CS669: Pattern Recognition

Programming Assignment 4

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By-

Group 12

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Introduction:

Datasets:

Dataset 1: 2-dimensional artificial data of 3 or 4 classes:
(a) Linearly separable dataset
(b) Nonlinearly separable data set **(Only for SVM)**
Dataset 2: Real world data set:
(a) Two dimensional speech dataset (used in Assignment 1)
(b) Image dataset

Classifiers to be built:

1. Bayes classifier using unimodal Gaussian distribution on Dataset-1(a) and Dataset-2.
2. Bayes classifier using GMM on Dataset-2. GMM is built using the K-means clustering to initialize the parameters.
3. Build Bayes classifier using unimodal Gaussian distribution on the 1-dimensional representation of Dataset-1(a) and Dataset-2(a) obtained using PCA.
4. Build Bayes classifier using unimodal Gaussian distribution and GMM on the reduced dimensional representations of Dataset-2 obtaind using PCA.
5. Fisher linear discriminant analysis (FDA) based classifier on Dataset-1 and Dataset-2. Use both Bayes classifier using unomodal Gaussian and GMM.
6. Perceptron-based classifier on Dataset-1.
7. SVM-based classifier using (a) linear kernel, (b) polynomial kernel and (c) Gaussian/RBF kernel on Dataset-1 and Dataset-2
8. SVM-based classifier using (a) linear kernel, (b) polynomial kernel and (c) Gaussian/RBF kernel on the reduced dimensional representations of Dataset-2 obtained using PCA.

Perform the experiments on different values of *K* in GMM for different reduced dimensions. Also perform experiments on different values of SVM and kernel parameters for different reduced dimensions.

Note: Concatenate the local feature vectors in each image to form a super vector. Now each image will become a vector with 36*23-dimension.

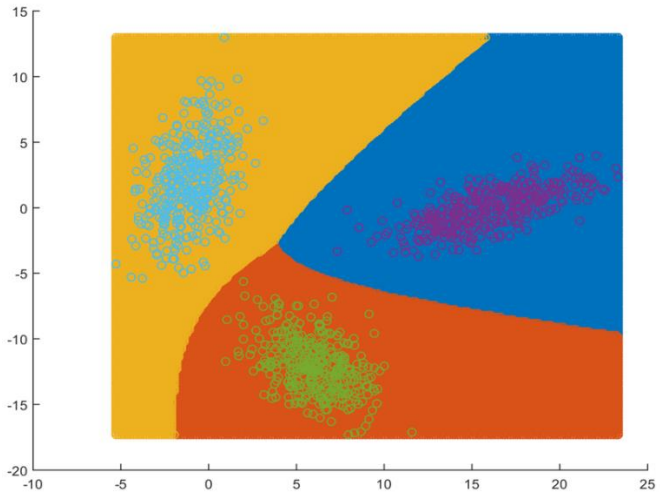
1. Bayes classifier using Unimodal Gaussian distribution on Dataset-1(a) and Dataset-2.

a. Dataset-1(a): Linearly Separable

i. **Classification Accuracy** = 100%

ii. Confusion Matrix based on performance for test data.

$$\begin{bmatrix} \mathbf{125} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{125} & \mathbf{2} \\ \mathbf{0} & \mathbf{0} & \mathbf{125} \end{bmatrix}$$



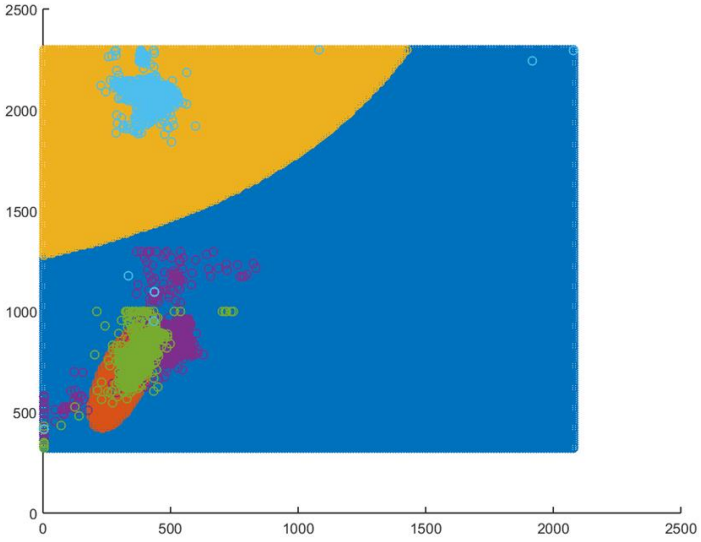
b. Dataset-2

Two dimensional speech dataset (used in Assignment 1)

Classification Accuracy: - 82.698%

Confusion Matrix

	Class1	Class2	Class3
Class1	411	203	0
Class2	91	531	0
Class3	11	8	554



2. Bayes classifier using GMM on Dataset-2. GMM is built using the K-means clustering to initialize the parameters.

Dataset	Confusion Matrix	Accuracy
Two dimensional speech dataset	**K = 8,8,4** $\begin{bmatrix} 404 & 214 & 4 \\ 45 & 573 & 4 \\ 7 & 13 & 552 \end{bmatrix}$	84%
Image dataset	**K= 16** $\begin{bmatrix} 80 & 3 & 7 \\ 2 & 80 & 0 \\ 3 & 2 & 72 \end{bmatrix}$	93.173%

3. Build Bayes classifier using unimodal Gaussian distribution on the 1- dimensional representation of Dataset-1(a) and Dataset-2(a) obtained using PCA.

Dataset	Confusion Matrix	Accuracy
Linearly Separable	$\begin{bmatrix} 123 & 2 & 0 \\ 4 & 120 & 1 \\ 0 & 0 & 125 \end{bmatrix}$	98.133 %
Two dimensional speech dataset	$\begin{bmatrix} 312 & 302 & 0 \\ 73 & 549 & 0 \\ 13 & 7 & 553 \end{bmatrix}$	78.165%

4. Build Bayes classifier using unimodal Gaussian distribution and GMM on the reduced dimensional representations of Dataset-2 obtained using PCA.

a. Two dimensional speech dataset
GMM

L	No. of Clusters	Confusion Matrix	Accuracy
1	**3**	$\begin{bmatrix} 499 & 115 & 0 \\ 98 & 524 & 0 \\ 16 & 10 & 547 \end{bmatrix}$	86.78%

b. Image dataset

Univariate

L	Confusion Matrix	Accuracy
1	$\begin{bmatrix} 26 & 34 & 30 \\ 12 & 70 & 0 \\ 21 & 2 & 54 \end{bmatrix}$	60.24%
2	$\begin{bmatrix} 26 & 37 & 27 \\ 9 & 70 & 3 \\ 9 & 3 & 65 \end{bmatrix}$	64.659%
4	$\begin{bmatrix} 59 & 15 & 16 \\ 5 & 73 & 4 \\ 9 & 3 & 65 \end{bmatrix}$	79%
8	$\begin{bmatrix} 73 & 8 & 9 \\ 11 & 68 & 3 \\ 6 & 4 & 67 \end{bmatrix}$	83.53%
16	$\begin{bmatrix} 77 & 4 & 9 \\ 6 & 68 & 8 \\ 8 & 3 & 66 \end{bmatrix}$	84.73%

Multivariate

L	No. of Clusters	Confusion Matrix	Accuracy
1	3	$\begin{bmatrix} 39 & 21 & 30 \\ 15 & 66 & 1 \\ 22 & 0 & 55 \end{bmatrix}$	64.25%
4	3	$\begin{bmatrix} 67 & 9 & 14 \\ 11 & 66 & 5 \\ 6 & 2 & 69 \end{bmatrix}$	81.124%
8	3	$\begin{bmatrix} 77 & 6 & 7 \\ 13 & 65 & 4 \\ 7 & 3 & 67 \end{bmatrix}$	83.93%

5. Fisher linear discriminant analysis (FDA) based classifier on Dataset-1 and Dataset-2. Use both Bayes classifier using unimodal Gaussian and GMM.

Dataset-1: Linearly Separable

Model	**Confusion Matrix**	**Accuracy**
Unimodal	$\begin{bmatrix} 125 & 0 & 0 \\ 0 & 125 & 0 \\ 0 & 0 & 125 \end{bmatrix}$	100%
GMM	$\begin{bmatrix} 125 & 0 & 0 \\ 0 & 125 & 0 \\ 0 & 0 & 125 \end{bmatrix}$	100%

Dataset-2: Speech Dataset

Model	**Confusion Matrix**	**Accuracy**
Unimodal	$\begin{bmatrix} 476 & 138 & 0 \\ 83 & 539 & 0 \\ 13 & 8 & 552 \end{bmatrix}$	86.62%
GMM	$\begin{bmatrix} 452 & 162 & 0 \\ 58 & 564 & 0 \\ 13 & 8 & 552 \end{bmatrix}$	86.67%

Dataset-2: Image Dataset

Matrix was coming out to be singular.

7. SVM-based classifier using (a) linear kernel, (b) Gaussian/RBF kernel on Dataset-1 and Dataset-2.

Dataset-1(a): Linearly Separable

Kernel	Confusion Matrix	Accuracy
Linear	$\begin{bmatrix} 125 & 0 & 0 \\ 0 & 125 & 0 \\ 0 & 0 & 125 \end{bmatrix}$	100%
RBF/Gaussian	$\begin{bmatrix} 125 & 0 & 0 \\ 0 & 125 & 0 \\ 0 & 0 & 125 \end{bmatrix}$	100%

Dataset-1(b): Non-Linearly Separable

Ring

Kernel	Confusion Matrix	Accuracy
Linear	$\begin{bmatrix} 0 & 75 \\ 0 & 300 \end{bmatrix}$	80%
RBF/Gaussian	$\begin{bmatrix} 75 & 0 \\ 0 & 300 \end{bmatrix}$	100%

Spiral

Kernel	Confusion Matrix	Accuracy
Linear	$\begin{bmatrix} 175 & 151 \\ 151 & 175 \end{bmatrix}$	53.68%
RBF/Gaussian	$\begin{bmatrix} 296 & 30 \\ 30 & 296 \end{bmatrix}$	90.798%

Interlock

Kernel	Confusion Matrix	Accuracy
Linear	$\begin{bmatrix} 118 & 7 \\ 1 & 124 \end{bmatrix}$	96.8%
RBF/Gaussian	$\begin{bmatrix} 125 & 0 \\ 0 & 125 \end{bmatrix}$	100 %

Dataset-2(a): Two dimensional Speech

Kernel	Confusion Matrix	Accuracy
Linear	$\begin{bmatrix} 415 & 199 & 0 \\ 20 & 602 & 0 \\ 0 & 15 & 558 \end{bmatrix}$	87.065%
RBF/Gaussian	$\begin{bmatrix} 402 & 211 & 1 \\ 40 & 580 & 2 \\ 3 & 12 & 558 \end{bmatrix}$	85.13%

Dataset-2(b): Image Dataset

Kernel	Confusion Matrix	Accuracy
Linear	$\begin{bmatrix} 86 & 2 & 2 \\ 1 & 81 & 0 \\ 4 & 2 & 71 \end{bmatrix}$	95.582%
RBF/Gaussian	$\begin{bmatrix} 90 & 0 & 0 \\ 82 & 0 & 0 \\ 77 & 0 & 0 \end{bmatrix}$	36.145%

8. SVM-based classifier using (a) linear kernel, (b) polynomial kernel and (c) Gaussian/RBF kernel on the reduced dimensional representations of Dataset-2 obtained using PCA.

Dataset-2(a): Speech Data

Kernel	L	Confusion Matrix	Accuracy
Linear	1	$\begin{bmatrix} 430 & 184 & 0 \\ 65 & 557 & 0 \\ 6 & 12 & 555 \end{bmatrix}$	85.24%
RBF/Gaussian	1	$\begin{bmatrix} 468 & 146 & 0 \\ 48 & 574 & 0 \\ 10 & 11 & 552 \end{bmatrix}$	88.115%

Dataset-2(b): Image Data

Kernel	**L**	**Confusion Matrix**	**Accuracy**
Linear	1	$\begin{bmatrix} 54 & 26 & 10 \\ 14 & 68 & 0 \\ 33 & 2 & 42 \end{bmatrix}$	65.863%
RBF/Gaussian	1	$\begin{bmatrix} 44 & 25 & 21 \\ 14 & 68 & 0 \\ 30 & 0 & 47 \end{bmatrix}$	63.855%
Linear	16	$\begin{bmatrix} 66 & 12 & 12 \\ 5 & 75 & 2 \\ 7 & 3 & 67 \end{bmatrix}$	83.534%
RBF/Gaussian	16	$\begin{bmatrix} 44 & 4 & 42 \\ 10 & 34 & 38 \\ 2 & 1 & 74 \end{bmatrix}$	61.044%