P2: Data Preprocessing and Clustering

Part A (by Roman Formicola)

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2. a)

In [19]:
```
import matplotlib.pyplot as plt
import numpy as np
dat = np.array([ [0, 4, 2], [1, 3, 1], [1, 4, 1], [2, 5, 2], [4, 0, 1],
                 [5, 1, 1], [5, 2, 2], [6, 3, 2] ])

#plotting the results
plt.scatter(dat[:,0], dat[:,1], c=dat[:,2])
plt.show()
```

b)

In [20]:
```
def computeCentroids(dat):
    nG1 = 0
    g1 = [0, 0]
    nG2 = 0
    g2 = [0, 0]
    for i in range(len(dat)):
        if(dat[i][2] == 1):
            g1[0] = g1[0] + dat[i][0]
            g1[1] = g1[1] + dat[i][1]
            nG1 += 1
        if(dat[i][2] == 2):
            g2[0] = g2[0] + dat[i][0]
            g2[1] = g2[1] + dat[i][1]
            nG2 += 1
    g1[0] = g1[0] / nG1
    g1[1] = g1[1] / nG1
    g2[0] = g2[0] / nG2
    g2[1] = g2[1] / nG2

    return g1, g2
```

In [21]:
```
import pandas as pd
centroids = computeCentroids(dat)
pd.DataFrame(centroids, index={"Group 1", "Group 2"}, columns={"X1", "X2"})
```

Out[21]:

	X1	X2
Group 1	3.75	2.0
Group 2	3.25	3.0

In [22]:
```
import math
def euclidDist(point, cluster):
    return math.sqrt((point[0] - cluster[0])**2 + (point[1] - cluster[1])**2)
```

c)

In [23]:
```
def kMeans(centroids):

    g2C = [ [], [], [], [], [], [], [], [] ]
    for i in range(8):
        dc1 = euclidDist(dat[i][0:2], centroids[0])
        g2C[i].append(dc1)
        dc2 = euclidDist(dat[i][0:2], centroids[1])
        g2C[i].append(dc2)
        if(dc2 < dc1):
            g2C[i].append(2)
        else:
            g2C[i].append(1)

    df = pd.DataFrame(g2C, index=[1, 2, 3, 4, 5, 6, 7, 8], columns={"dc1", "dc2", "Group"})
    df.style.set_caption("Hello world")
    display(df)
    return g2C
```

In [24]:
```
i1 = kMeans(centroids)
```

	dc1	dc2	Group
1	3.400368	3.400368	1
2	2.010564	2.290000	1
3	2.657536	2.462214	2
4	3.092329	2.358495	2
5	2.358495	3.092329	1
6	2.462214	2.657536	1
7	2.250000	2.010564	2
8	3.400368	3.400368	1

d)

In [25]:
```
centroids2 = computeCentroids(i1)
display(pd.DataFrame(centroids2, index={"Group 1", "Group 2"}, columns={"X1", "X2"}))
i2 = kMeans(centroids2)
centroids3 = computeCentroids(i2)
display(pd.DataFrame(centroids3, index={"Group 1", "Group 2"}, columns={"X1", "X2"}))
i3 = kMeans(centroids3)
```

	X1	X2
Group 1	2.727402	2.960120
Group 2	2.666622	2.278758

	dc1	dc2	Group
1	2.618563	3.173865	1
2	1.727862	1.815990	1
3	2.016251	2.395893	1
4	2.165692	2.801703	1
5	3.223083	2.640196	2
6	3.001129	2.660604	2
7	2.467090	2.348970	2
8	3.814794	3.572043	2

	X1	X2
Group 1	2.207180	2.548868
Group 2	3.126251	2.805303

	dc1	dc2	Group
1	2.642582	3.340752	1
2	1.299424	2.135147	1
3	1.889147	2.439953	1
4	2.461865	2.466807	1
5	3.114601	2.936224	2
6	3.192582	2.601933	2
7	2.645858	2.039472	2
8	4.096138	3.393752	2

e)

