Data Mining & Advanced Statistical Methods in BA

FACE RECOGNITION

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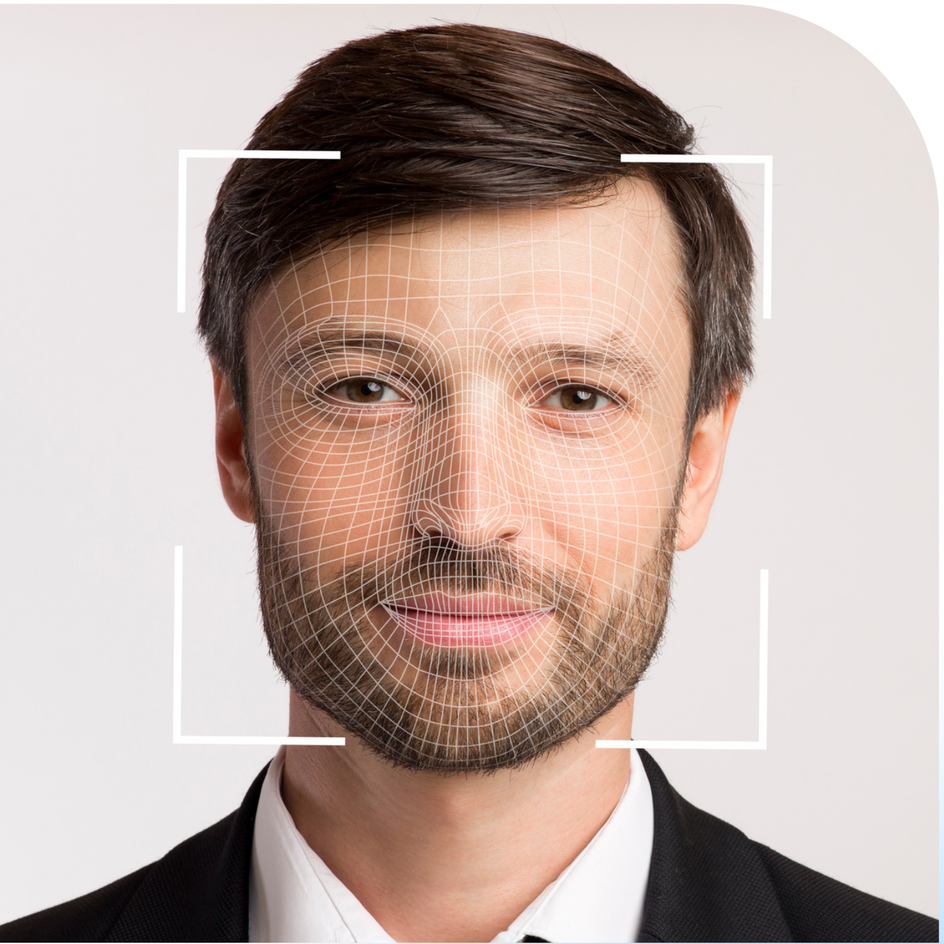
Outlines:



- Introduction
- Literature review
- Solution
- Result
- Conclusion

Introduction

Problem Definition	Motivation	Problem Setting	Demo

a. problem
definition

- **Human face is considered the prime factor in recognizing a person’s identity**

- **Face recognition is used for 2 primary tasks**
  - verification
  - identification

- **Application areas**
  - security
  - surveillance
  - investigation
  - identity verification

b.

motivation

enhance customer service by identifying customers

BACK TO AGENDA

enhance customer service by

identifying service

- identify the customer segment based on purchasing/visiting frequency
- analyzing customers past purchase history
- knowing demographic information of customer

c. problem
setting

TASK 1 & TASK 2

ORL dataset

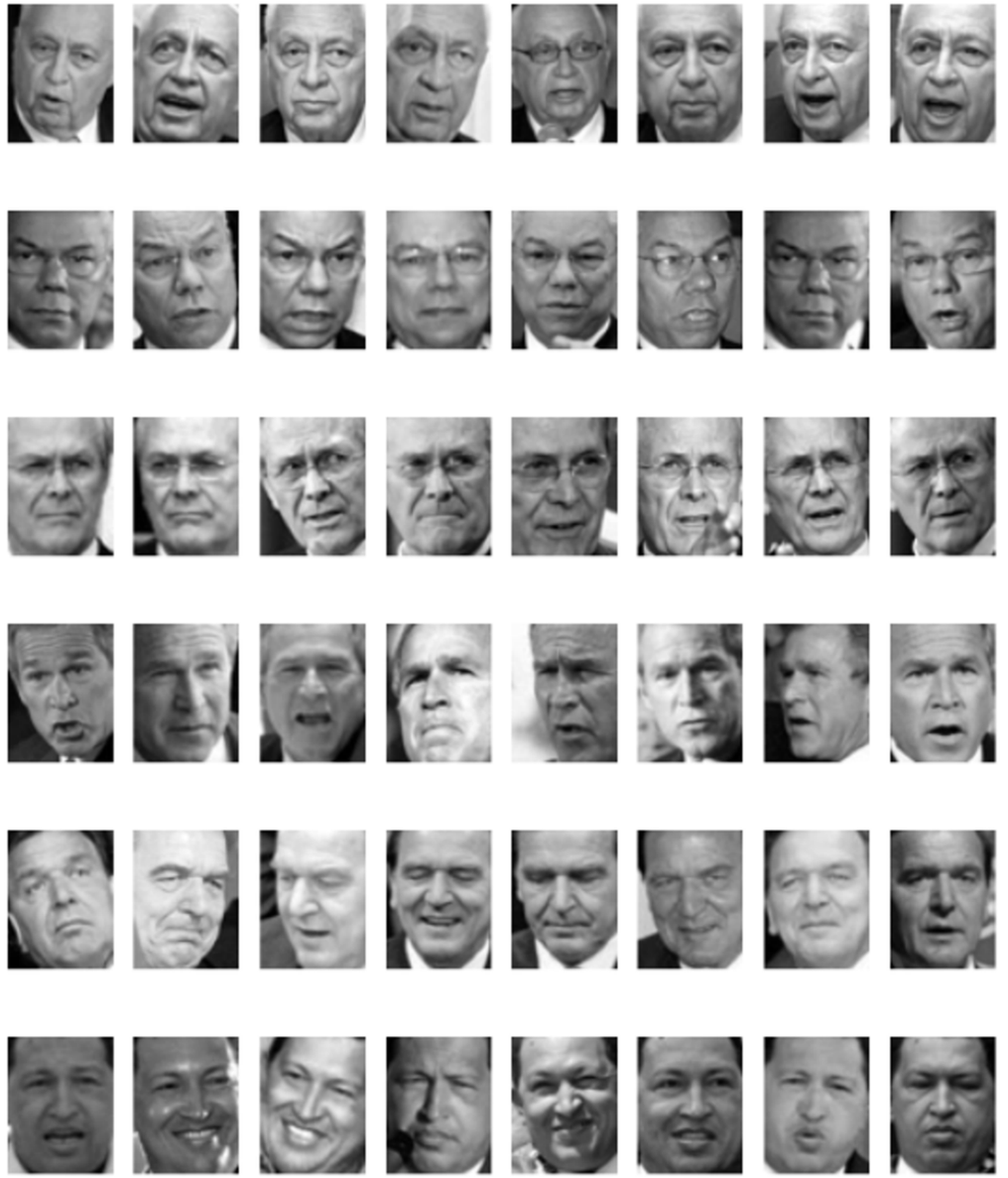
- dark homogeneous background with the subjects in an upright, frontal position
- taken at different times, varying the lighting, facial expressions and facial details
- contains 400 images from 40 distinct subjects
- size: 92 x 112

ORL dataset

TASK 3

LFW (Labeled Faces in the Wild) dataset

- variation in posture, facial quality, hairstyles, focus
- contains 1288 images from 7 identities
- choose images from people that have at least 70 images with size 62 x 47



c. problem
setting

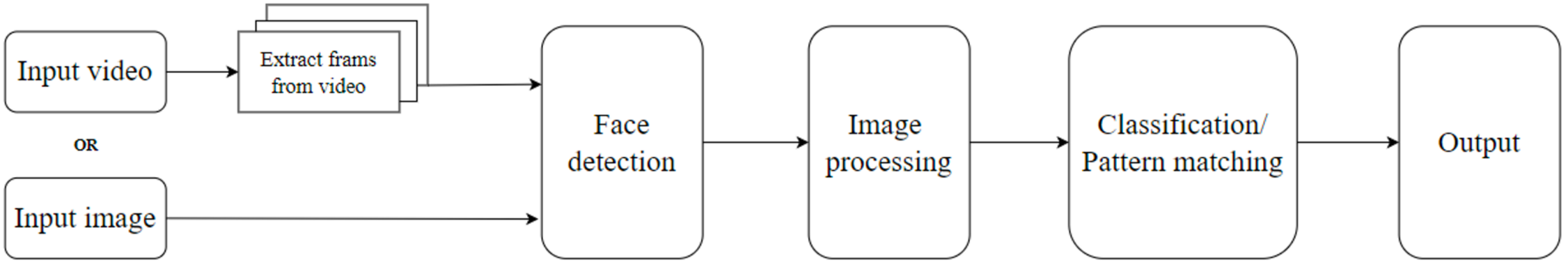
GOAL

accurately and reliably recognize and verify the identity of individuals based on their facial features under varying conditions

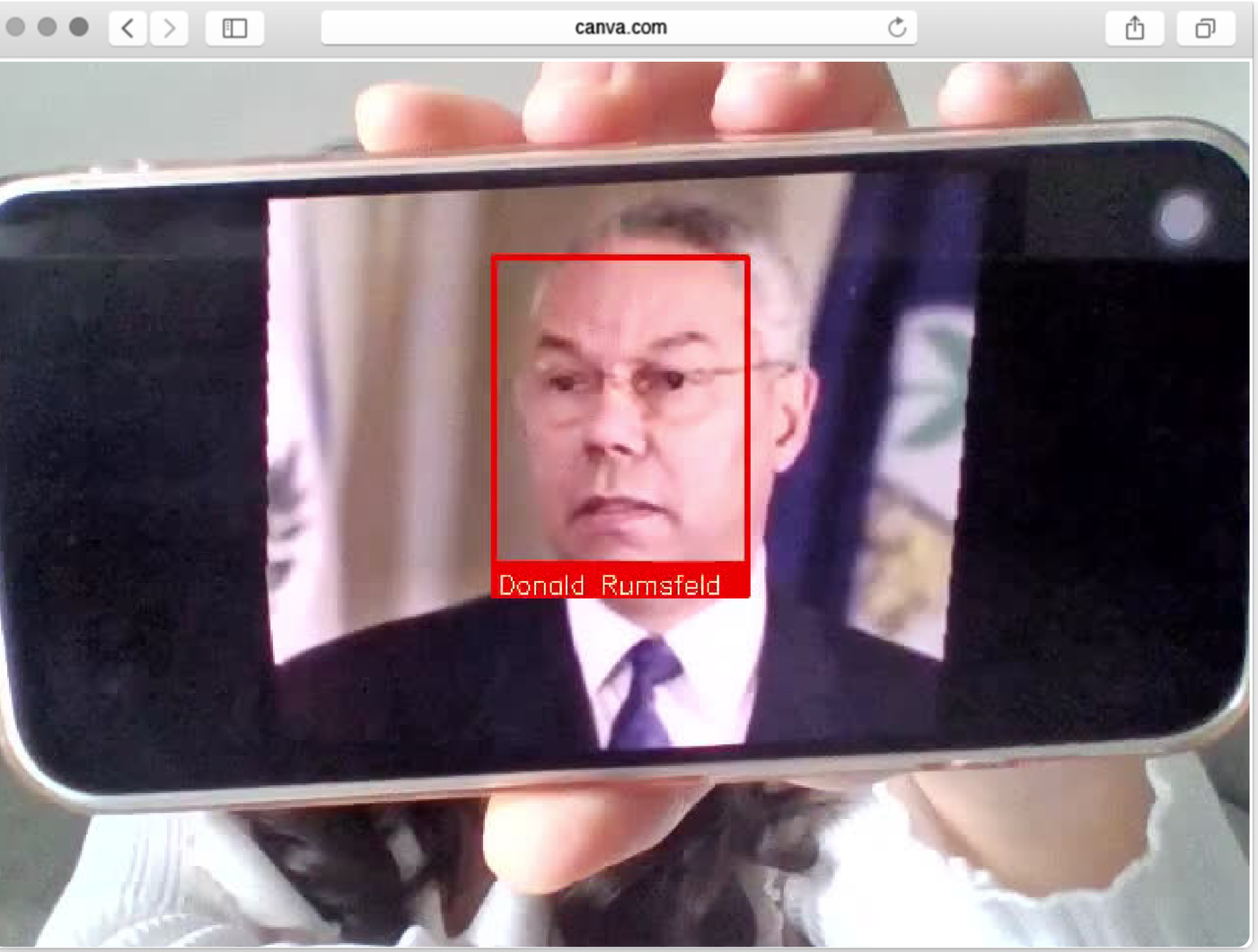
Predict: 1 (True label: 1)

d. demo

pipeline



BACK TO AGENDA



d. demo

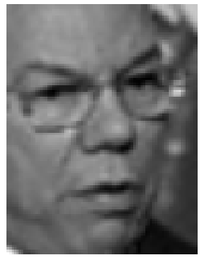
real-time

prediction &

best match

Predict: 1 (True label: 1)

#1
Name/ID: 1
Distance: 5.533



#2
Name/ID: 1
Distance: 5.678

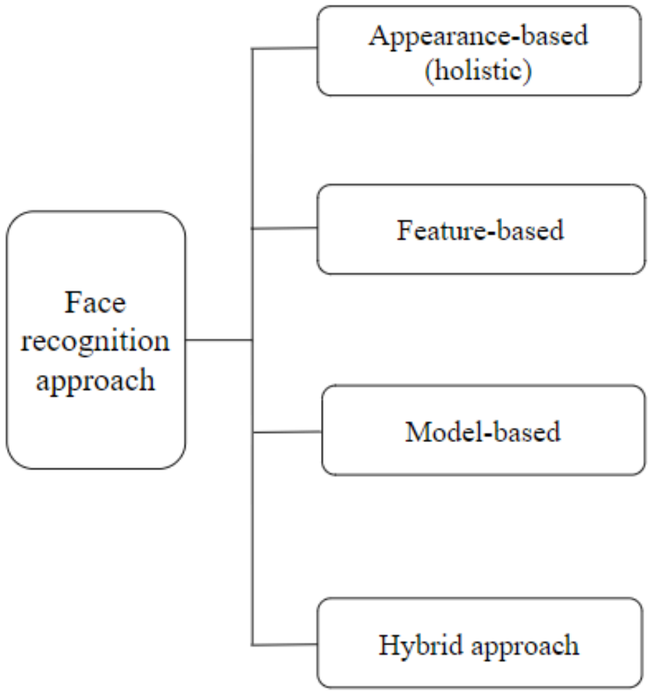
#3
Name/ID: 3
Distance: 6.168

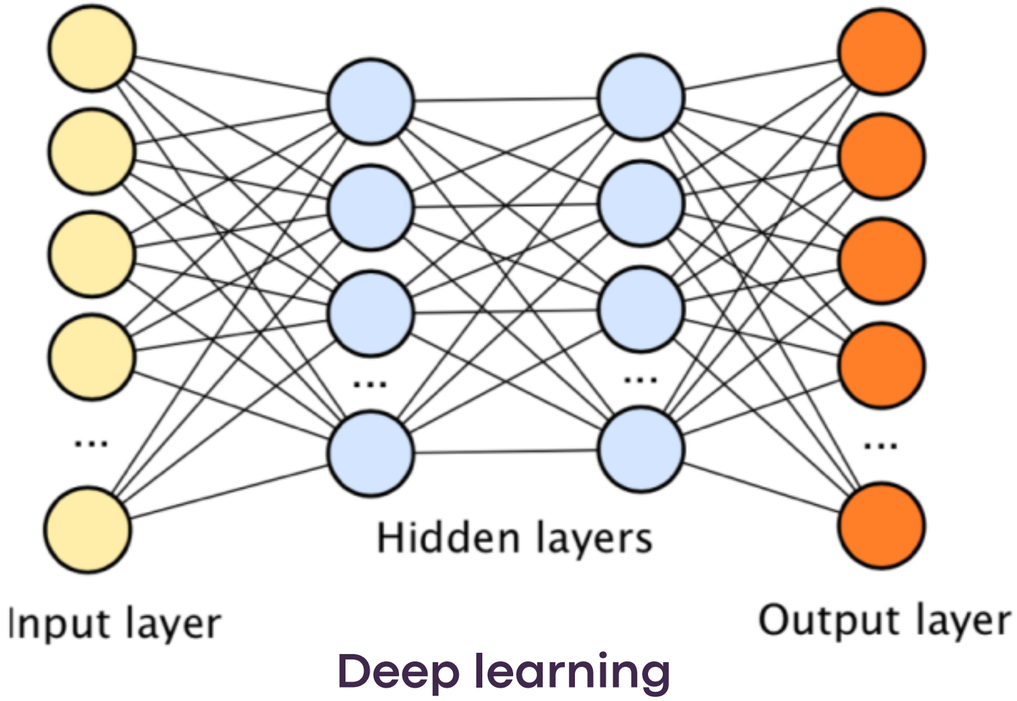
Best match

Literature review

According to **M.K.Rusia (2022)**, the process of recognizing a person's face can be broken down into two steps:

1. detecting the location of the face
2. classifying the detected region





Literature review

Several approaches have been experiment with ORL and LFW dataset:

- Simplify high-dimensional data visualization, and reveal patterns and relationships.

ORL dataset	LFW dataset
M.Turk and A. Pentland (1991): 89.5% accuracy	**D. Yi et al** (2014): 96.33%
Lawrence et al (1997): 96.2 accuracy	**Taigman et al** (2014): 97.35%
...	...

Chellapa et al (1995) presented a survey on face recognition. Currently, one of the methods that yields promising results on frontal face recognition is the principal component analysis (PCA)

Literature review

- **The main objective of this research:**

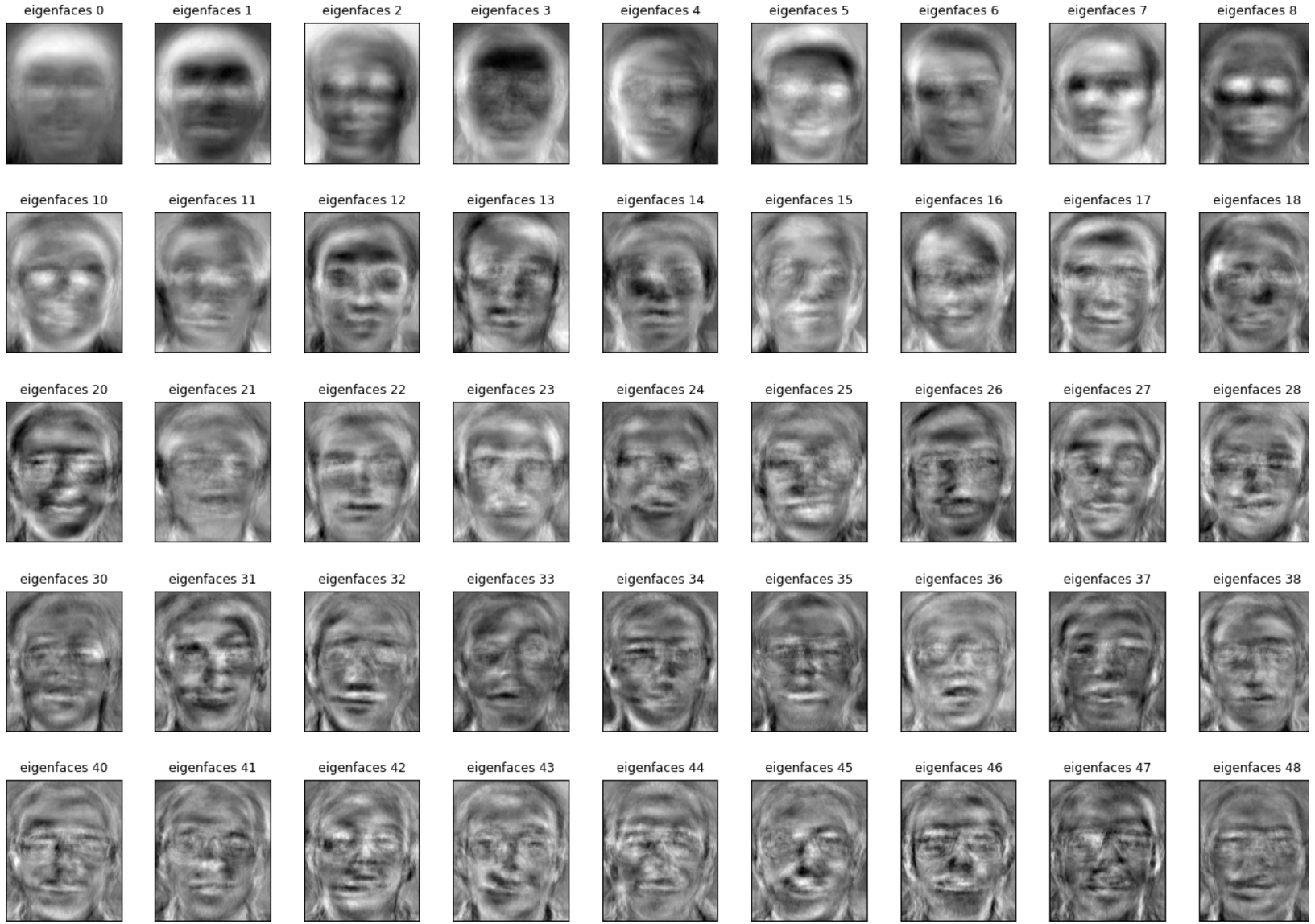
improve the accuracy and precision of face recognition under **varying facial expression**, **illumination**, and **pose conditions** by using **PCA and its extension** with advanced image processing techniques such as:

- contrast adjustment
- bilateral filter
- gaussian blur

solution

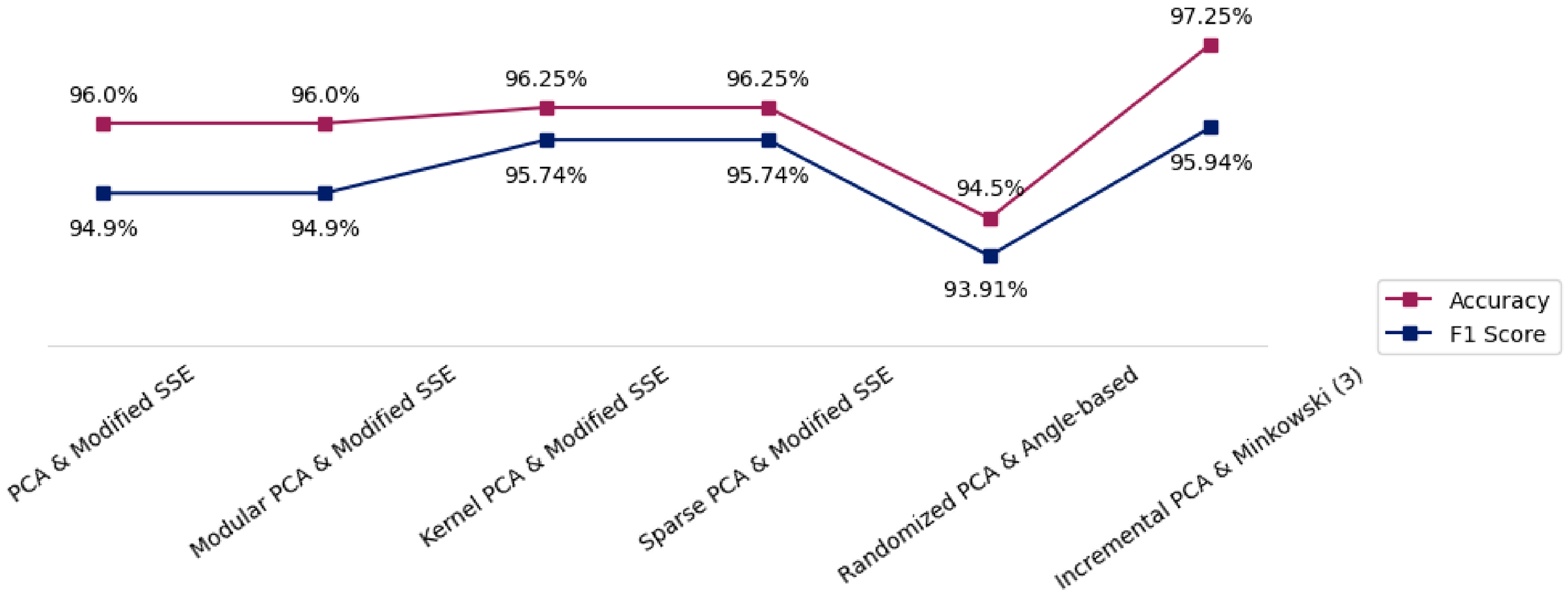
TASK 01

- **Eigenface**



Top-performing Distance Measures on ATT dataset

from k-fold cross-validation



solution

TASK 02

- **Evaluation different classification model:**

	Model	Accuracy	Recall	F1-score	Precision	ROC-AUC
1.	Logistic Regression & PCA	1,000	1,000	1,000	1,000	1,000
2.	SVM & PCA	1,000	1,000	1,000	1,000	1,000
3.	K-Nearest Neighbor & PCA	0.9875	0.993	0.992	0.993	0.996
4.	Random Forest & PCA	0,9875	0,9722	0,9667	0,963	0,9859
5.	Gaussian Naive Bayes & PCA	0,975	0,9583	0,9506	0,9528	0,979
6.	Decision Trees & KernelPCA	0,7375	0,7612	0,7181	0,7554	0,8876

solution

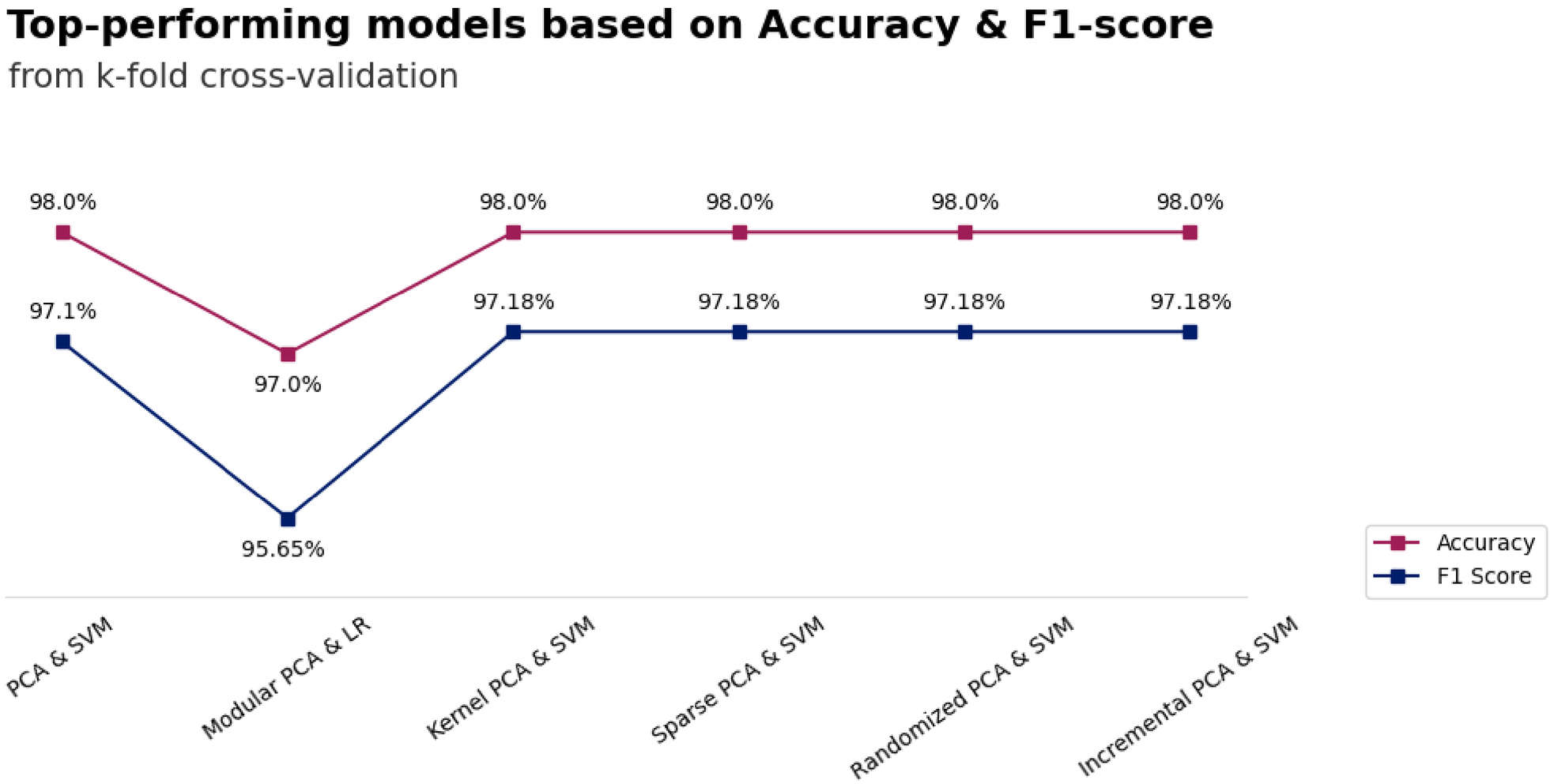
TASK 02

- **Usual Wrong prediction image in test set:**

Wrong Prediction Face:

- Wrong prediction tend to occur at person contains characters like wearing glasses, having beard or mustache, different head position, facial expression, or lightning condition.

- **Evaluation in different types of PCA**



solution

TASK 03

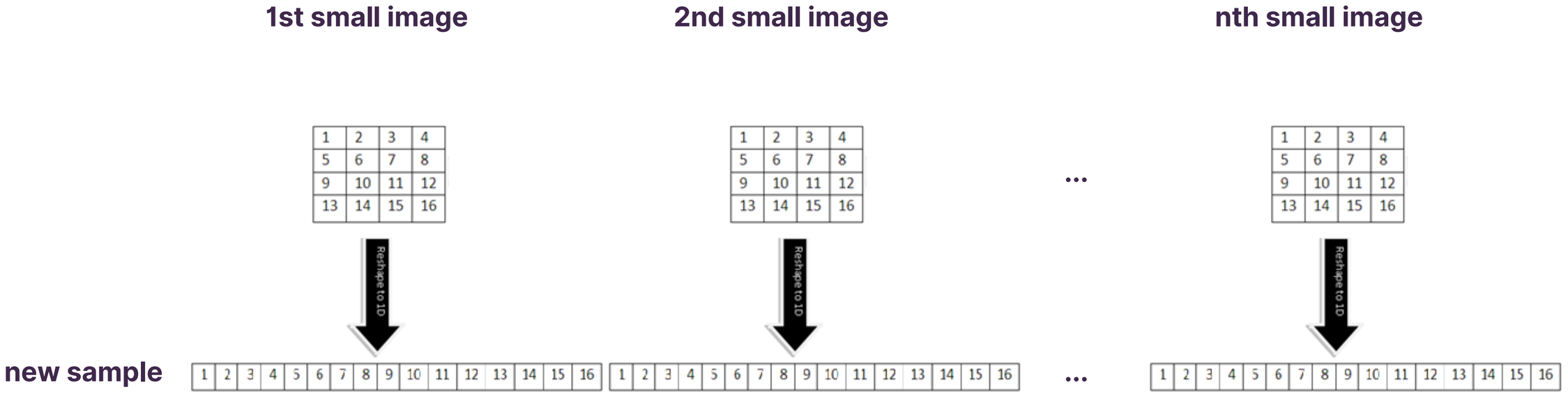
Modular PCA is an extension of the conventional PCA method.

- In the modular PCA method, the face images are **divided into smaller images** that are equal in size.

solution

TASK 03

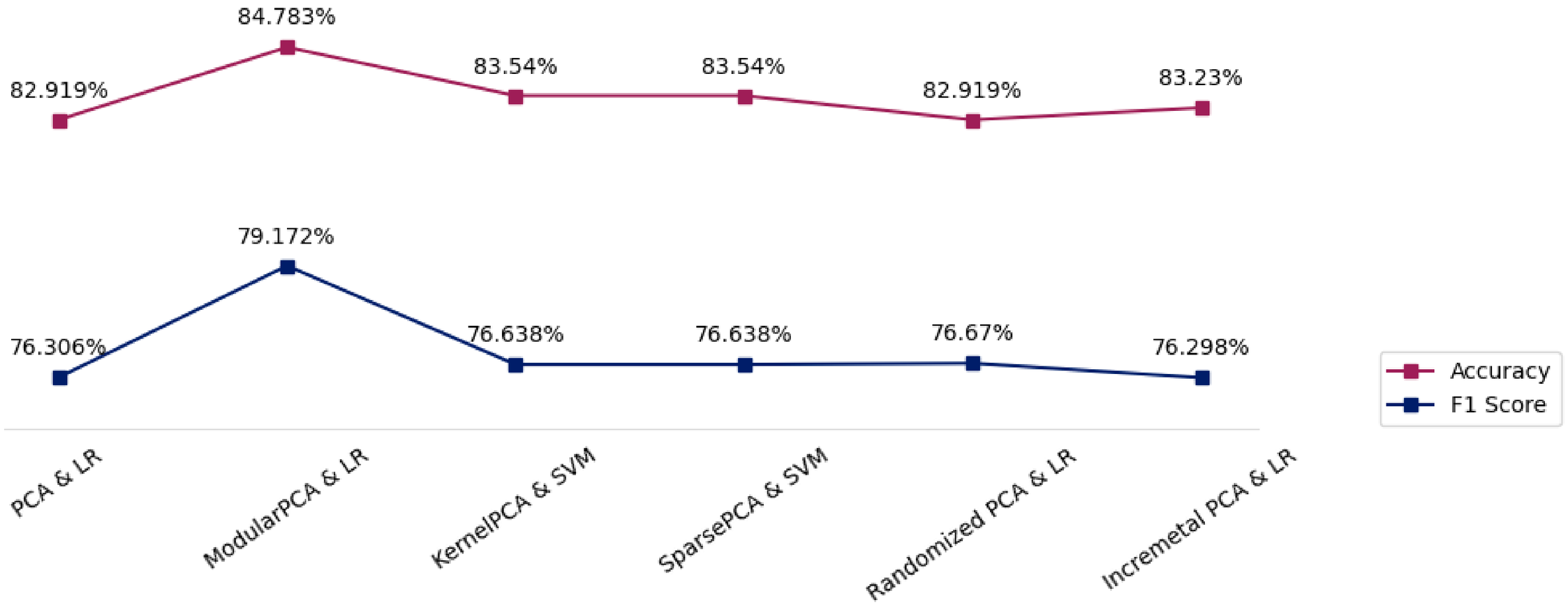
- Each small image is represented as a numpy matrix.
- **Reshape** each small image as an **array** and **concentrate** the array of these small images into a sample.



- Then we apply **conventional PCA** to get the result.

Top-performing models on LFW dataset

from k-fold cross-validation



solution

TASK 03

Image enhancement is the process of improving the quality and appearance of an image. In this research, we focus on **3 techniques:**

- **Contrast adjustment**
- **Gaussian blur**
- **Bllateral filter**

1. CONTRAST ADJUSTMENT

Contrast adjustment involves modifying the difference in intensity between the light and dark regions of an image.

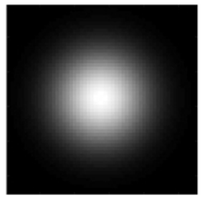
Low contrast | Original | High contrast

2. GAUSSIAN BLUR

Gaussian Blur is used for smoothening images and reducing noise.

$$GB[I]_p = \sum_{q \epsilon S} G_\sigma(||p - q||) I_q$$

Normalized Gaussian Function



Here, **GB[I]p** is the result at pixel **p**, and the RHS is essentially a sum over all pixels **q** weighted by the Gaussian function. **Iq** is the intensity at pixel **q**.

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2. GAUSSIAN BLUR

OpenCV has a function called **GaussianBlur()** with the following arguments:

- **radius**: blur radius, changing the value of the radius the different intensities of the GaussianBlur image were obtained.

Original

Gaussian Blur

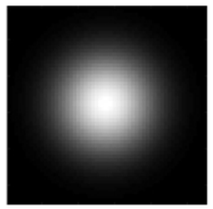
3. BILATERAL FILTER

Bilateral filter is used for smoothening images and reducing noise, while preserving edges:

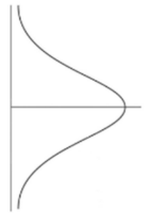
$$BF[I]_p = \frac{1}{W_p} \sum_{q \epsilon S} G_{\sigma_s}(||p-q||) G_{\sigma_r}(|I_p - I_q|) I_q$$

Normalization Factor

Space Weight



Range Weight



3. BILATERAL FILTER

OpenCV has a function called **bilateralFilter()** with the following arguments:

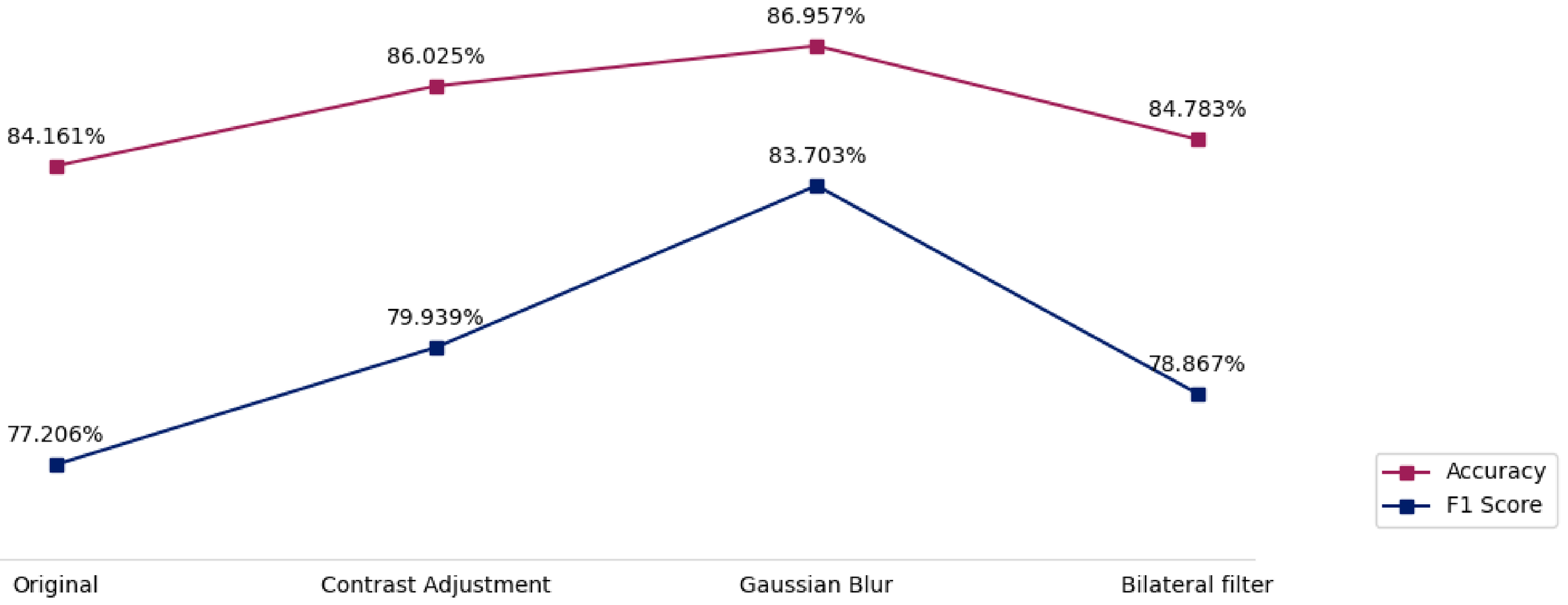
- **d**: diameter of each pixel neighborhood.
- **sigmaColor**: value of in the color space. The greater the value, the more colors farther to each other will start to get mixed.
- **sigmaSpace**: value of in the coordinate space. The greater its value, the more further pixels will mix, given that their colors lie within the sigmaColor range.

Original

Bilateral Filter

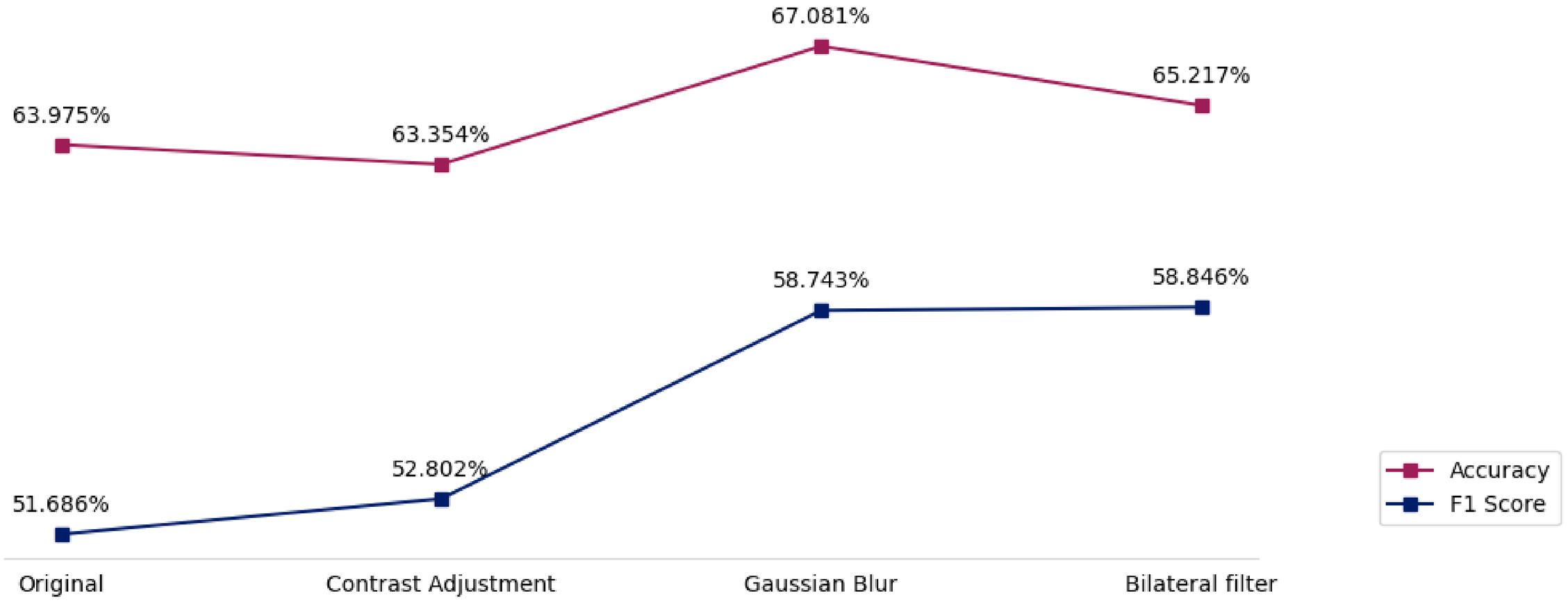
Top-performing models based on image enhancement

using Modular PCA and Logistic Regression



Top-performing models based on image enhancement

using Modular PCA and Weighted SSE



result

metrics of evaluation

ACCURACY

$$\text{Accuracy} = \frac{\text{Number of Correct Predictions}}{\text{Total Number of Predictions}}$$

F1-SCORE

$$\text{F1-Score} = 2 \times \frac{\text{Precision x Recall}}{\text{Precision + Recall}}$$

