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ECE 763 Computer Vision Project 01

Objective –

Face image classification using Gaussian model, Mixture of Gaussian model, tdistribution, Mixture of t-distribution, Factor Analysis and Mixture of Factor Analyzer

Data Preparation –

1. FDDB (Face Detection Data Set and Benchmark) dataset from University of Massachusetts was used.
2. This data set contains the annotations for 5171 faces in a set of 2845 images taken from the Faces in the Wild data set.
3. The images show ellipse drawn in the region of interest i.e. faces



4. The dataset has images and annotation .txt files describing ellipse details in terms of it axes, centers to extract only face from the image.
5. Using annotation files both face & non face images were extracted (Face & Non Face - 3868)
6. Face Images look like-



Face-Image-0



Face-Image-3



Face-Image-4



Face-Image-5



Face-Image-15



Face-Image-18



Face-Image-19



Face-Image-22



Face-Image-28



Face-Image-31

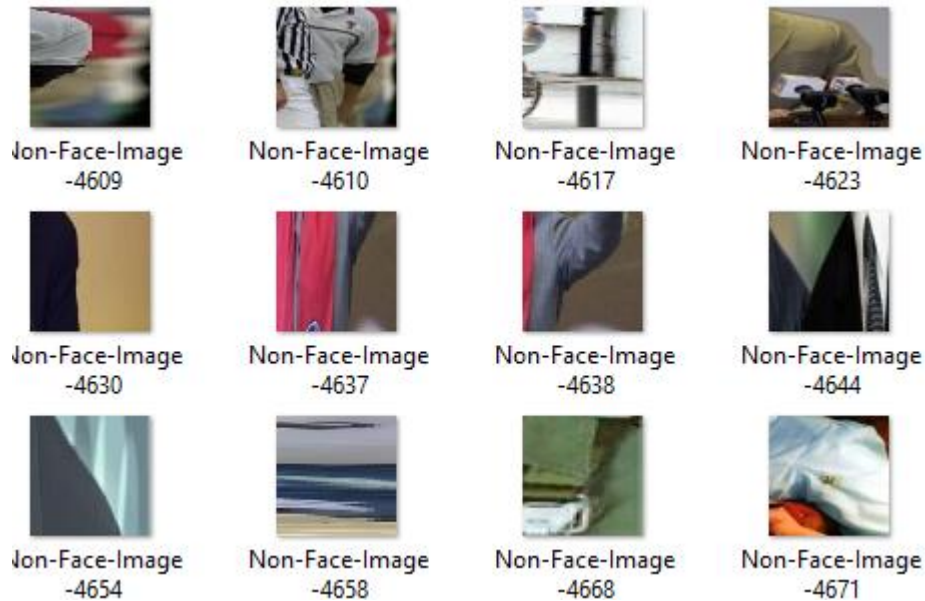


Face-Image-34



Face-Image-37

7. Non Face Images look like-



8. Data was split into Training & Testing Data as follows-

1. Training Data for Face Images – 1000
2. Training Data for Non Face Images – 1000
3. Testing Data for Face Images – 100
4. Testing Data for Non Face Images – 100

Overall 2000 images were used for training & 200 for testing

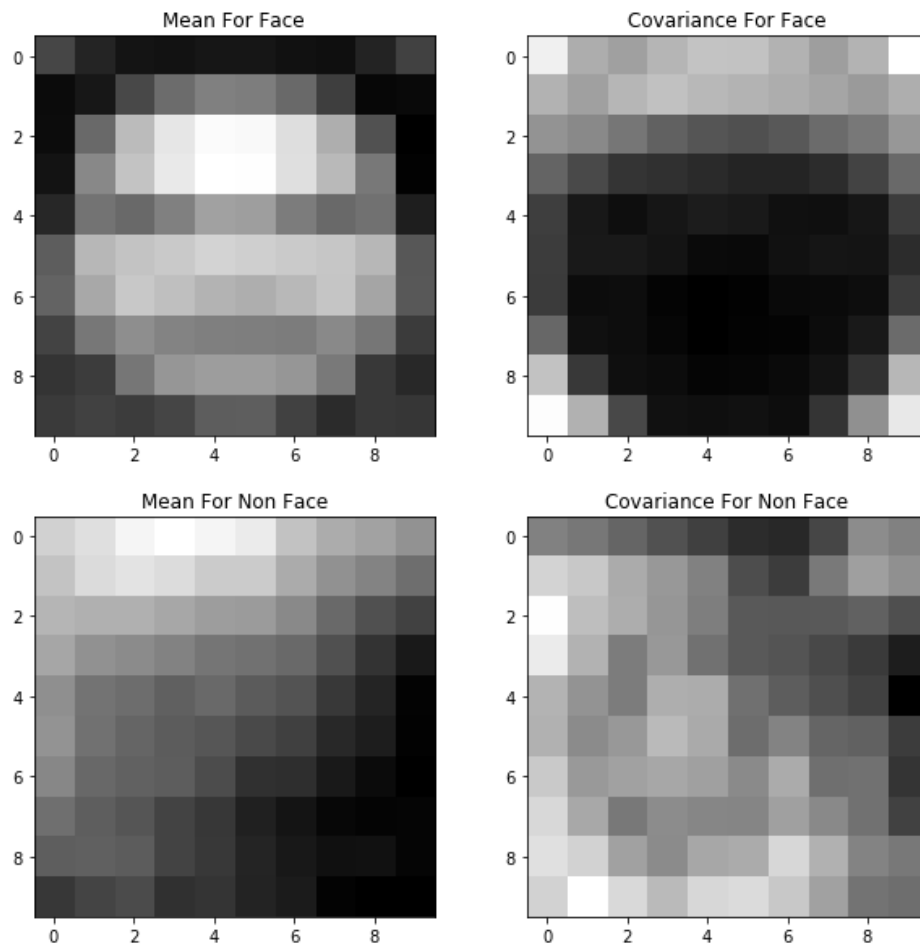
Modelling Data Densities (models) for Face Detection

Generalized Steps-

- Fit/Train model using training data (10*10*1 i.e. greyscale images)
- Evaluate the model using testing data
- Use confusion matrix i.e. false positive rate, false negative rate, and misclassification rate as metrics to evaluate the model performance.
- Plot ROC Curve.

1. Gaussian Model

1. Mean & Covariance (10*10*1 Images were used i.e. 100*1 feature vector)



2. Model Evaluation using Confusion Matrix

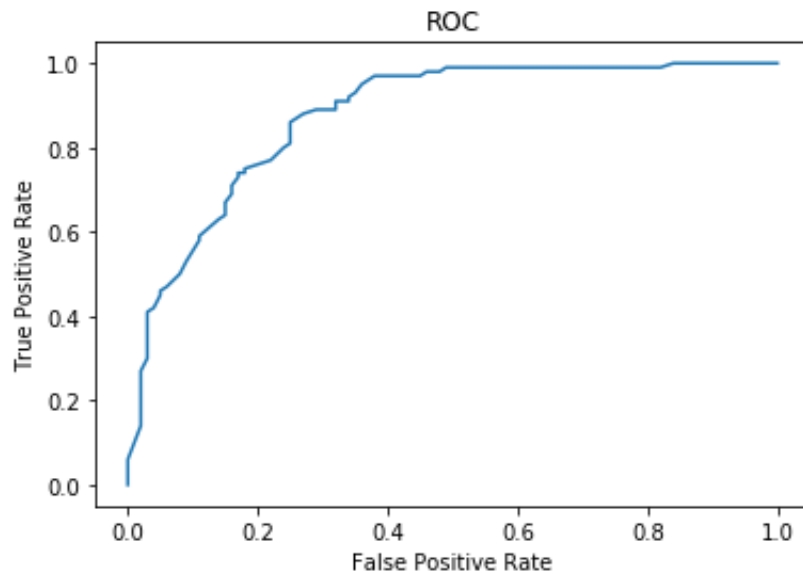
False Positive Rate (%)	False Negative Rate (%)	Misclassification Rate (%)
25	19	22

