93
```
import numpy as np
import pandas as pd
from sklearn.cluster import KMeans
from sklearn.cluster import Birch
from sklearn.cluster import AgglomerativeClustering
from sklearn.cluster import DBSCAN
from matplotlib import pyplot as plt

np.random.seed(1)
```

94
```
def equalProb():
    if np.random.random() < 0.95: return 0
    else: return 1

def boundedNormal(bound, stddev):
    rNum = np.random.normal(stddev)
    while rNum < -bound or rNum > bound:
        rNum = np.random.normal(0, stddev)
    return rNum
```

95
```
def gen_data_one():
    """This Function Generates Data Set 1"""
    center1 = 10
    center2 = 20
    center3 = 30
    bound = 4
    stddev = 2

    tuples = []
    numTuples = 1000

    for i in range(numTuples):
        rNum = np.random.randint(3)
        if rNum == 0:
            # candidate = 0
            rNum = boundedNormal(bound, stddev)
            a1 = center1 + rNum
            rNum = boundedNormal(bound, stddev)
            a2 = center1 + rNum

        elif rNum ==1:
            # candidate = 1
            rNum = boundedNormal(bound+10, stddev+10)
            a1 = center2 + rNum
            rNum = boundedNormal(bound+5, stddev+5)
            a2 = center2 + rNum + 5

        else:
            # candidate = 2
            rNum =boundedNormal(bound+4, stddev)
            a1 = center3 + rNum
            rNum = boundedNormal(bound+2, stddev)
            a2 = center3 + rNum

        atuple = (a1, a2)
        tuples.append(atuple)

    df = pd.DataFrame(tuples, columns=["a1", "a2"])
    return df
```

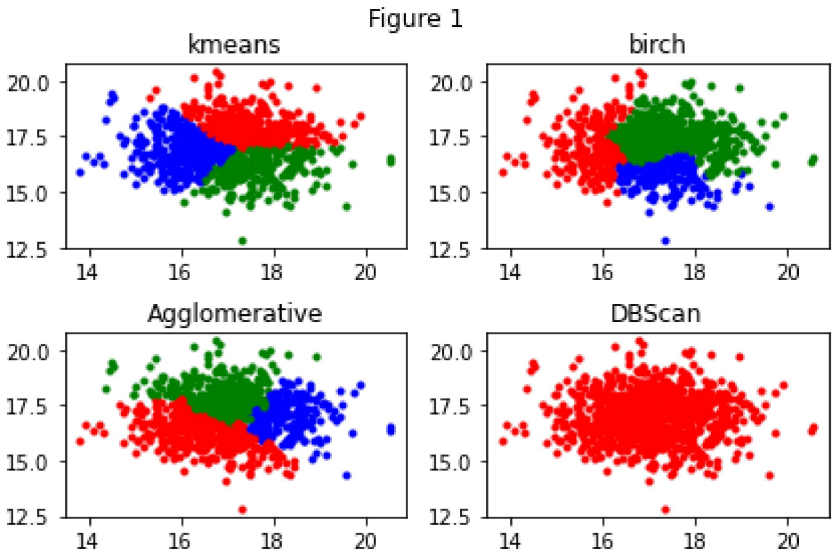
96
```
    def gen_data_two():
        """This Function Generates Data Set 1"""
        center1 = 15
        center2 = 15
        center3 = 15
        bound = 25
        stddev = 2

        tuples = []
        numTuples = 1000

        for i in range(numTuples):
            rNum = np.random.randint(3)
            if rNum == 0:
                # candidate = 0
                rNum = boundedNormal(bound, stddev)
                a1 = center1 + rNum
                rNum = boundedNormal(bound, stddev)
                a2 = center1 + rNum

            elif rNum ==1:
                # candidate = 1
                rNum = boundedNormal(bound, stddev)
                a1 = center2 + rNum
                rNum = boundedNormal(bound, stddev)
                a2 = center2 + rNum

            else:
                # candidate = 2
                rNum =boundedNormal(bound, stddev)
                a1 = center3 + rNum
                rNum = boundedNormal(bound, stddev)
                a2 = center3 + rNum

            atuple = (a1, a2)
            tuples.append(atuple)

        df = pd.DataFrame(tuples, columns=["a1", "a2"])
        return df
```

