CS 479/679 Pattern Recognition
Spring 2016 – Prof. Bebis
Programming Assignment 1 - Due: 2/22/2016

1. Generate 10,000 samples from each 2D Gaussian distribution specified by the following parameters:

$$\mu_1 = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \quad \Sigma_1 = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix} \quad \mu_2 = \begin{bmatrix} 6 \\ 6 \end{bmatrix} \quad \Sigma_2 = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$$

   Please, note that this is not the same as sampling the functions shown above; see "Generating Gaussian Random Numbers" on the course's webpage for more information on how to generate the samples using the **Box-Muller** transformation. A link to C code has been provided. Since the code generates samples for 1D distributions, you would need to call the function twice to get a 2D sample (x, y); use the x-mean, x-variance for the x sample and the y-mean, y-variance for the y sample.

   a. Assuming $P(\omega_1) = P(\omega_2)$
      i. Design a Bayes classifier for minimum error.
      ii. Plot the Bayes decision boundary together with the generated samples to better visualize and interpret the classification results.
      iii. Report the number of misclassified samples for each class separately and the total number of misclassified samples.
      iv. Plot the Chernoff bound as a function of β and find the optimum β for the minimum.
      v. Calculate the Bhattacharyya bound.

   b. Repeat part (a) for $P(\omega_1) = 0.2$ and $P(\omega_2) = 0.8$.

2. Repeat (1) using the following parameters:

$$\mu_1 = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \quad \Sigma_1 = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix} \quad \mu_2 = \begin{bmatrix} 6 \\ 6 \end{bmatrix} \quad \Sigma_2 = \begin{bmatrix} 4 & 0 \\ 0 & 8 \end{bmatrix}$$

3. For part 2, use the minimum-distance classifier to classify the samples and compare your results (i.e., misclassified samples) with the Bayes classifier from part 2.

PROJECT REPORT SUBMISSION REQUIREMENTS

1. Cover Page. The cover page should contain Project title, Project number, Course number, Student's name, Date due, and Date handed in.

2. Technical discussion. This section should include the techniques used and the principal equations (if any) implemented.

3. Discussion of results. A discussion of results should include major findings in terms of the project objectives, and make clear reference to any figures generated.

4. Division of work: Include a statement that describes how the work was divided between the two group members.

5. Program listings. Includes listings of all programs written by the student. Standard routines and other material obtained from other sources should be acknowledged by name, but their listings should not be included.

You need to turn in a printed copy of your report (i.e., items 1-4), in the beginning of the class on the due date. Program listings (i.e., item 5) should be emailed to the instructor, as a zip file, before class on the due date. Each group should submit one report only.