CS6316: HW6

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1. Unsupervised Learning with Clustering

    1.3 K-means Clustering
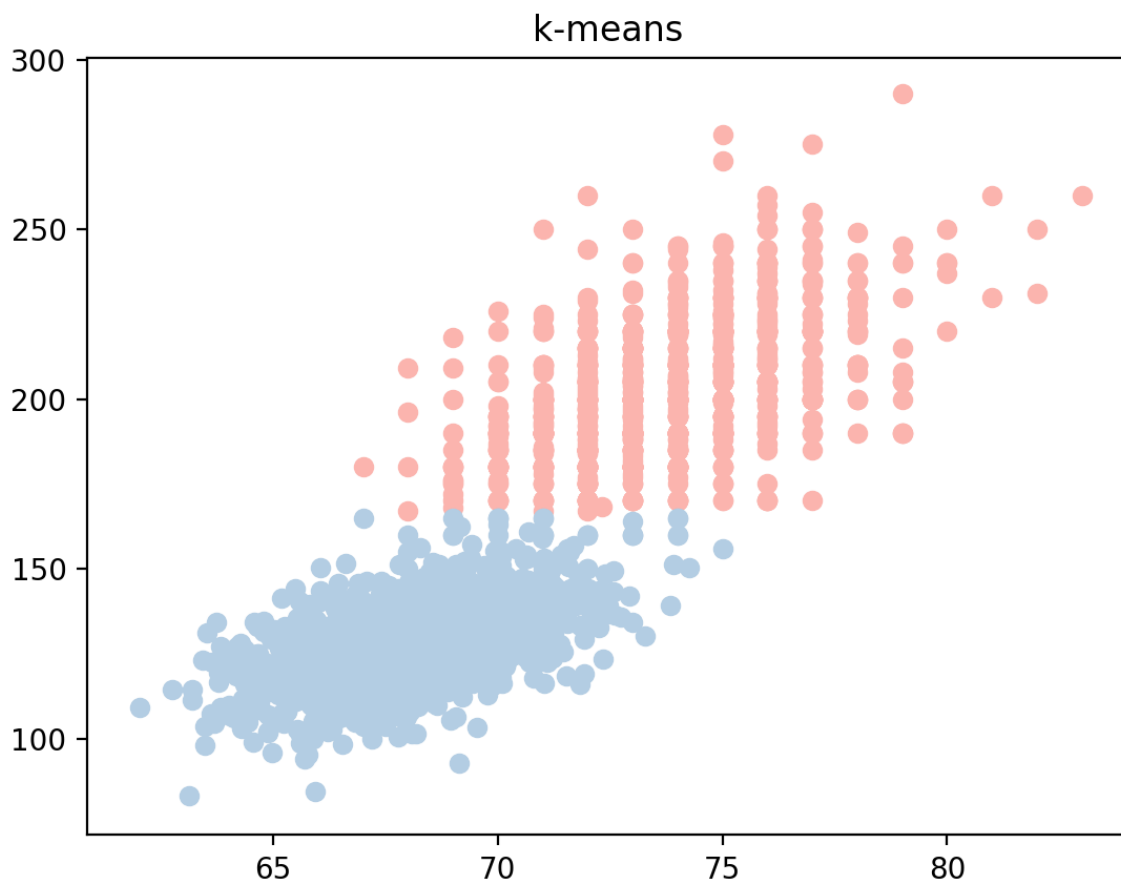
    Figure 1 is the scatter plot of the K-means.

Figure 1: K-means Scatter Plot

The relationship between k and objective function value is shown in Figure 2.

Figure 2: K Knee Finding

The purities of clusters when k equals 2 is shown in the table below

Cluster	Purity
0	0.9990
1	0.9724

1.4 Guassian Mixture model

Figure 3 is the scatter plot of the GMM with covType of diag for dataset1.

Figure 4 is the scatter plot of the GMM with covType of full for dataset1.

Figure 5 is the scatter plot of the GMM with covType of diag for dataset2.

Figure 6 is the scatter plot of the GMM with covType of full for dataset2.

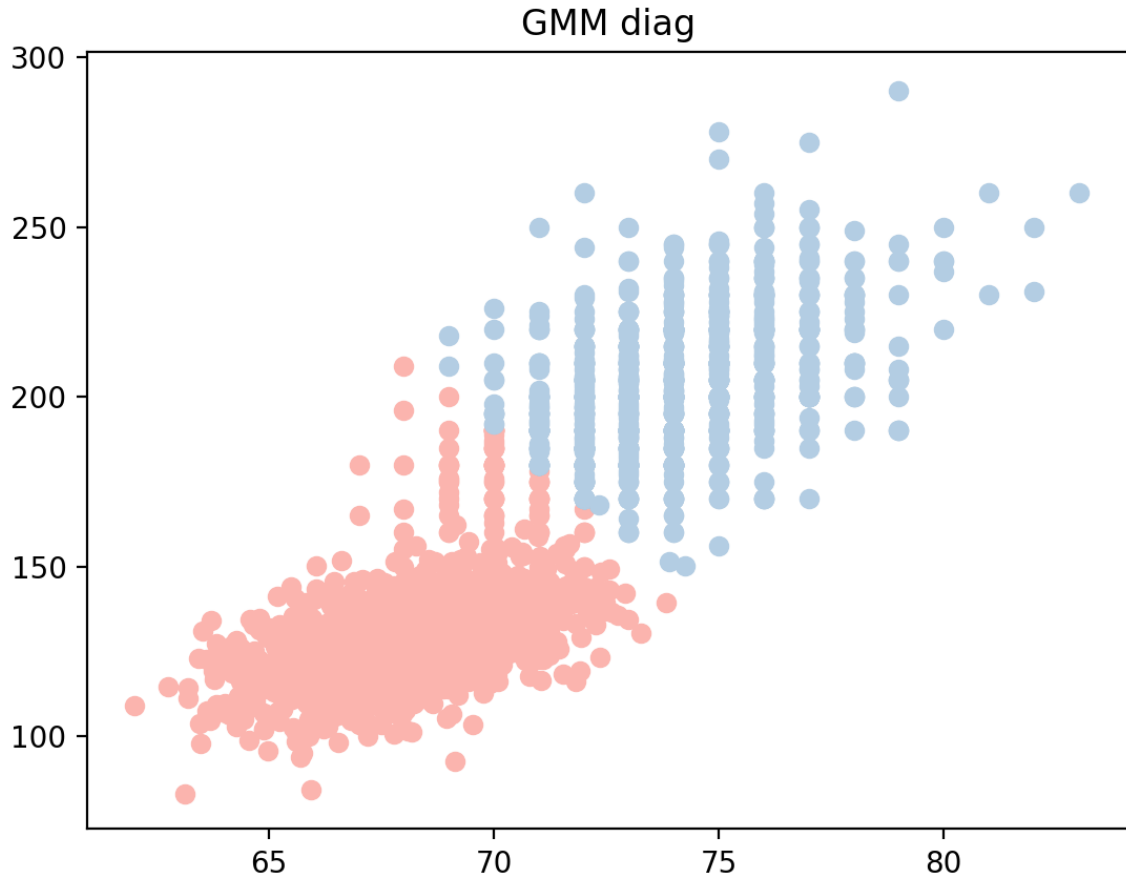The purities of dataset1 with GMM diag are shown in the table below