97
```
    def plot_clustering(theData, kmeansLabels,brcLabels,aggLabels, dbLabels,graph_title):
        fig, ax = plt.subplots(2,2)

        # Plotting Kmeans
        for i in range(len(theData)):
            if kmeansLabels[i] == 0: theColor= "red"
            if kmeansLabels[i] == 1: theColor= "green"
            if kmeansLabels[i] == 2: theColor= "blue"
            ax[0,0].scatter(theData[i][0], theData[i][1], s=9.5, alpha=1.0, color=theColor)
            ax[0,0].set_title("kmeans")

        # Plotting Birch
        for i in range(len(theData)):
            if brcLabels[i] == 0: theColor = "red"
            if brcLabels[i] == 1: theColor = "green"
            if brcLabels[i] == 2: theColor = "blue"
            ax[0,1].scatter(theData[i][0], theData[i][1], s=9.5, alpha=1.0, color=theColor)
            ax[0,1].set_title("birch")

        # Plotting Agglomerative
        for i in range(len(theData)):
            if aggLabels[i] == 0: theColor = "red"
```

```
            if aggLabels[i] == 1: theColor = "green"
            if aggLabels[i] == 2: theColor = "blue"
            ax[1, 0].scatter(theData[i][0], theData[i][1], s=9.5, color=theColor)
            ax[1, 0].set_title("Agglomerative")

        # Plotting DBScan
        for i in range(len(theData)):
            if dbLabels[i] ==0: theColor = "red"
            elif dbLabels[i] == 1: theColor = "green"
            elif dbLabels[i] == 2: theColor = "blue"
            ax[1, 1].scatter(theData[i][0], theData[i][1], s= 9.5, alpha=1.0, color=theColor)
            ax[1, 1].set_title("DBScan")

        fig.tight_layout()
        fig.suptitle(graph_title)
        fig.subplots_adjust(top=0.88)
        plt.figure(figsize=(7, 5))
        plt.show()
```

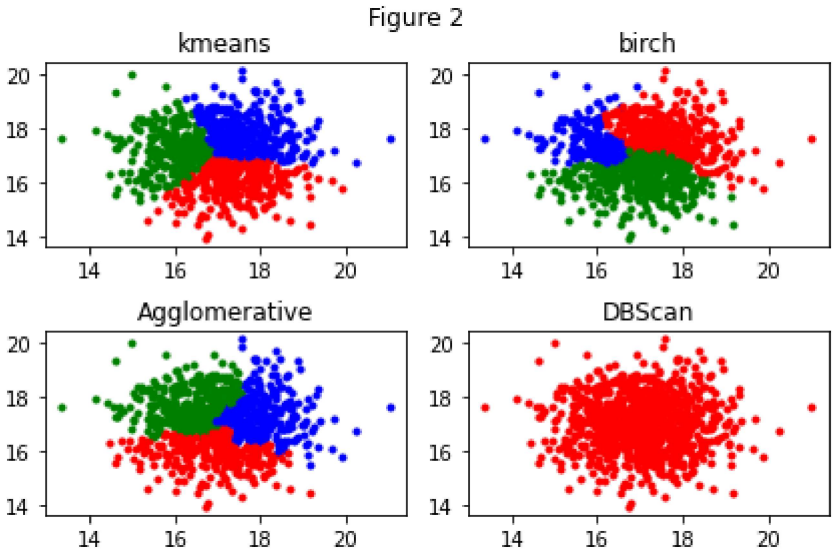
98
```
def create_graph(df, title):
    """This Function Goes through and creates the clustring graphs out of the data shown"""
    numClusters= 3
    df = gen_data_two()
    theData = df.to_numpy()

    # kMeans
    kmeans = KMeans(n_clusters=numClusters, random_state=0).fit(df)

    # Birch
    brc = Birch(n_clusters=numClusters).fit(df)

    # Agglomerative
    agg = AgglomerativeClustering(n_clusters=numClusters, linkage="ward").fit(df)

    # DBSCAN
    db = DBSCAN(eps=1.5, min_samples=4).fit(df)

    plot_clustering(theData, kmeans.labels_, brc.labels_,agg.labels_, db.labels_, title)
```

99
```
create_graph(gen_data_one(), "Figure 1")
```




```
<Figure size 504x360 with 0 Axes>
```

```
100 create_graph(gen_data_two(), "Figure 2")
```




```
<Figure size 504x360 with 0 Axes>
```