Week 10

Agenda

1. GMM Review
2. Case Study

For next week: Read ‘Eigenface’ paper

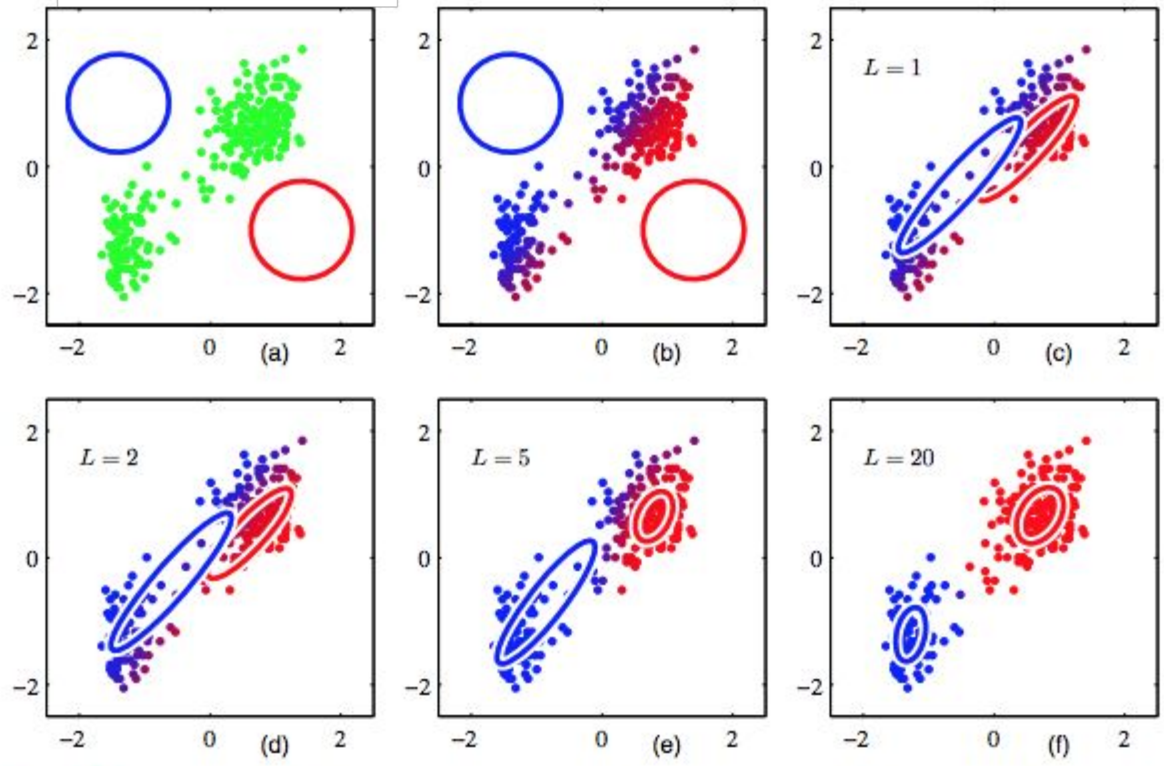


Figure 9.8 Illustration of the EM algorithm using the Old Faithful set as used for the illustration of the K-means algorithm in Figure 9.1. See the text for details.

PARAMETERS

1. To build a K-Means model, how many parameters do we need to fit to the data?
2. What about for GMM?
3. What are the implications for choosing each of the four types of covariance matrices (at the left)?

Pros of GMMs?

1.

Cons of GMMs?

1.

EM for GMMs

- E-step: Evaluate the Responsibilities

$$\boxed{\tau(z_{nk}) \quad = \quad \frac{\pi_k N(x_n|\mu_k, \Sigma_k)}{\sum_{j=1}^{K} \pi_j N(x_n|\mu_j, \Sigma_j)}}$$

- M-Step: Re-estimate Parameters

$$\boxed{\mu_k^{new} = \frac{\sum_{n=1}^{N} \tau(z_{nk}) x_n}{N_k}}$$

$$\boxed{\Sigma_k^{new} \quad = \quad \frac{1}{N_k} \sum_{n=1}^{N} \tau(z_{nk})(x_k - \mu_k^{new})(x_k - \mu_k^{new})^T}$$

$$\boxed{\pi_k^{new} = \frac{N_k}{N}}$$

Initialization

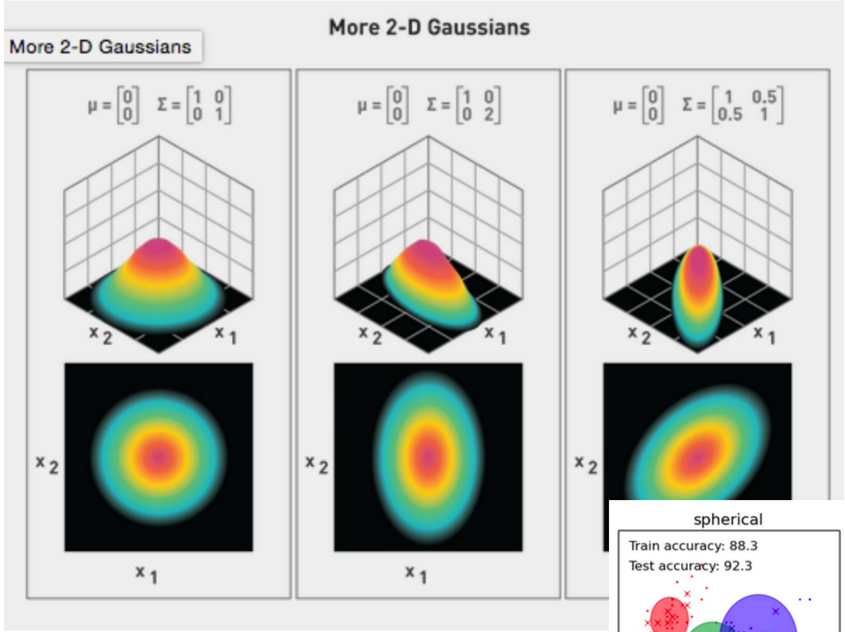
- Can use kmeans (faster). Mixing is proportional to number of examples in each cluster.

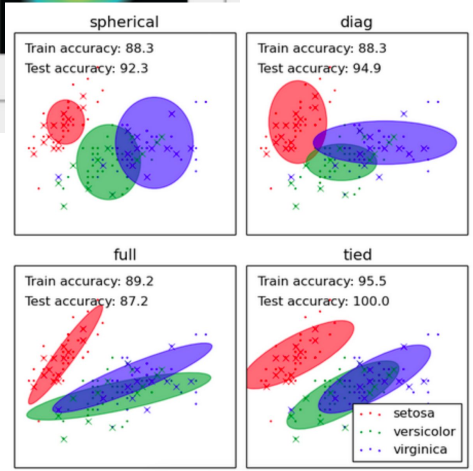
E-Step

- Compute the 'responsibilities'

M-Step

- Update the parameters





Covariance Types

Spherical (7)(1)
[7.5 0 0
0 7.5 0
0 0 7.5]

Diagnol (21)(3)
[4 0 0
0 8.4 0
0 0 6]

Full (42)(6)
[4 1 5
1 8.4 6
5 6 6]

Case Study...

Final Thoughts?