Cluster	Purity
0	0.9315
1	0.9968

Figure 3: GMM Diag Dataset1 Plot

The purities of dataset1 with GMM full are shown in the table below

Cluster	Purity
0	1.0
1	0.5394

The purities of dataset2 with GMM diag are shown in the table below

Cluster	Purity
0	0.6875
1	0.5268

The purities of dataset2 with GMM full are shown in the table below

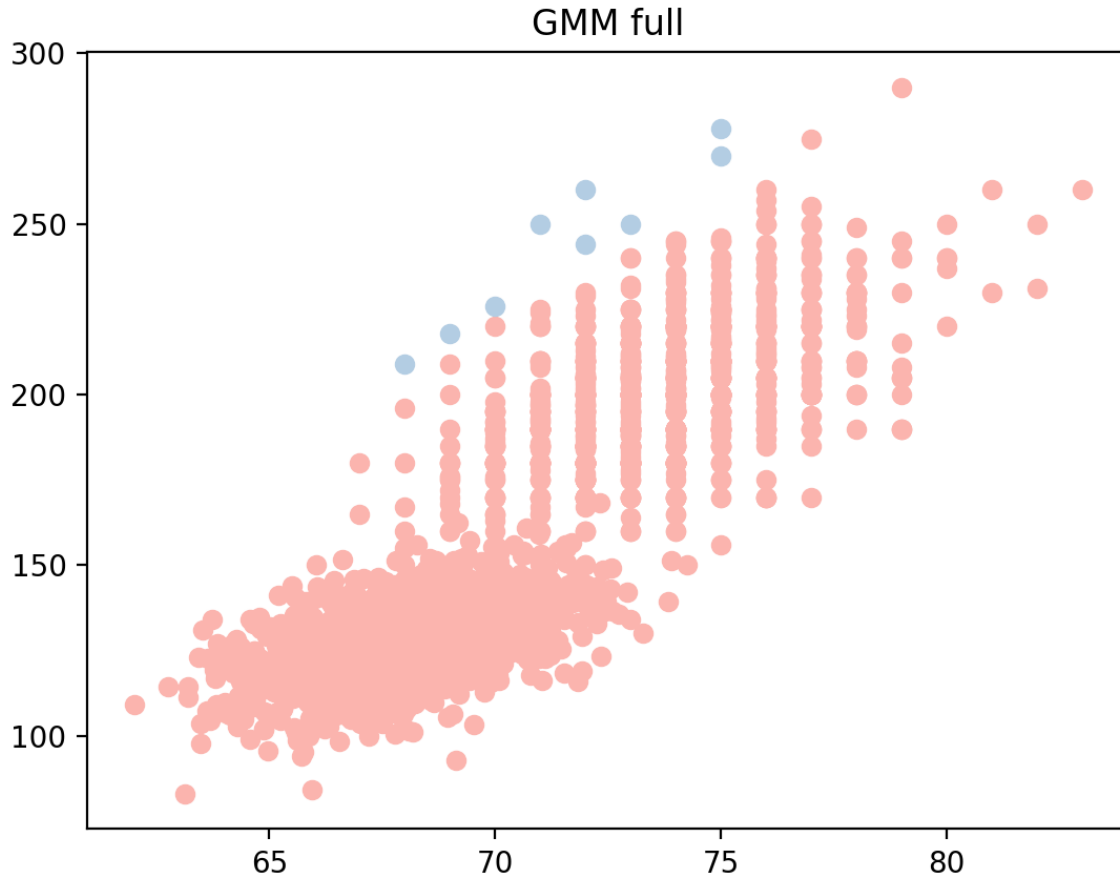| Cluster	Purity
0	0.5161
1	1.0

Figure 4: GMM Full Dataset1 Plot

2. Sample QA Questions

   2.2 Decision Tree

   (a)

   $$-2 * 0.5 * \log_2 0.5 = 1.0$$
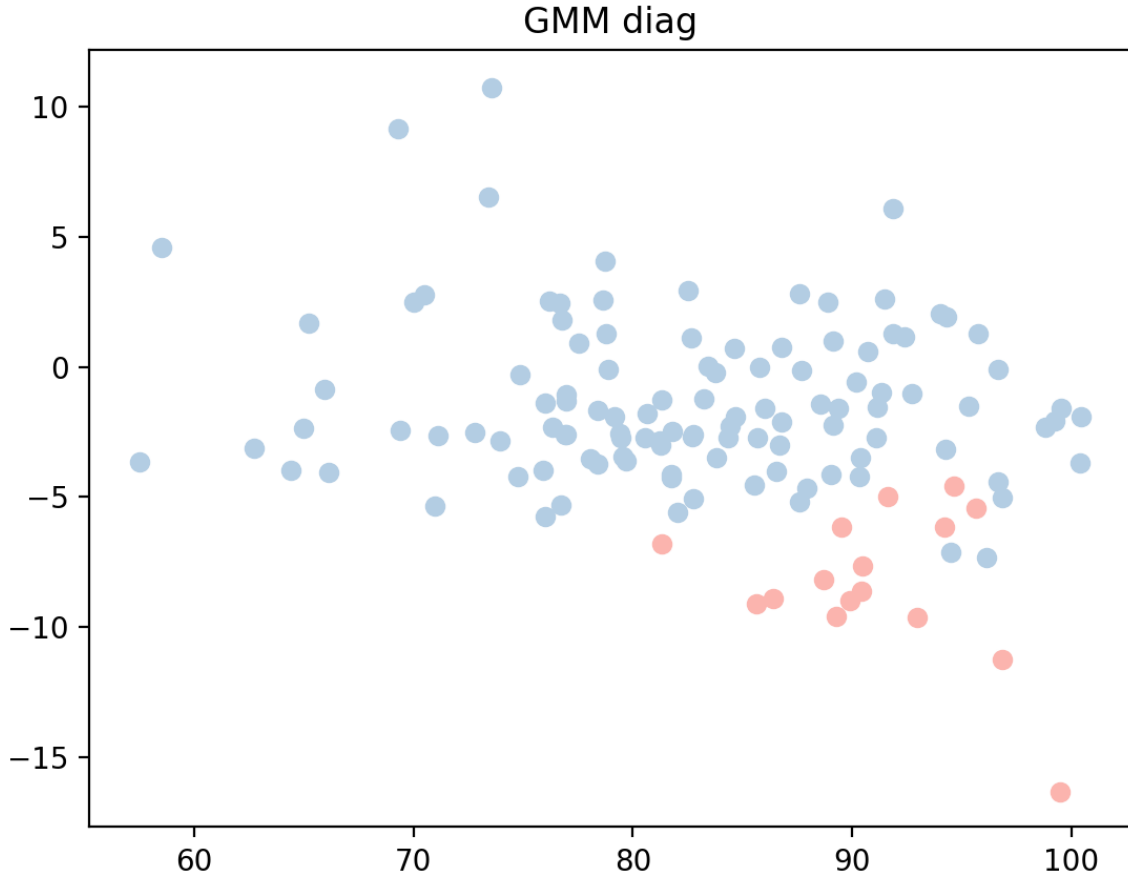
   (b)

   $$-1 * \log_2 1 = 0$$

   (c)

Figure 5: GMM Diag Dataset2 Plot

$$\begin{aligned}
H(E|Color) &= p(Color = G)H(E|Color = G) + p(Color = B)H(E|Color = B) \\
&\quad + p(Color = R)H(E|Color = R) \\
&= 1/3 * 0 + 2/9 * 1.0 + 4/9 * 0 \\
&= 0.2222
\end{aligned}$$

$$\begin{aligned}
H(E|Wig) &= p(Wig = Y)H(E|Wig = Y) + p(Wig = N)H(E|Wig = N) \\
&= 2/9 * 1.0 + 7/9 * 0.9852 \\
&= 0.9885
\end{aligned}$$

$$\begin{aligned}
H(E|Ears) &= p(Ears = 2)H(E|Ears = 2) + p(Ears = 3)H(E|Ears = 3) \\
&= 8/9 * 1.0 + 1/9 * 0 \\
&= 0.8888
\end{aligned}$$

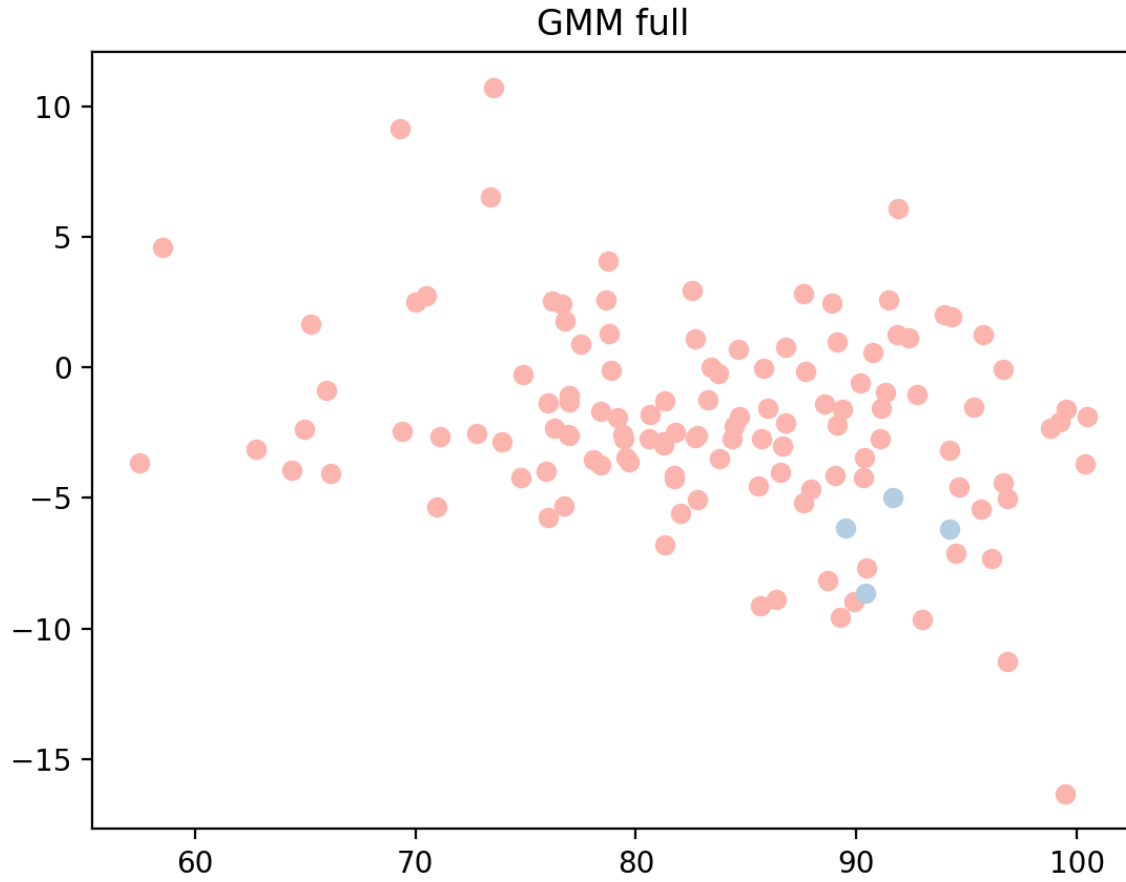Since the entropy is lowest when conditioned on Color, color will be chosen.

Figure 6: GMM Full Dataset2 Plot

(d)

The learned decision tree is shown in Figure 7

(e)

The maximum training set error is
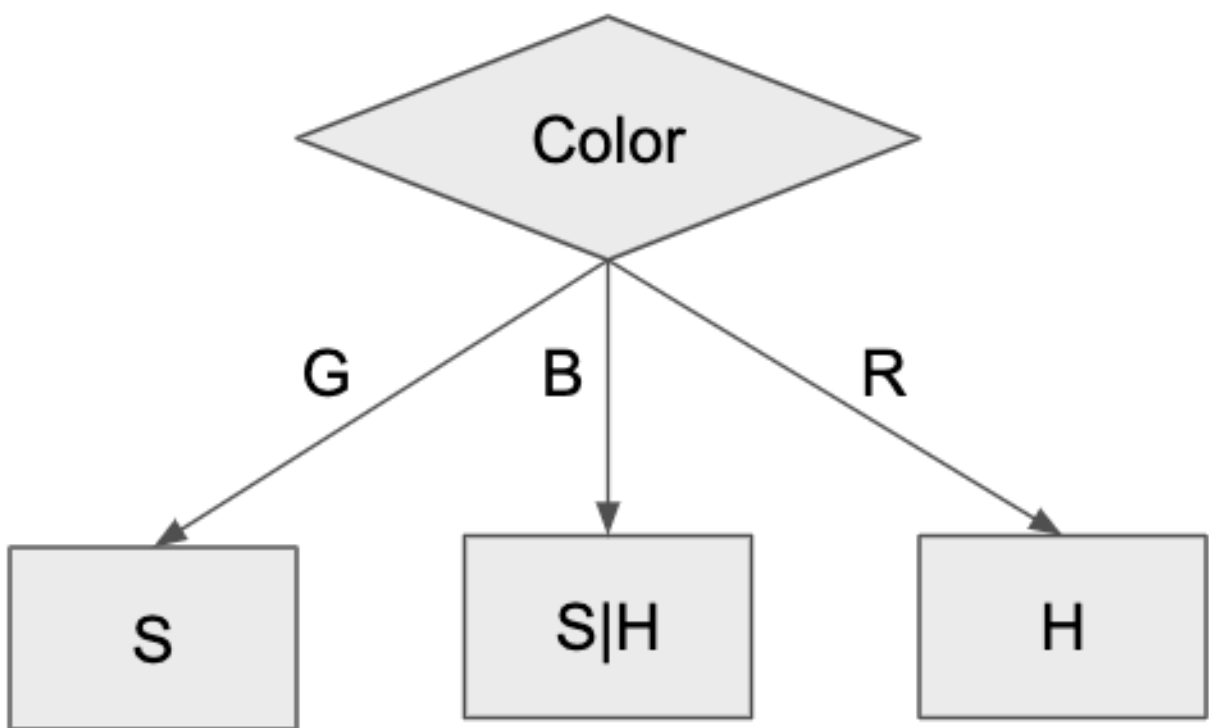
$$50\%$$

.

(f)

Feature 1	Output
0	0
1	0
0	1
1	1

Figure 7: Decision Tree