In [26]:
```
nI = np.array(i3)
centroids3 = np.array(centroids3)
plt.scatter(dat[:,0], dat[:,1], c=nI[:,2])

plt.scatter(centroids3[0][0], centroids3[0][1], color='r', label="X1 Centroid")
plt.scatter(centroids3[1][0], centroids3[1][1], color='b', label="X2 Centroid")
plt.xlabel("X1")
plt.ylabel("X2")
plt.title("Q2 Sample Data")
plt.legend(fancybox=True, framealpha=1, shadow=True, borderpad=1)
plt.show()
```

3. a)

Step 1: Combine 2 and 5

d(b, e) = 0.2 / 2 = 0.1

In [27]:
```
import pandas as pd
D1 = [[0, '-', '-', '-', '-'],
      [0.6, 0, '-', '-', '-'],
      [0.4, 0.5, 0, '-', '-'],
      [0.7, 0.9, 0.65, 0]]
pd.DataFrame(D1, index=[1, 25, 3, 4], columns=[1, 25, 3, 4])
```

Out[27]:

	1	25	3	4
1	0.0	-	-	-
25	0.6	0	-	-
3	0.4	0.5	0	-
4	0.7	0.9	0.65	0

Step 2: Combine 1 and 3

d(a, c) = 0.4 / 2 = 0.2

In [28]:
```
D2 = [[0, '-', '-'],
      [0.6, 0, '-'],
      [0.7, 0.9, 0]]
pd.DataFrame(D2, index=[13, 25, 4], columns=[13, 25, 4])
```

Out[28]:

	13	25	4
13	0.0	-	-
25	0.6	0	-
4	0.7	0.9	0

Step 3: Combine 13 and 25

d(ac, be) = 0.6 / 2 = 0.3

In [29]:
```
D3 = [[0, '-'],
      [0.9, 0]]
pd.DataFrame(D3, index=[1235, 4], columns=[1235, 4])
```

Out[29]:

	1235	4
1235	0.0	-
4	0.8	0

Step 4: Combine 1235 and 4

d(abce, d) = 0.8 / 2 = 0.4

In [30]:
```
D4 = [[0]]
pd.DataFrame(D4, index=[12345], columns=[12345])
```

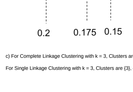
Out[30]:

	12345
12345	0

In [31]:
```
from IPython.display import Image

fig = Image(filename='Comp-Link-Dendrogram.png')
fig
```

Out[31]:



b) Step 1: Combine 3 and 5:

d(b, e) = 0.2 / 1 = 0.1

In [32]:
```
import pandas as pd
bD1 = [[0, '-', '-', '-', '-'],
       [0.3, 0, '-', '-', '-'],
       [0.4, 0.4, 0, '-', '-'],
       [0.7, 0.9, 0.65, 0]]
pd.DataFrame(bD1, index=[1, 25, 3, 4], columns=[1, 25, 3, 4])
```

Out[32]:

	1	25	3	4
1	0.0	-	-	-
25	0.3	0	-	-
3	0.4	0.4	0	-
4	0.7	0.35	0.65	0

Step 2: Combine 1 and 25

d(a, be) = 0.3 / 2 = 0.15

In [33]:
```
bD2 = [[0, '-', '-'],
       [0.35, 0, '-'],
       [0.65, 0.65, 0]]
pd.DataFrame(bD2, index=[125, 3, 4], columns=[125, 3, 4])
```

Out[33]:

	125	3	4
125	0.00	-	-
3	0.40	0	-
4	0.35	0.45	0

Step 3: Combine 125 and 4

d(abe, d) = 0.35 / 2 = 0.175

In [34]:
```
bD3 = [[0, '-'],
       [0.4, 0]]
pd.DataFrame(bD3, index=[1245, 3], columns=[1245, 3])
```

Out[34]:

	1245	3
1245	0.0	-
3	0.4	0

Step 4: Combine 1245 and 3

d(abde, 3) = 0.4 / 2 = 0.2

In [35]:
```
bD4 = [[0]]
pd.DataFrame(bD4, index=[12345], columns=[12345])
```

Out[35]:

	12345
12345	0

In [36]:
```
fig2 = Image(filename='Single-Link-Dendrogram.png')
fig2
```

Out[36]:

c) For Complete Linkage Clustering with k = 3, Clusters are [2, 5], [1,3], [4]

For Single Linkage Clustering with k = 3, Clusters are [3], [4], [2, 5, 1]