Pattern Recognition and Machine Learning : Assignment 4

- The assignment is **due** on **April 4**.
- Submit a soft copy of the code and report highlighting the observations and inferences before the deadline.
- Let me inform you that this assignment is very challenging and exciting. So start early! Do ask for any clarifications, if necessary.

Task 1

Implement a Gaussian Mixture Model (GMM) based clustering scheme on the image '`ski_image.jpg`'. To aid you through this task, you may consider incorporating the following suggestions :

- Assume that the mixture comprises 3 Gaussian components (clusters).
- The RGB values of pixel intensities (after appropriate normalization to the range [0,1]) can be used as features.
- You may consider starting the iterations using the means

$$\boldsymbol{\mu_1} = \begin{bmatrix} 0.47 \\ 0.47 \\ 0.47 \end{bmatrix} \qquad \boldsymbol{\mu_2} = \begin{bmatrix} 0.05 \\ 0.05 \\ 0.05 \end{bmatrix} \qquad \boldsymbol{\mu_3} = \begin{bmatrix} 0.7 \\ 0.7 \\ 0.7 \end{bmatrix}.$$

- The covariance matrix corresponding to each Gaussian may be initialized as

$$\boldsymbol{\Sigma_i} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \qquad i = 1, 2, 3$$

- The weighting of each Gaussian component (prior weights) in the GMM may be initialized to $\frac{1}{3}$.

$$\boldsymbol{\pi_i} = \tfrac{1}{3} \qquad i = 1, 2, 3$$

- It is very important that you iterate through the algorithm several times , so that the likelihood function converges.

1. Display the segmented output.

2. Display a graph depicting the convergence of the log likelihood values.

3. What are the final values of the means, prior weights and covariance matrices

Task 2

In this task, you will apply the Gaussian Mixture Model as a density estimation technique to the problem of classification. The description of the data to be used for training and testing is as follows:

- You have been provided training features, corresponding to two classes ω_1 and ω_2 in the files `Pattern1.mat` and `Pattern2.mat` respectively. Each file contains 200 instances (training examples), of 120 feature dimensions.

- The features corresponding to 100 testing samples of ω_1 and ω_2 are contained in `Test1.mat` and `Test2.mat` respectively.

1. Utilize the features contained in `Pattern1.mat` and `Pattern2.mat` to build separate Gaussian Mixture Models for the classes ω_1 and ω_2. You may choose 2 Gaussian components in each mixture. The initial means may be randomly chosen from the training data by running the k-means algorithm. The covariance matrix for each Gaussian component can be initialized to the identity matrix.

2. Use the trained models from part (1) to test the performance of the features contained in the files `Test1.mat` and `Test2.mat`. Report the recognition accuracy for each class.