3. ROC Curve

FPR:0.25

FNR:0.19

MSR:0.22

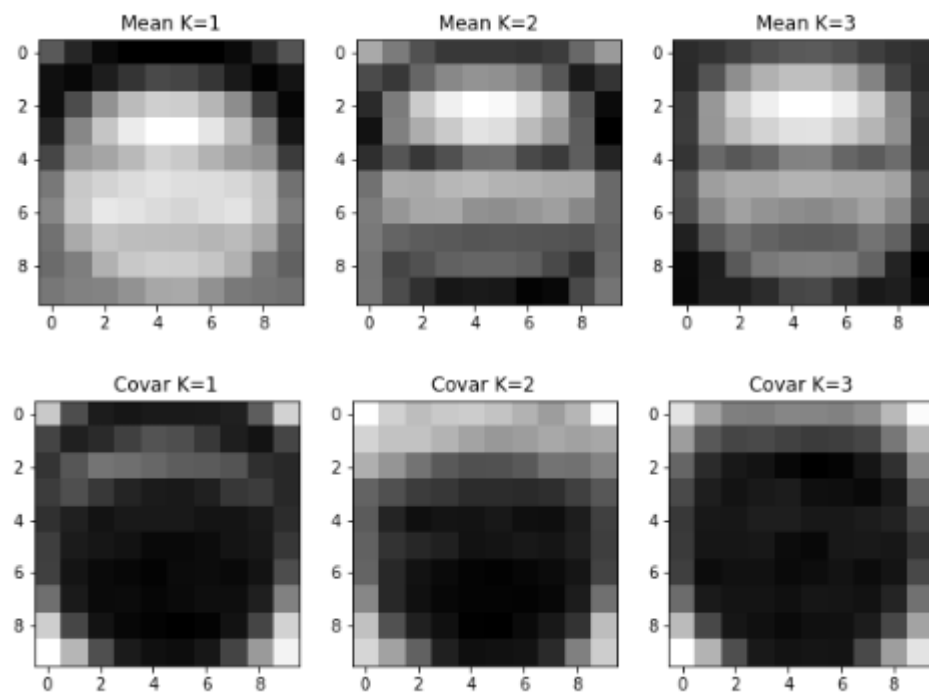


2. Mixture of Gaussian Model

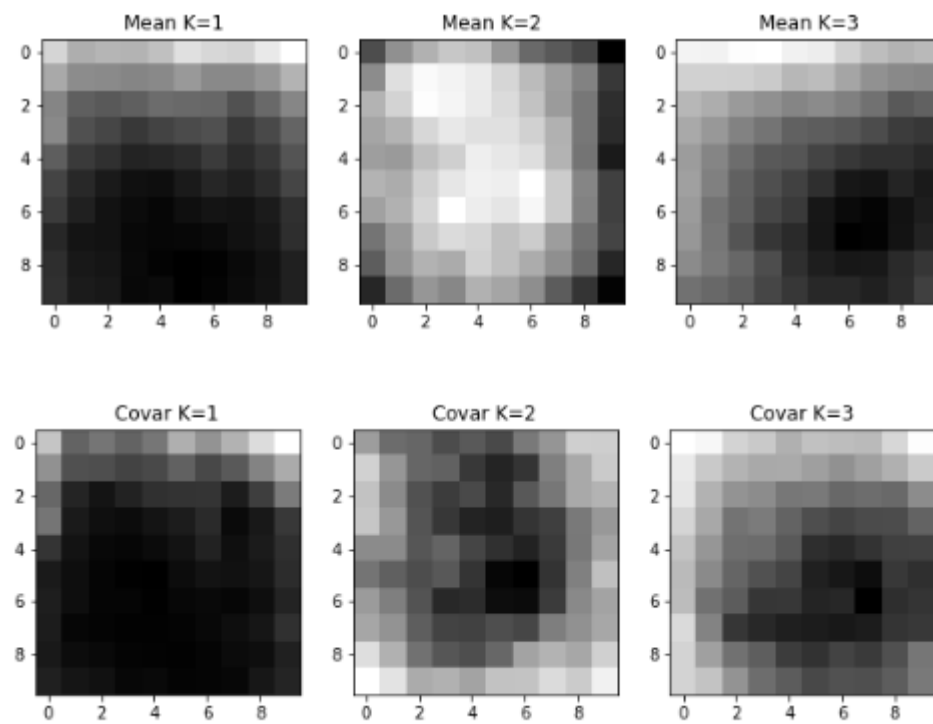
Here $K = 3$ i.e. 3 mixtures were used. It was chosen to avoid computational time and also gave pretty good results.

1. Mean & Covariance ($10 \times 10 \times 1$ Images were used i.e. 100×1 feature vector)

FACE IMAGES



NON FACE IMAGES

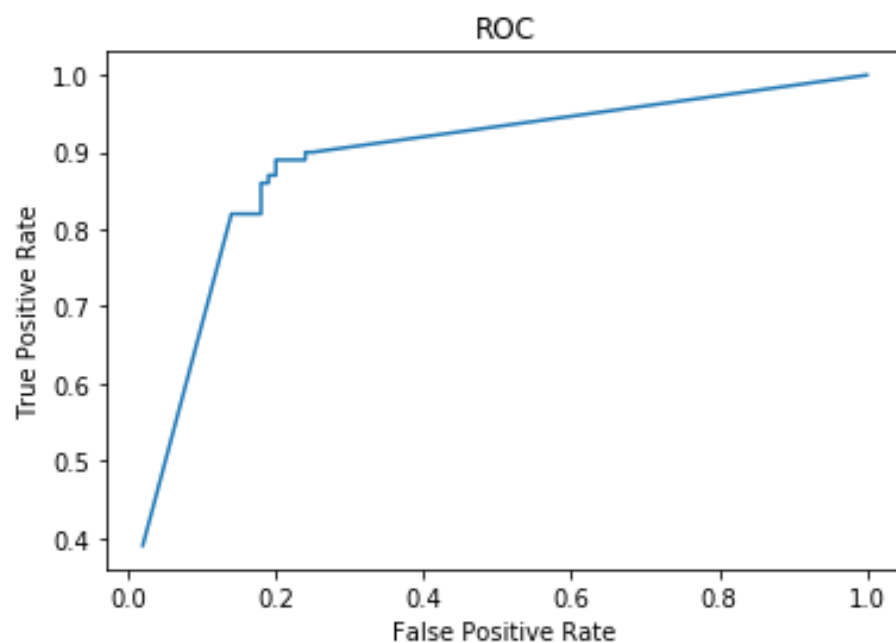


2. Model Evaluation using Confusion Matrix

False Positive Rate (%)	False Negative Rate (%)	Misclassification Rate (%)
20	11	15.5

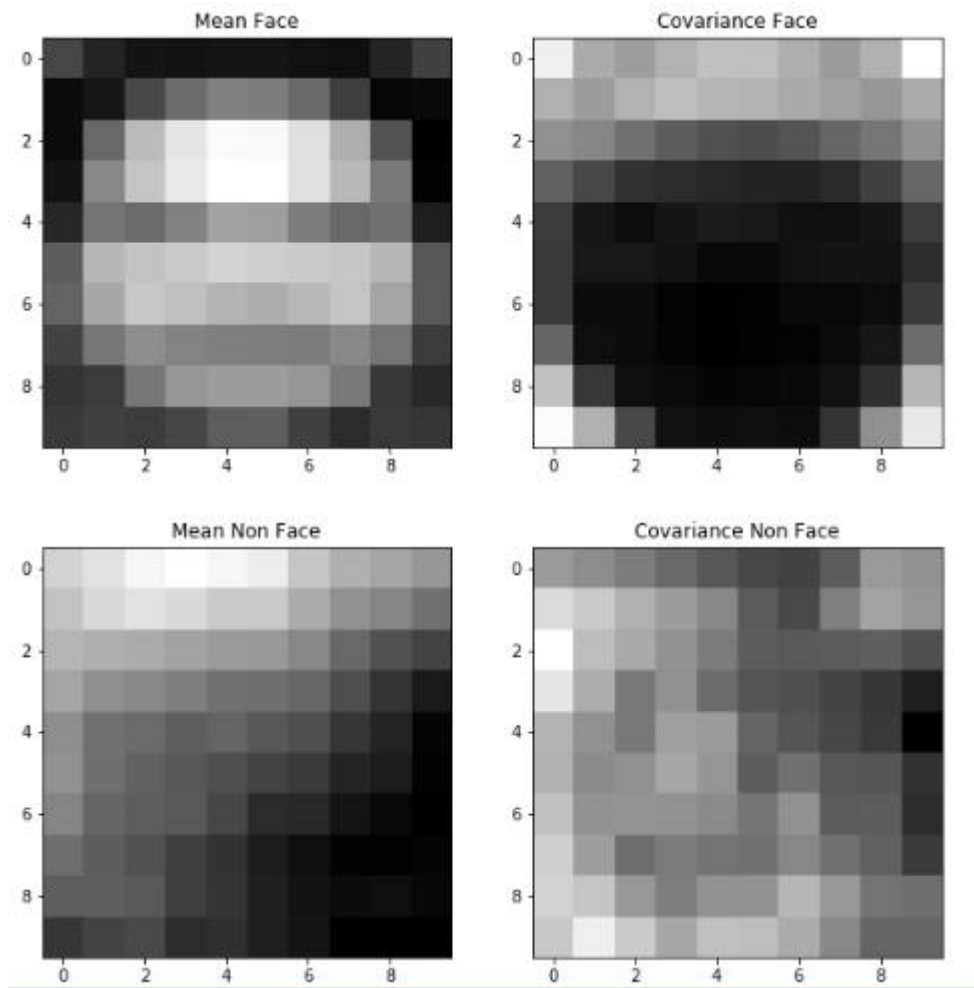
3. ROC Curve

FPR:0.2
FNR:0.11
MSR:0.155



3. Student's t distribution

1. Mean & Covariance (10*10*1 Images were used i.e. 100*1 feature vector)



2. Model Evaluation using Confusion Matrix

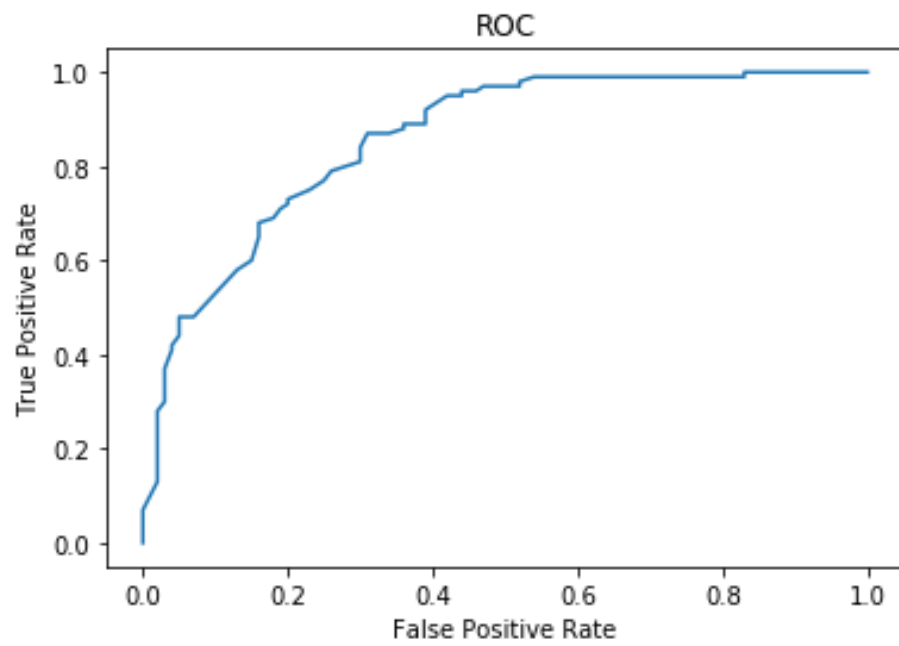
False Positive Rate (%)	False Negative Rate (%)	Misclassification Rate (%)
28	20	24

3. ROC Curve

FPR:0.28

FNR:0.2

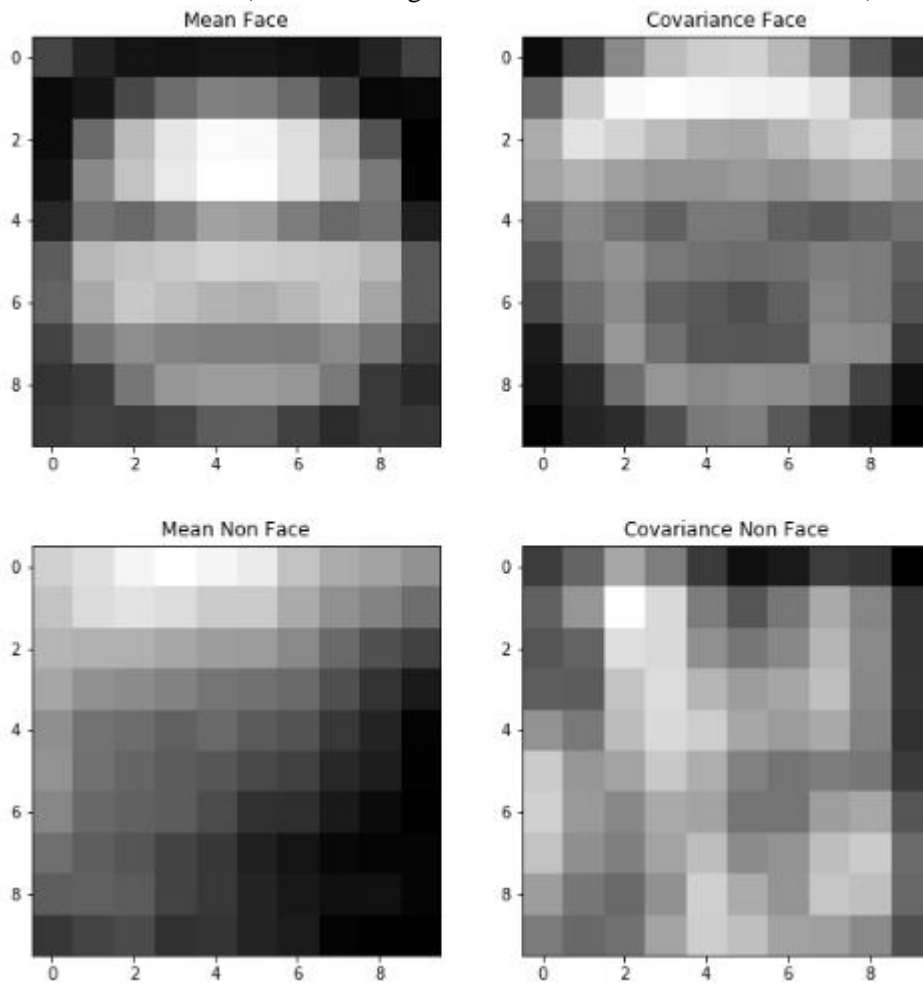
MSR:0.24



4. Factor Analyzer

Phi matrix is initialized randomly; this randomization affects accuracy. In multiple test the misclassification rates varied from 12-18%. Choice of phi matrix must be considered. Here $K = 5$ i.e. 5 factors were chosen. It was mostly to avoid computational time & gave pretty good results. (phi is $D \times 5$ matrix)

1. Mean & Covariance ($10 \times 10 \times 1$ Images were used i.e. 100×1 feature vector)



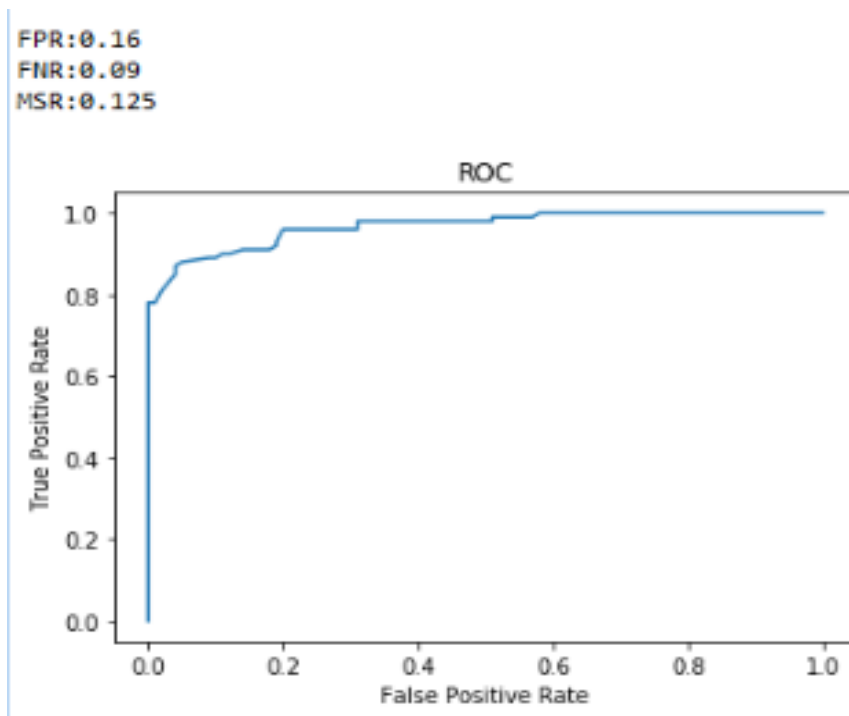
We can see that mean & covariance for face test data resembles face structure with 2 eyes, 1 nose and a mouth.

The mean & covariance for non-face images is random (i.e. mostly uncorrelated data).

2. Model Evaluation using Confusion matrix

False Positive Rate (%)	False Negative Rate (%)	Misclassification Rate (%)
16	9	12.5

3. ROC Curve



RESULTS-

MODEL	FALSE POSITIVE (%)	FALSE NEGATIVE (%)	MISCLASSIFICATION (%)
GAUSSIAN	25	19	22
MIXTURE OF GAUSSIAN	20	11	15.5
t	28	20	24
FACTOR ANALYSIS	16	9	12.5

CONCLUSION-

1. Single Gaussian & Student's t distribution shows almost similar performance as there aren't much outliers in the data.
2. Mixture of Gaussian is the best model as it gives highest accuracy for all the runtimes. Whereas, Factor analysis also gives great results but it is biased on the phi matrix, its initialization affects the accuracy changing the sparsity of covariance matrix.