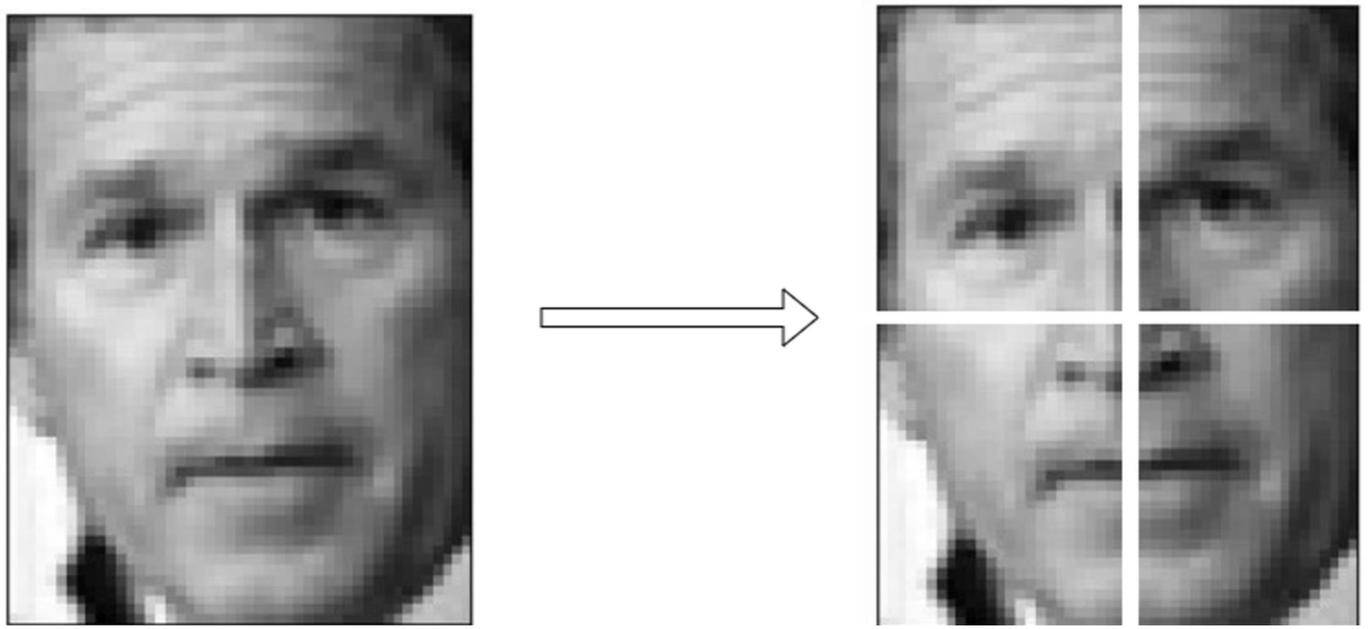
result

metrics of evaluation

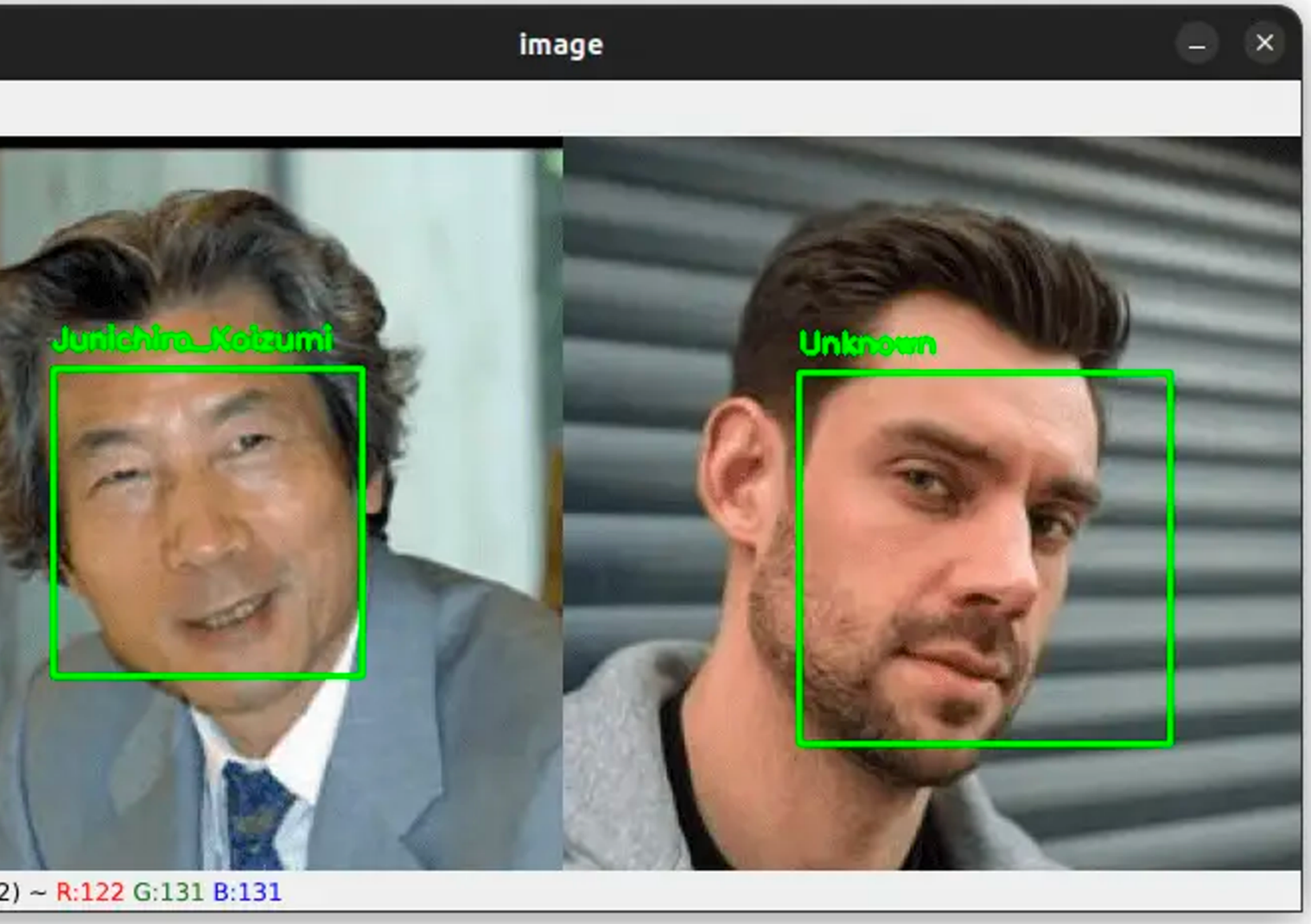
	Dataset	Accuracy	F1-score
1.	ATT dataset	1,0	1,0
2.	LFW dataset	0.86957	0.83703

Conclusion

- Modula PCA
- Image enhancement

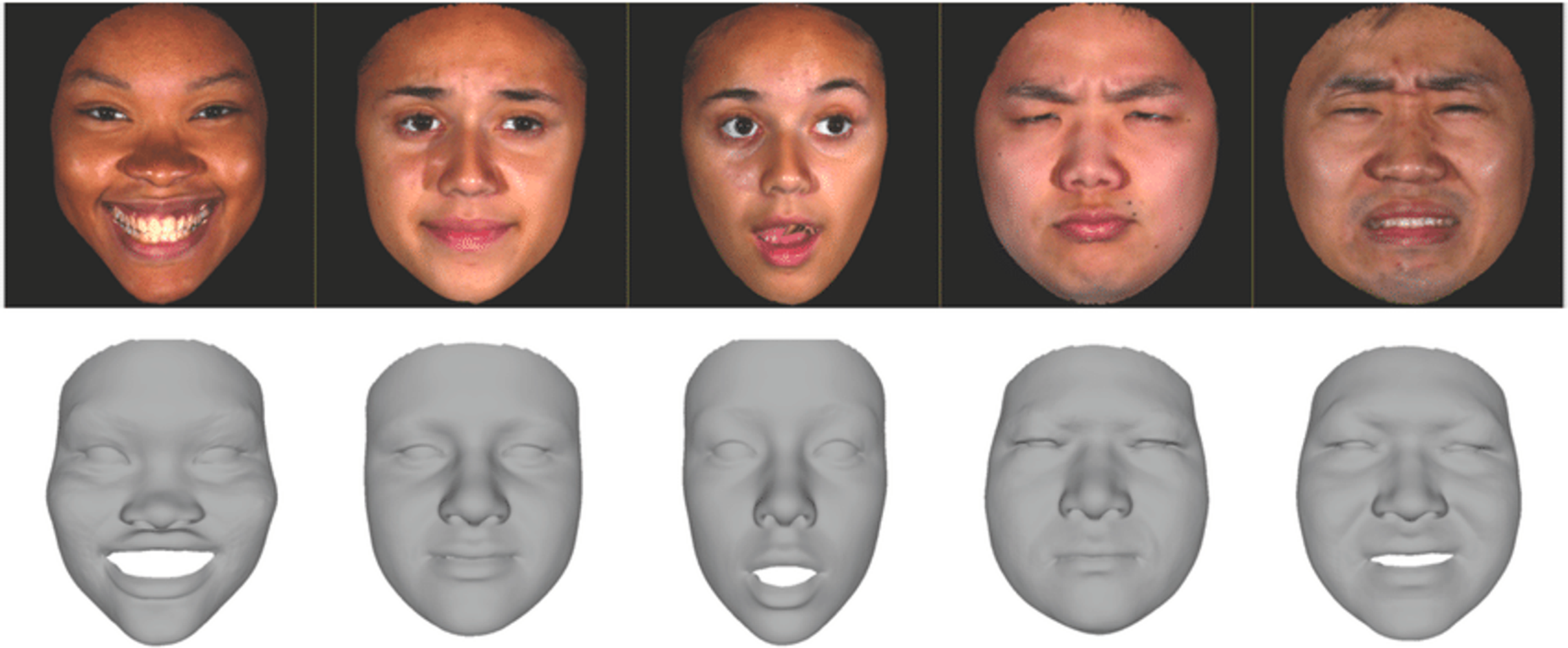


BACK TO AGENDA



detecting
unknown-face

working with 3D images



THANKS!

Do you have any questions?

Send it to us! We hope you listen to something new.