



# **PROJECT OF DIGITAL SIGNAL AND IMAGE MANAGEMENT**

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# MAIN GOALS

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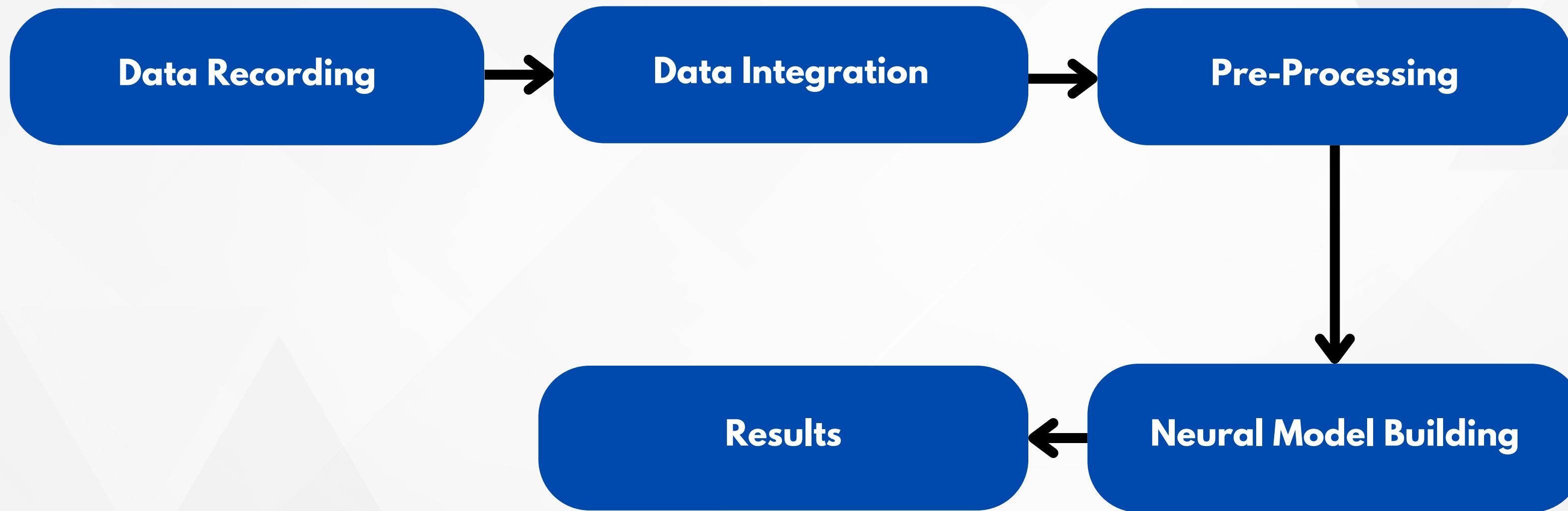
**MONO-DIMENSIONAL SIGNAL PROCESSING**  
**Multi-Class Classification for Speaker & Digit Recognition**

**BI-DIMENSIONAL SIGNAL PROCESSING**  
**Multi-Class Classification for Face Recognition**

**RETRIEVAL**  
**Image Retrieval of the 10 most similar images given as input**

# **MONO-DIMENSIONAL**

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# DATA RECORDING

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- 50 recordings per group member of every digit from 0 to 9
- Trimmed every recording removing the silences before and after the pronunciation of the word
- Enriched using registrations from the Dataset Free Spoken Digits, labeling the speakers as “Unknown”

# PRE-PROCESSING

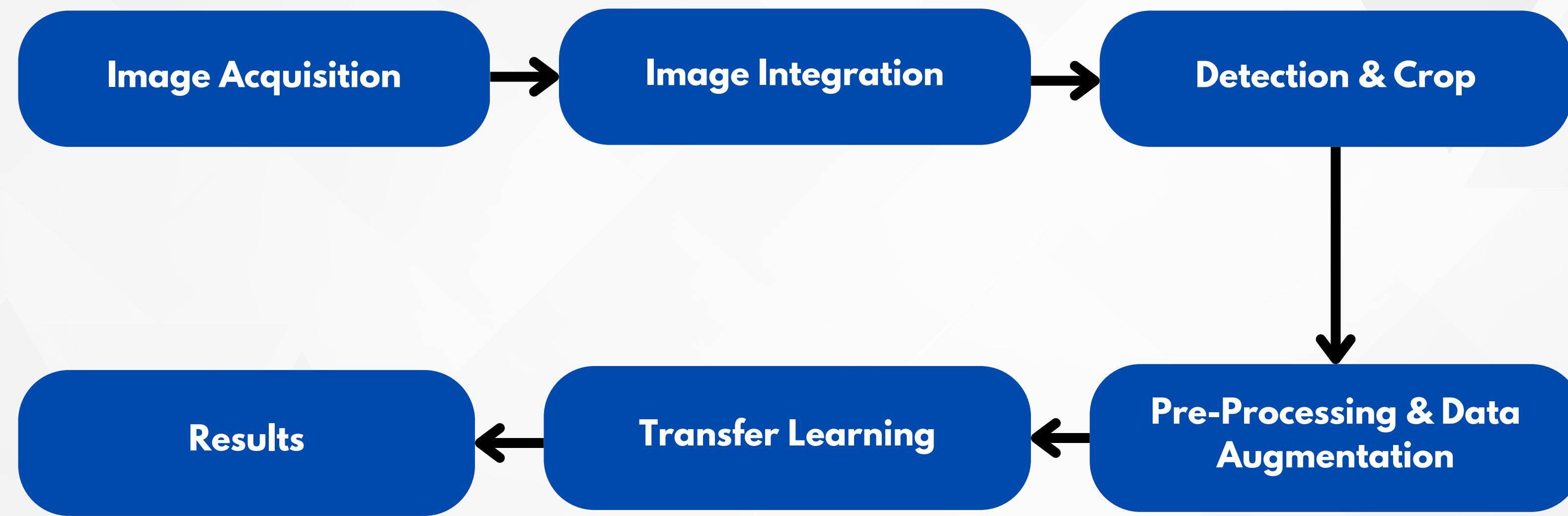
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We extracted differents feature to feed the neural networks builded:

- For the CNN, we used a combination of zcr, standard deviation, energy and a flattening of the Mfcc.
- For the RNN, we used the complete Mel Frequency Spectrogram

# BI-DIMENSIONAL

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# **IMAGE ACQUISITION**

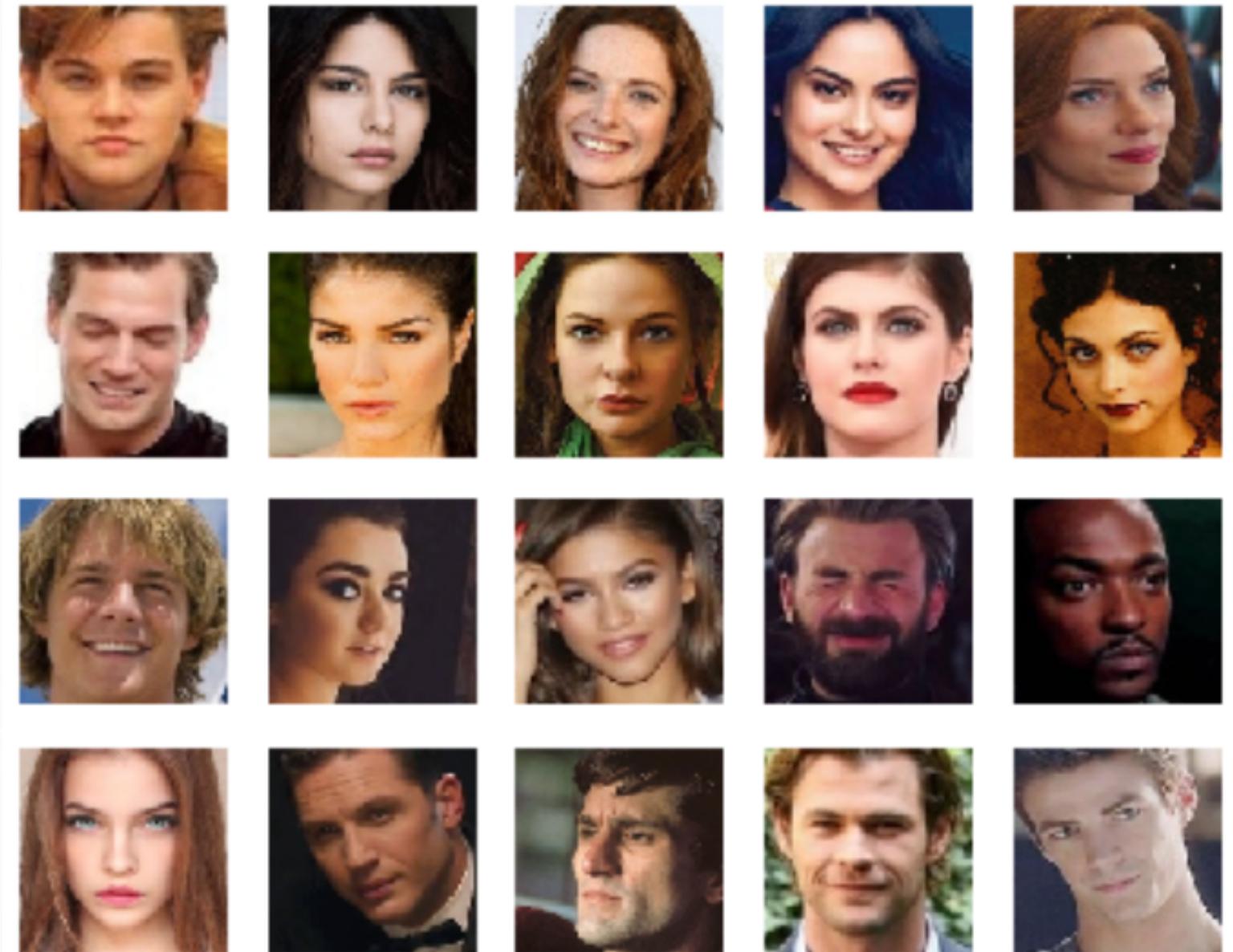
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- To tackle the task it was necessary to take some photos of the group members.
- Acquisition via Webcam every half second, using **OpenCV**
- Approach:
  1. *acquisition of 2000 photos per subject*
  2. *different light conditions*
  3. *different poses*
  4. *different environments*

# IMAGE INTEGRATION

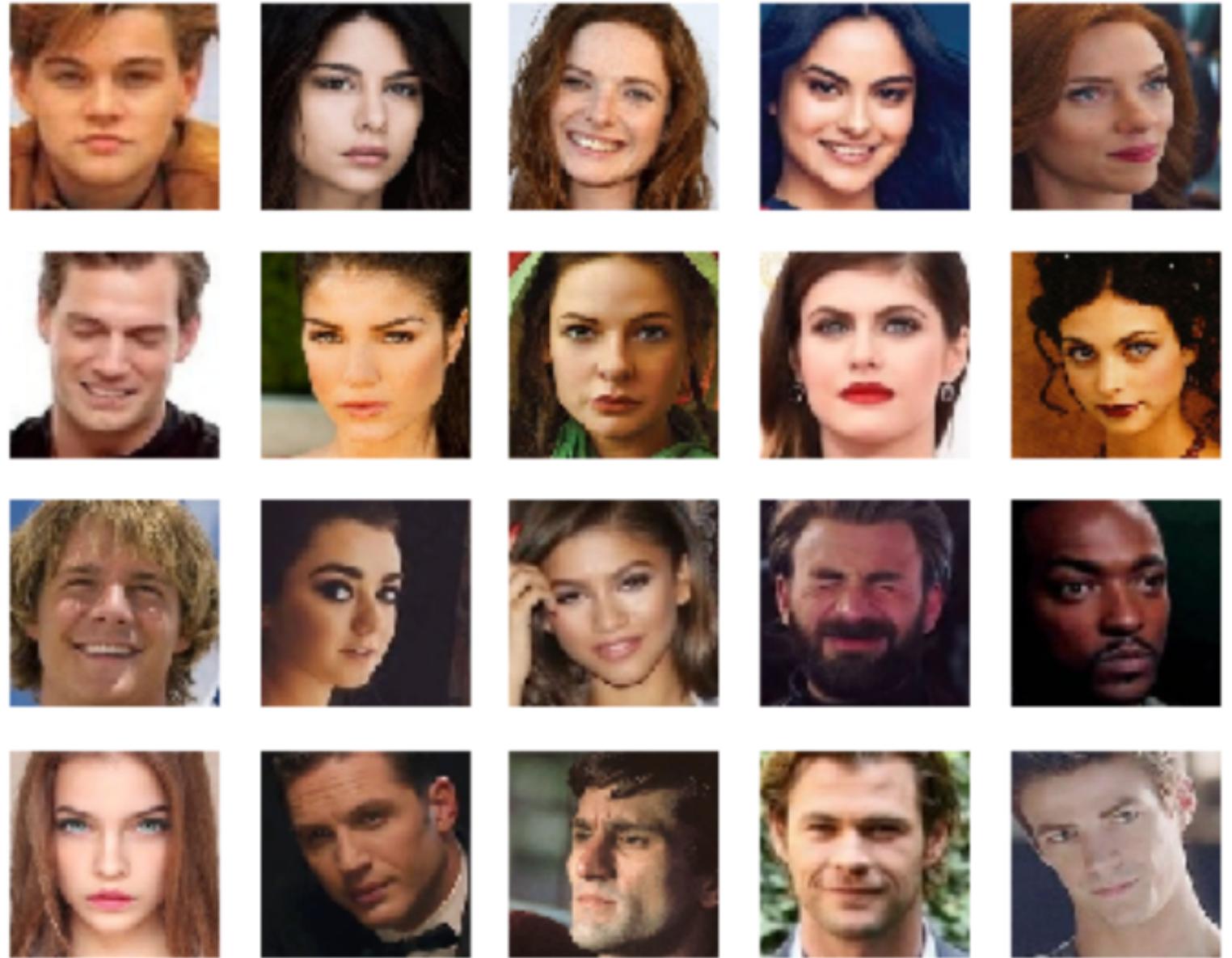
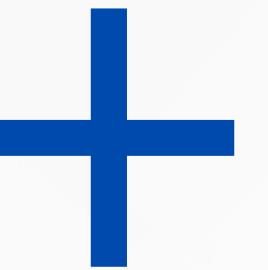
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- To prevent all the faces subjected to the model from being traced back to the two members of the group, we integrated a dataset containing photos of various well-known people extracted from Pinterest
- We randomly chose some of these photos and assigned the label "**Unknown**"



# FINAL DATASET

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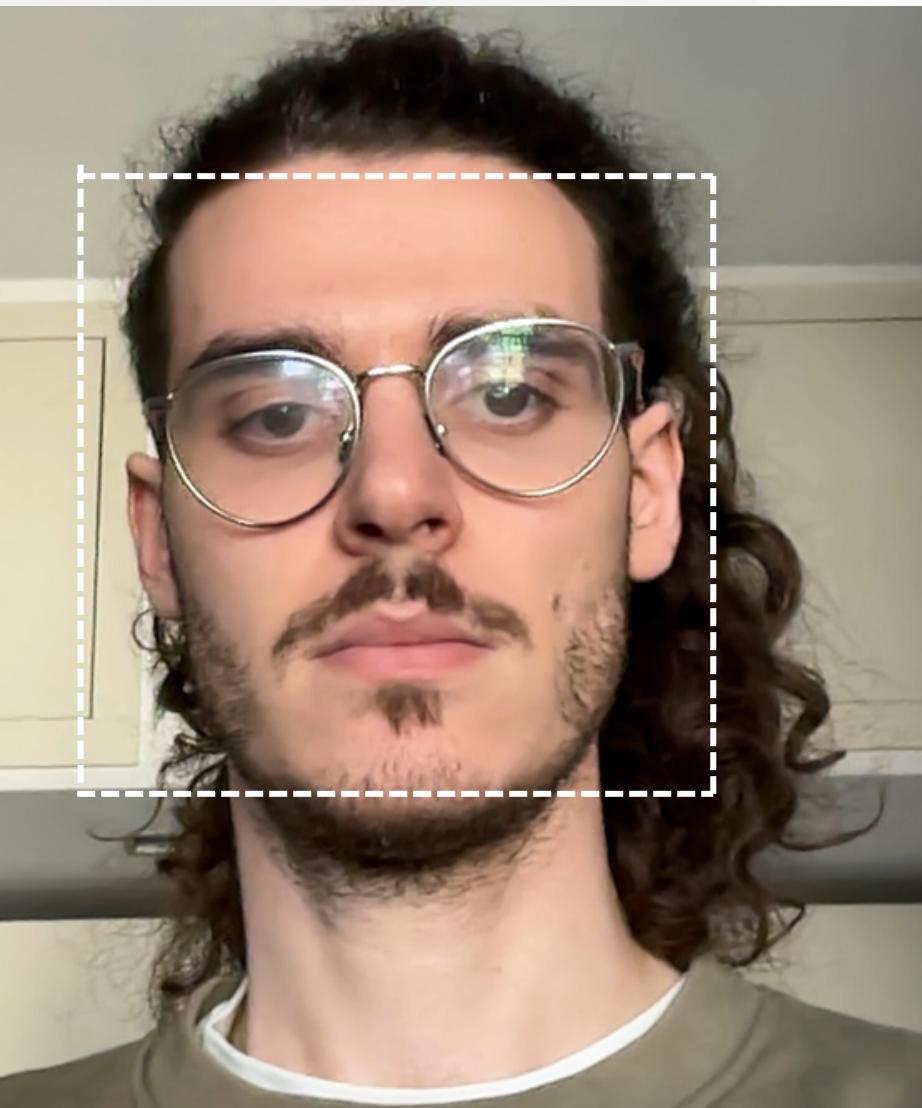
# CROPPING

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- We used the **MTCNN** model to detect the face within the captured image
- MTCNN (*Multi-Task Cascaded Convolutional Networks*) is a library used for detecting faces and facial features in images. It is a convolutional neural network (CNN) based approach that addresses 3 different steps of face detection in a sequential manner:
  - Face Detection
  - Facial Landmark Alignment
  - Face Detection Refinement
- After detecting the face, we cropped each image based on the bounding box coordinates extracted from MTCNN

# CROPPING

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We created a function that automatically crops all the photos and discards when:

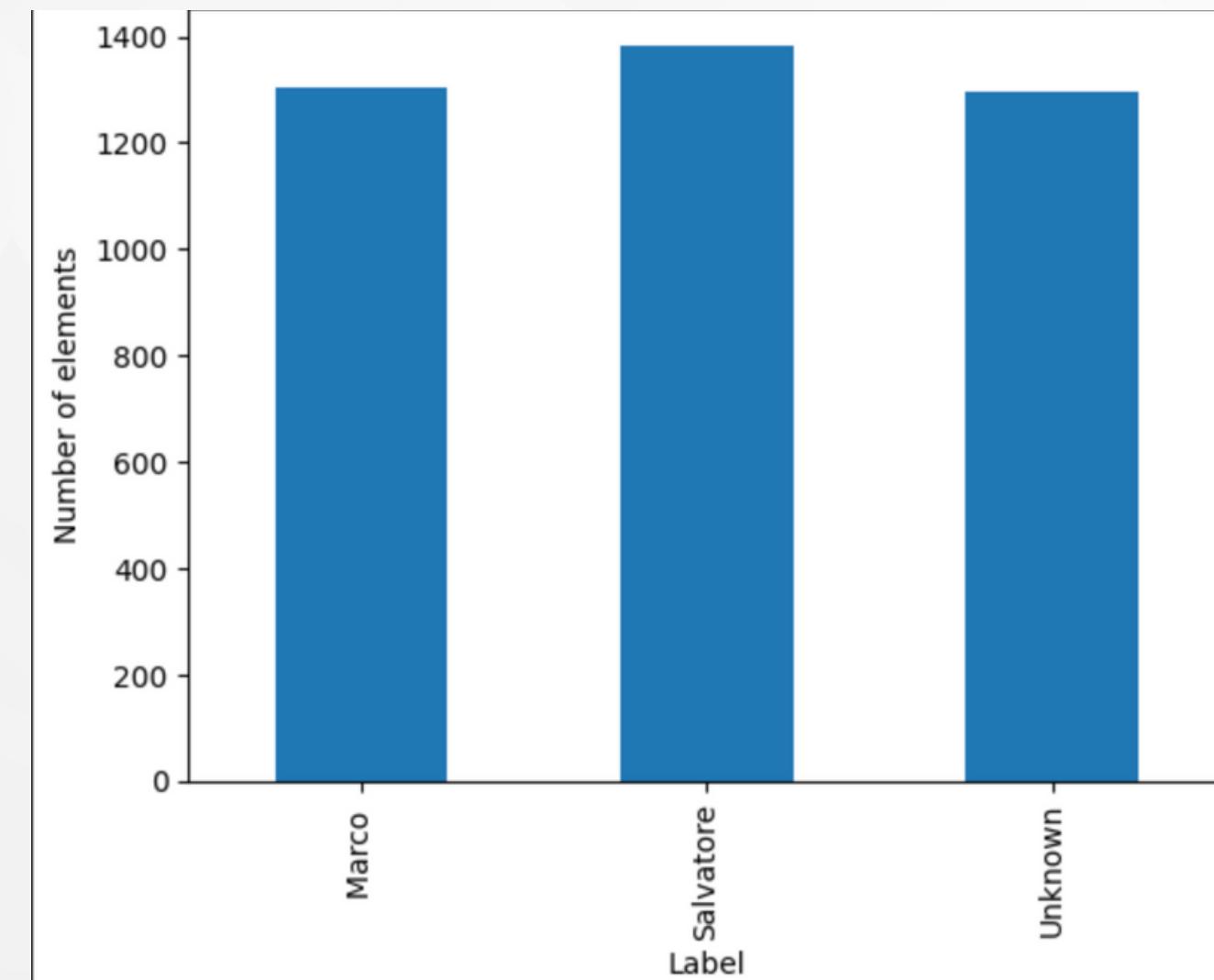
- no face was detected
- the size of the detected face is too small (width,height<50)

# TRAIN/TEST/VALIDATION SPLIT

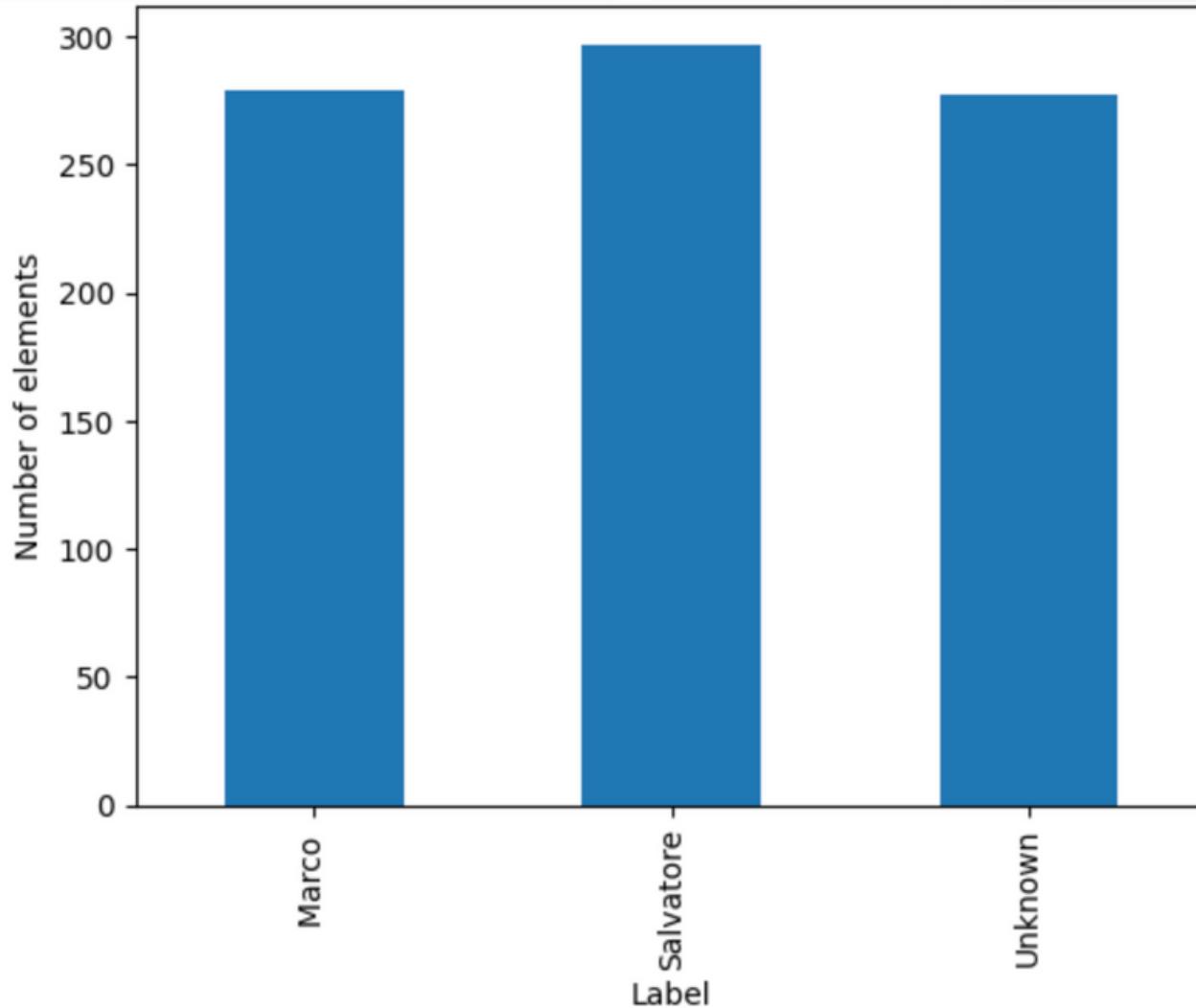
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After the crop of the images, were obtained 5689 images which were divided into *Training, Test and Validation set*, with percentages of 70%, 15%, 15% respectively. The distribution of the classes in the three sets is shown below:

**TRAIN:**



**TEST & VAL:**

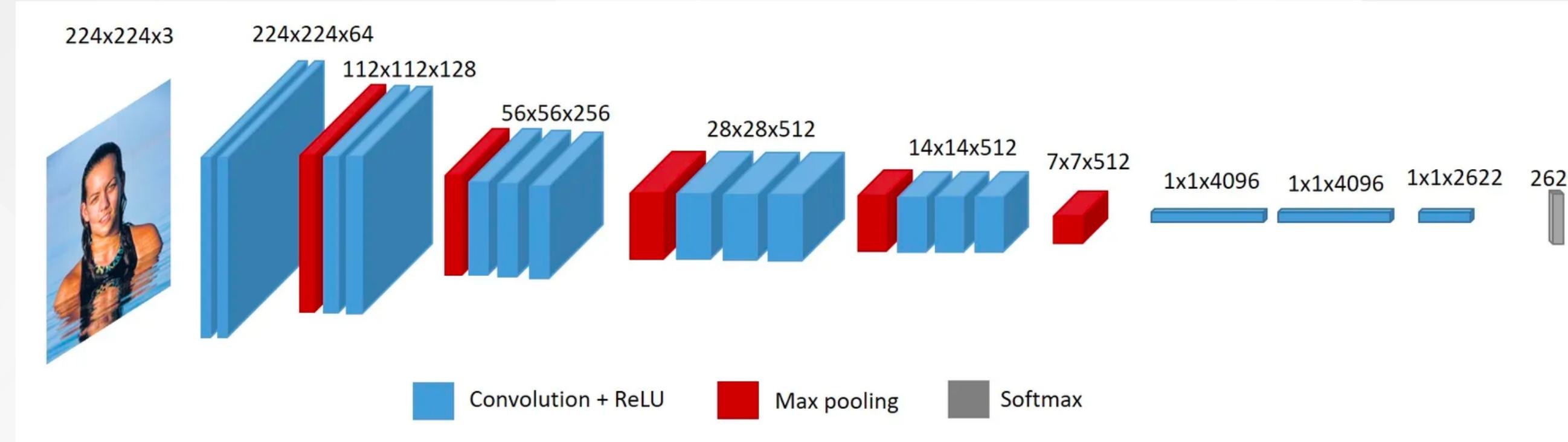


# DATA AUGMENTATION

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- We have implemented a function designed to create data generators for training, validating, and testing neural network models in TensorFlow using **Keras' ImageDataGenerator module**.
- This module allows you to perform *data augmentation* during training, i.e. apply random transformations to images to improve the generalization of the model.
- The following transformations were performed:
  - Horizontal Flip
  - 15 degree rotation
  - Changing the brightness
  - Zoom

# TRANSFER LEARNING



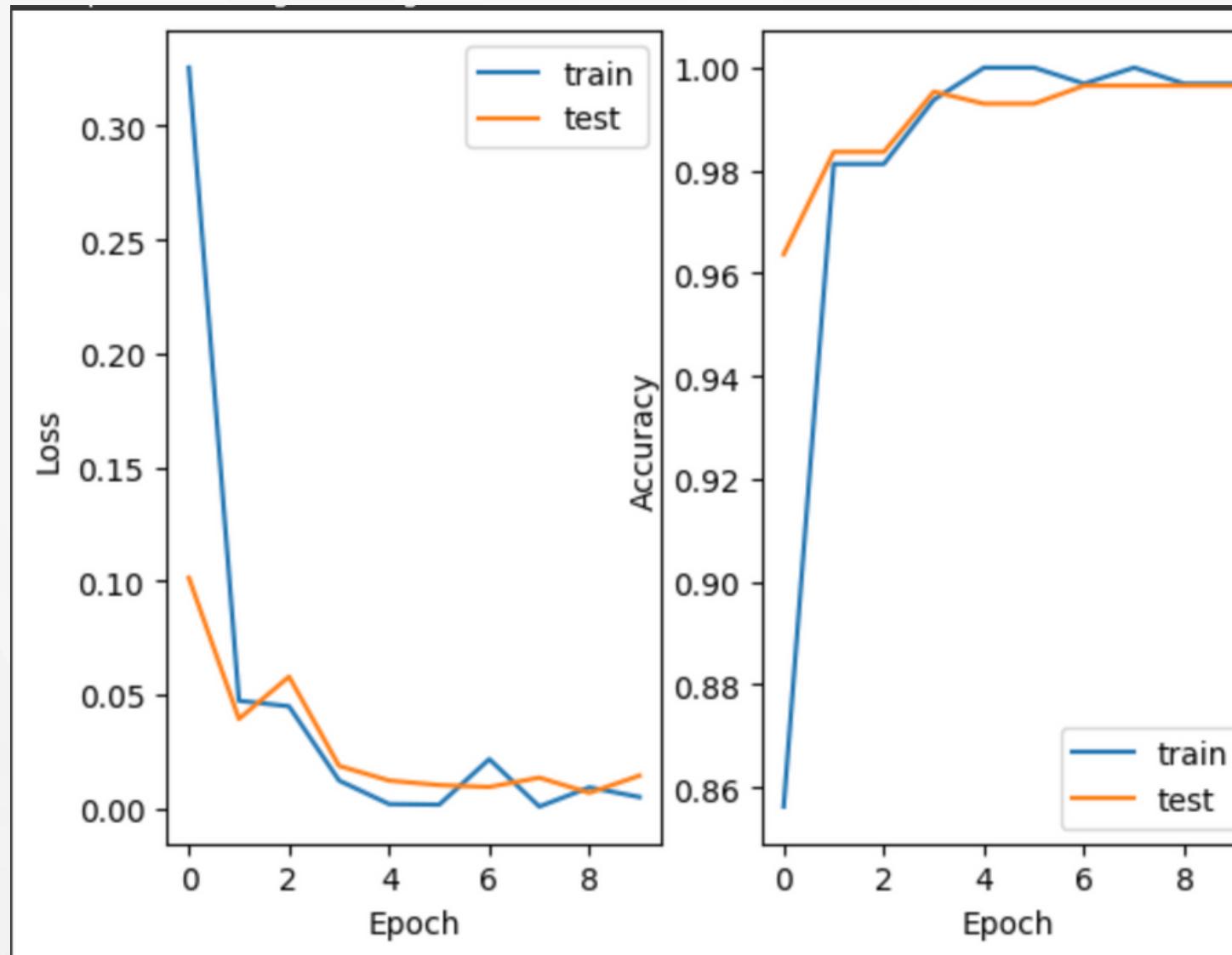
For the final classification we used the **VGGFace** network to which we added the following layers:

- Flatten layer to flatten the output of the pooling layer
- Two fully connected Dense layers with *ReLU* activation and a final Dense layer with *softmax* activation for the output

# RESULTS

The network was trained with the following parameters:

- **Epochs**=10
- **Optimizer**=Adam
- **Loss**=Categorical Cross Entropy



	precision	recall	f1-score	support
Marco	0.99	1.00	1.00	279
Salvatore	1.00	0.99	1.00	297
Unknown	1.00	1.00	1.00	277
accuracy			1.00	853
macro avg	1.00	1.00	1.00	853
weighted avg	1.00	1.00	1.00	853

# FAILED ATTEMPT

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Before using the VGGFace network we also used the **InceptionResNetV2 (IncRes)** network to which we added the following layers:

- Flatten layer to flatten the output of the IncRes
- Dropout layer to reduce overfitting
- Dense layer with softmax activation

This model also obtained excellent performances but the reason why it was not chosen was because we obtained predictions that were not always correct.

In particular, Marco's face was often classified as Unknown.

# RETRIEVAL

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# RESULTS

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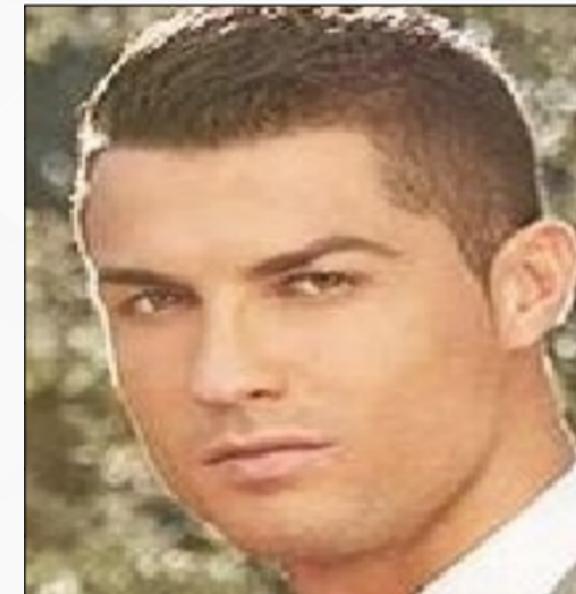


**9/10**

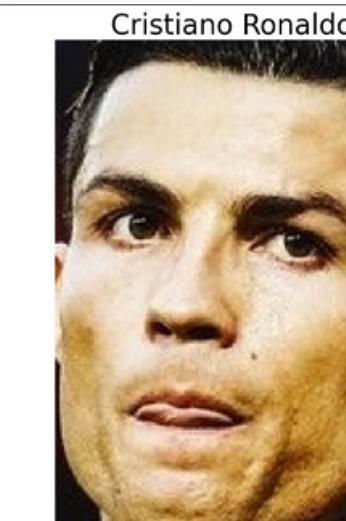


# RESULTS

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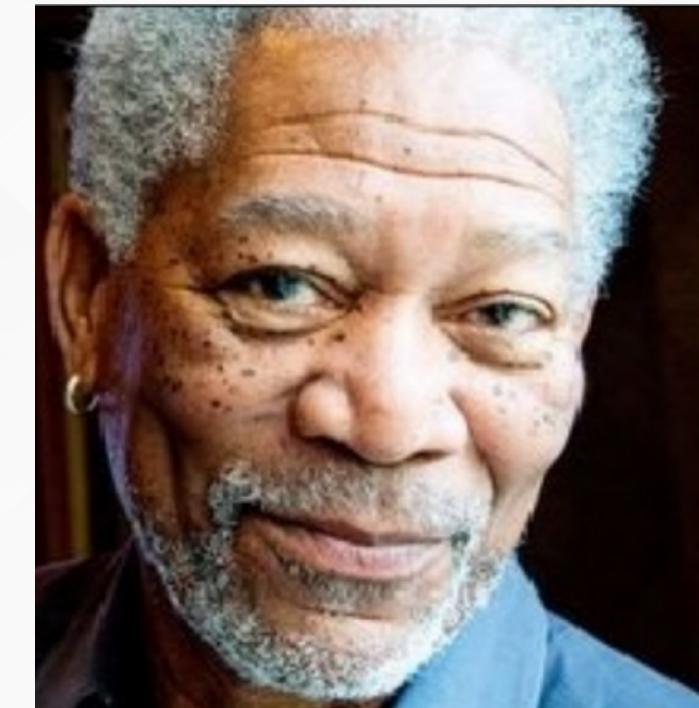


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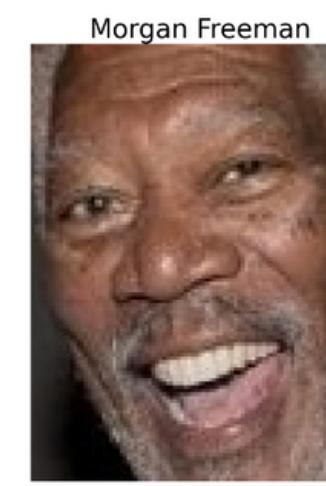
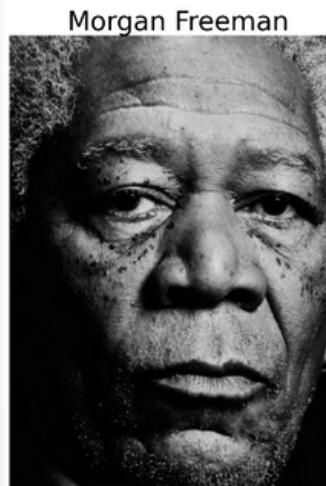


# RESULTS

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# THANK YOU

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