == cluster)
            # create scatter of these samples
            axes2[row,col].scatter(data_values[row_ix, 0], data_values[row_ix,␣
↪1],linewidths = 0.2, edgecolors = "black")
            axes2[row,col].set_xlabel("X")
            axes2[row,col].set_ylabel("Y")
            axes2[row,col].set_title("No. Clusters: {},  : {}, MinPts: {}".
↪format(len(unique(dbscan_clusters))-1,e,s))
            axes2[row,col].grid(True, alpha = 0.25)
        col += 1
    row += 1
# show the plot
fig2.tight_layout()
plt.show()
```



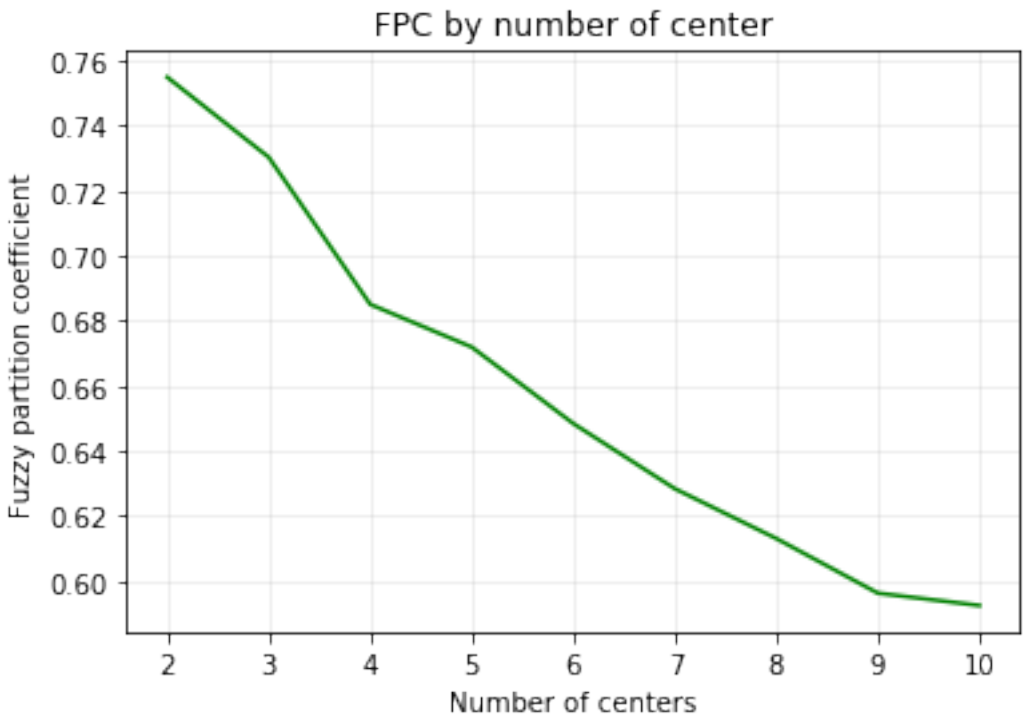
Fuzzy c-means

[17]:
```
#Apple
#Plotting Fuzzy c-means. Based on scikit-fuzzy (n.d.) and Ruane (2022)

cluster_matrix = [[2,3,4], [5,6,7], [8,9,10]]


# Set up the loop and plot
fig3, axes3 = plt.subplots(3, 3, figsize=(15, 15))
#mi data es data_values
fpc_values = []
```

```
row = 0
for r in range(3):
    col = 0
    for c in range(3):
        cntr, u, u0, d, jm, p, fpc = fuzz.cluster.cmeans(
        k_frame.T, cluster_matrix[row][col], 1.75, error=0.005, maxiter=1000,␣
↪init=None, seed = 905)

        # Plot assigned clusters, for each data point in training set
        cluster_membership = np.argmax(u, axis=0)
        fpc_values.append(fpc)

        for j in range(cluster_matrix[row][col]):
            row_ix = np.where(cluster_membership == j )
            axes3[row,col].scatter(
                k_frame["x"].loc[row_ix[0]], k_frame["y"].
↪loc[row_ix[0]],linewidths = 0.2, edgecolors = "black")
        for c in range(cluster_matrix[row][col]):
            axes3[row,col].scatter(
                x = cntr[c][0], y = cntr[c][1], marker = "*", color = "black",␣
↪linewidth = 1, edgecolors = "black", s = 100)
        axes3[row,col].set_xlabel("X")
        axes3[row,col].set_ylabel("Y")
        axes3[row,col].set_title("No. Clusters: {}, FPC: {}".
↪format(cluster_matrix[row][col],round(fpc,4)))
        axes3[row,col].grid(True, alpha = 0.25)
        col += 1

    row += 1
```



[18]:
```
#Apple
#Plotting FPC Coefficient. Based on scikit-fuzzy (n.d.)
fig5, ax5 = plt.subplots()
ax5.plot(np.r_[2:11], fpc_values, color = "green")
ax5.set_xlabel("Number of centers")
ax5.set_ylabel("Fuzzy partition coefficient")
ax5.set_title("FPC by number of center")
ax5.grid(True, alpha = 0.25)
```


FPC by number of center
Fuzzy partition coefficient
0.76
0.74
0.72
0.70
0.68
0.66
0.64
0.62
0.60
2
3
4
5
6
7
8
9
10
Number of centers

[ ]: