# UNIVERSITY OF SOUTH FLORIDA

# Project 2

## Pattern Recognition

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In this project, we were given 4 datasets with ten classes each and also with ten samples for each class. We were expected to design six classifiers and train each classifier on Data Set A, and also use it to classify Data Set A and the three test sets B, C, and D

The 6 classifiers were trained by the following methods:

1. *Minimum distance moment classifier.*
   For this classifier we have used the Identity covariance matrix as the covariance matrix for all classes to find the probabilities. We classified the element to the class for which the element had the maximum probability.

2. *Bayes moment classifier with identical covariance.*
   For this classifier we have used the average covariance matrix as the covariance matrix for all classes to find the probabilities. We classified the element to the class for which the element had the maximum probability.

3. *Bayes moment classifier with individual class covariance.*
   For this classifier we have used the individual class covariance matrix as the covariance matrix for all classes to find the probabilities. We classified the element to the class for which the element had the maximum probability.

4. *Bayes moment classifier with individual class covariance (only first four moments).*
   For this classifier we have used the individual class covariance matrix (of only the first four moments) as the covariance matrix for all classes to find the probabilities. We classified the element to the class for which the element had the maximum probability.

For the first four classifiers we have used the multivariate Bayes probability function given by:

$$p(\underline{x}) = p(x_1, x_2, \ldots, x_d) = \frac{1}{(2\pi)^{\frac{d}{2}}|\Sigma|^{\frac{1}{2}}} e^{-\frac{1}{2}(\underline{x}-\underline{\mu})^T \Sigma^{-1} (\underline{x}-\underline{\mu})}$$

where $\underline{\mu} = (\mu_1, \ldots, \mu_d)$ is a $d \times 1$ dimensional vector of mean values and $\Sigma$ is a $d \times d$ covariance matrix with entries $\sigma_{ij} = cov(X_i, X_j)$ and diagonal terms $\sigma_{ii} = cov(X_i, X_i)$ being the variance $\sigma_i^2$ for each of the individual $X_i$ variables.

5. *Minimum distance classifier in binary pixel space.*
   For this classifier we found the pixel density probability for each pixel in each class. The pixel density probability is given by the formula

$$P_{ik} = \frac{\sum m_{ik} + 1}{n + 2}$$

Where $P_{ik}$ - Pixel density probability at I for class k

$m_{ik}$ - Element i for class k

n – number of class

We selected the class for which the Euclidian distance is minimum for the element.

6. *Bayes classifier in binary pixel space.*
   For this classifier we used the Bayes classifier in binary pixel given by the formula.

$$G_k(X) = \sum_i ((x_i)\ln(p_i) + (1 - x_i)\ln(1 - p_i))$$

Where pi – Pixel density probability at i

xi – Pixel at i

We used the pixel probability we found in question 5.

We selected the class for which the Bayes classifier is maximum for the element.

# Result:

The result of the project is displayed in the table below

| Test Method | A | B | C | D |
|---|---|---|---|---|
| 1 | 37 | 50 | 49 | 51 |
| 2 | 28 | 47 | 39 | 48 |
| 3 | 1 | 68 | 54 | 64 |
| 4 | 28 | 71 | 64 | 70 |
| 5 | 9 | 40 | 33 | 32 |
| 6 | 9 | 40 | 31 | 32 |

## Appendix:

We used a website to know how to use the Matlab which is http://www.mathworks.com/

The results of our project are shown in the next page: