

## **PR ASSIGNMENT - 2 (Deadline : 06/03/2021 )**

### **Design of Bayes Classifier**

#### **Deliverables for this assignment:**

1. Programming Assignment (MATLAB or Python)
  2. Code file and output screenshots for all. **You can make use of built in command to find the covariance matrix, where normalization is done using  $1/n-1$ .**
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Q1. Find and plot the decision boundary between class  $\omega_1$  and  $\omega_2$ . Assume  $P(\omega_1) = P(\omega_2)$ .

$$\omega_1 = [1,6; 3,4; 3,8; 5,6]$$

$$\omega_2 = [3,0; 1,-2; 3,-4; 5,-2]$$

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Q2. Find and plot the decision boundary between class  $\omega_1$  and  $\omega_2$ . Assume  $P(\omega_1)=0.3$ ;  $P(\omega_2)=0.7$

$$\omega_1 = [1,-1; 2,-5; 3,-6; 4,-10; 5,-12; 6,-15]$$

$$\omega_2 = [-1,1; -2,5; -3,6; -4,10; -5,12; -6, 15]$$

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Q3. Find and plot the decision boundary between class  $\omega_1$  and  $\omega_2$ . Assume  $P(\omega_1) = P(\omega_2)$ .

$$\omega_1 = [2,6; 3,4; 3,8; 4,6]$$

$$\omega_2 = [3,0; 1,-2; 3,-4; 5,-2]$$

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Q4. Implement Bayes Classifier for Iris Dataset.

Dataset Specifications:

Total number of samples = 150

Number of classes = 3 (Iris setosa, Iris virginica, and Iris versicolor)

Number of samples in each class = 50

Use the following information to design classifier:

Number of training feature vectors ( first 40 in each class) = 40

Number of test feature vectors ( remaining 10 in each class) = 10

Number of dimensions = 4

Feature vector = <sepal length, sepal width, petal length, petal width>

If the samples follow a multivariate normal density, find the accuracy of classification for the test feature vectors.

Q5. Use only two features: Petal Length and Petal Width, for 3 class classification and draw the decision boundary between them (2 dimension, 3 regions also called as multi-class problem)

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Q6. Consider the 128- dimensional feature vectors given in the “face feature vectors.csv” file. Use this information to design and implement a Bayes Classifier.

Dataset Specifications:

Total number of samples = 800

Number of classes = 2 ( labelled as “male” and “female”)

Samples from “1 to 400” belongs to class “male”

Samples from “401 to 800” belongs to class “female”

Number of samples per class = 400

Use the following information to design classifier:

Number of test feature vectors ( first 5 in each class) = 5

Number of training feature vectors ( remaining 395 in each class) = 395

Number of dimensions = 128

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### Design of Bayes Classifier

Given,

Iris dataset

$X = \langle x_1, x_2, x_3, x_4 \rangle$

Number of classes =  $\omega_1, \omega_2, \omega_3$  ;  $c=3$

$N=150$ ;  $n(\omega_1)=n(\omega_2)=n(\omega_3)=50$

Bayes Rule:

$$\text{Find } P(\omega_i|X) = \frac{P(X|\omega_i).P(\omega_i)}{P(X)}$$

$P(X)$  is a constant for all classes; so it can be ignored.

Steps to follow in Iris Classification:

1. Find apriori probability  $P(\omega_i) = \frac{n(\omega_i)}{N} = \frac{50}{150}$
2. Find  $P(X|\omega_i)$ , it's multivariate class, by following normal density

$$P(X|\omega_i) = \frac{1}{(2\pi)^{d/2} |\Sigma_i|^{1/2}} \exp \left[ -\frac{1}{2} \{ (X - \mu_i)^t \Sigma_i^{-1} (X - \mu_i) \} \right]$$

- 2 a. Find the mean vector
- 2 b. Find the covariance matrix,  $\Sigma_i$
- 2 c. Find the  $|\Sigma_i|$  and  $|\Sigma_i|^{-1}$
3. Find  $P(\omega_1|X)$ ,  $P(\omega_2|X)$  and  $P(\omega_3|X)$ . Find the maximum and assign  $X$  to that class.  
Also, plot the accuracy for :
  - i) Separate classes
  - ii) Overall performance
4. Find the discriminant function and draw the decision surface between the classes.

Note: The same steps can be followed for Q6.

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