Assignment 1

Machine Learning 1, SS24

Team Members		
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1.1 K-means Algorithm

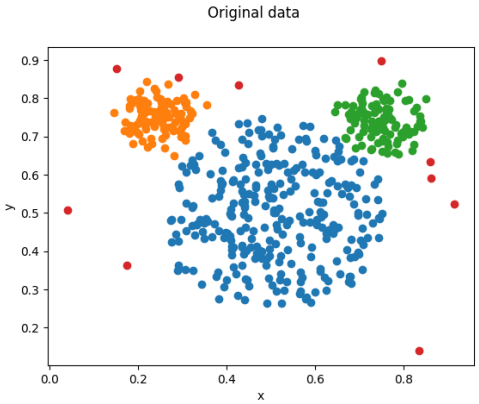

Figure 1: Original data

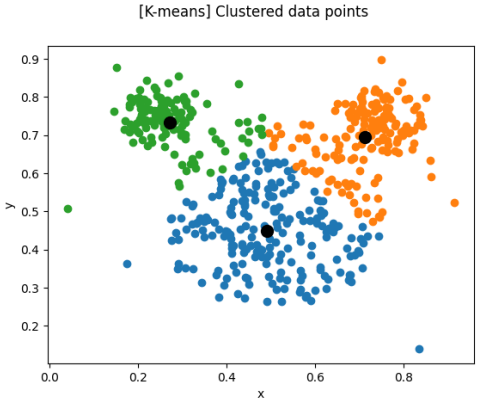

Figure 2: K-means clustered data (K=3)
The K-means clustering doesn't quite match the original data although it's not too far off. A higher number of iterations didn't make a difference.

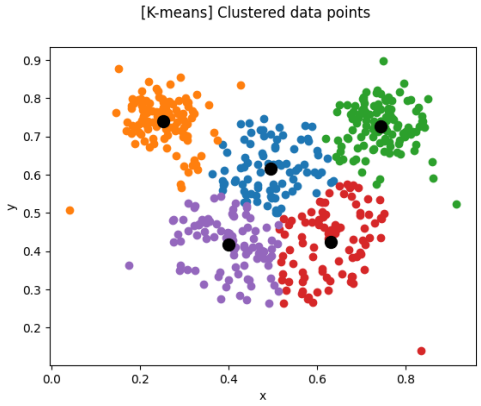

Figure 3: K-means clustered data (K=5)
The plot with $K = 5$ shows five distinct clusters, illustrating a more refined clustering than with $K = 3$.

1.2 EM Algorithm

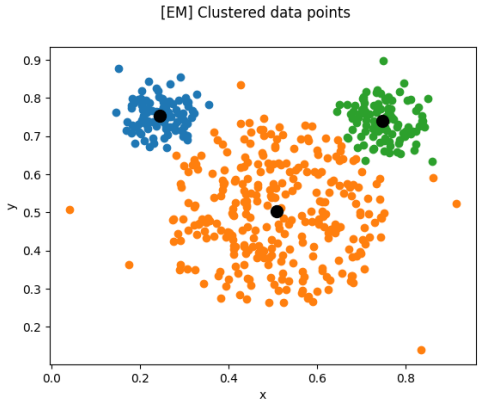

Figure 4: EM clustered data (K=3)
The EM clustering with $K = 3$ shows clusters that are similar in general shape to the K-means clusters but with some differences in the placement of points, especially in the overlapping regions.

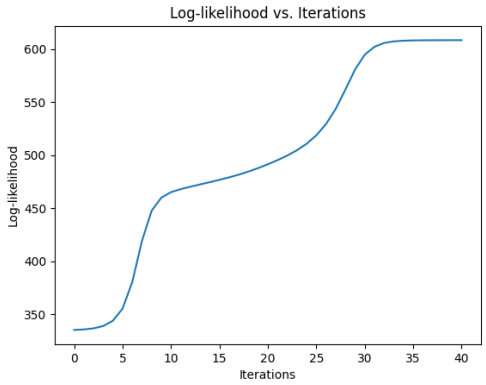

Figure 5: Log-likelihood over iterations
The plot shows the log-likelihood converging after enough iterations.

Initial and Final weights
Initial weights:

$$\begin{bmatrix} 0.33333333 \\ 0.33333333 \\ 0.33333333 \end{bmatrix}$$

Final weights:

$$\begin{bmatrix} 0.20081324 \\ 0.60008472 \\ 0.19908404 \end{bmatrix}$$

1.3 Summary and comparison of two algorithms [5 points]

Tasks:

1. **Which algorithm works better for the Mouse data set? Why? Explain by comparing the plots of the original data, after K-means clustering, and after EM clustering using the GMM.**

   We can see that the EM algorithm works much better and makes each "ear" and the "head of Mickey mouse its own cluster. The distinction is far less clear for K-means.

2. **Are there noisy data points (outliers) in the original data? Is K-means robust to noise? Is EM robust to noise?**

   There is noise in the original data. Neither algorithm is robust to noise.

3. **What is the main difference between the K-means and EM algorithm? Briefly discuss the connection between z_{ik} (K-means) and γ_{ik} (in EM).**

The main fundamental difference is that K-means performs hard assigment of points whereas EM assigns the probability that a point belongs to a cluster. .