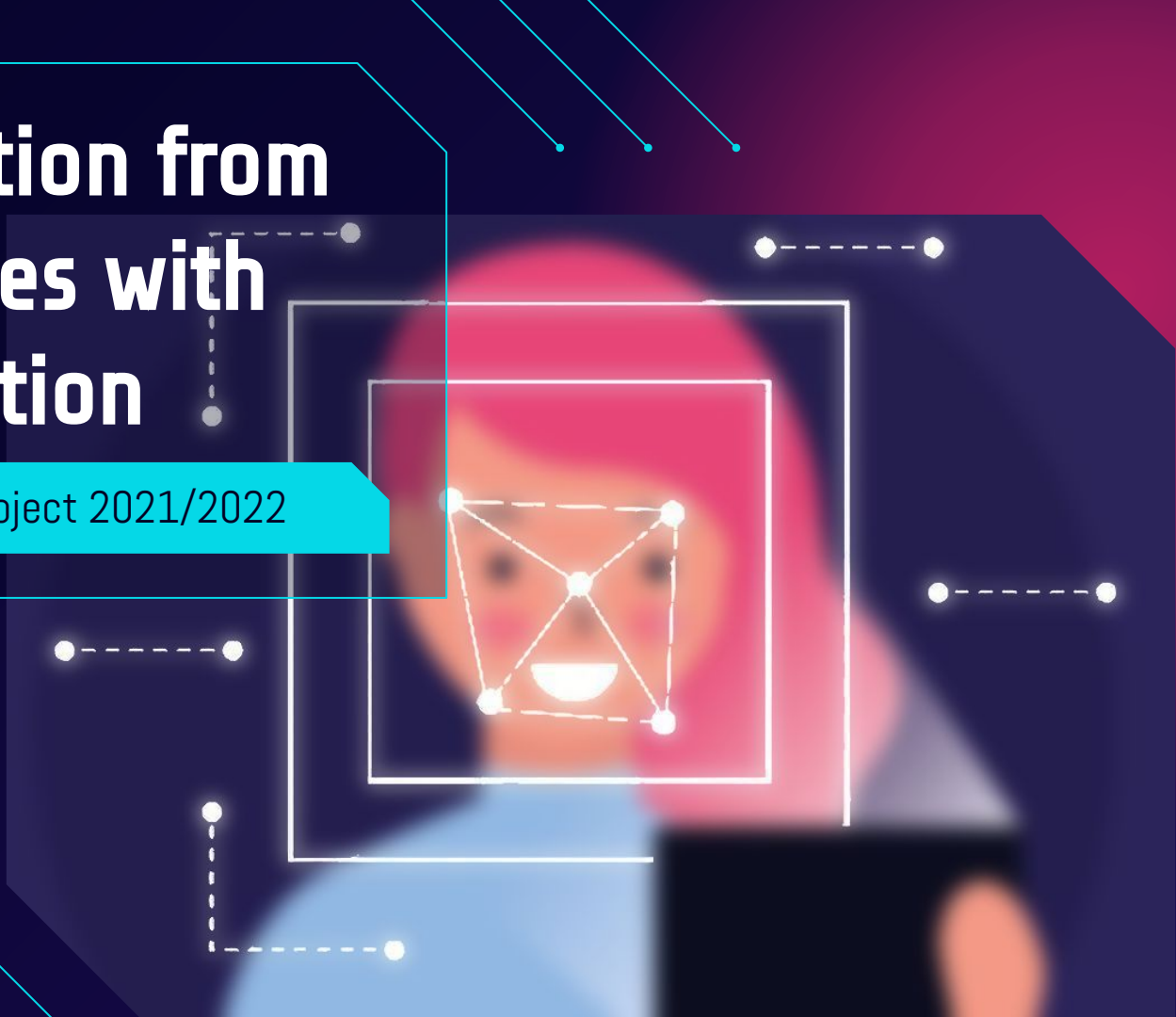


Face Recognition from low-res images with Super-Resolution

Biometric Systems Project 2021/2022



1795119 Matteo Orsini
1815023 Fabrizio Rossi

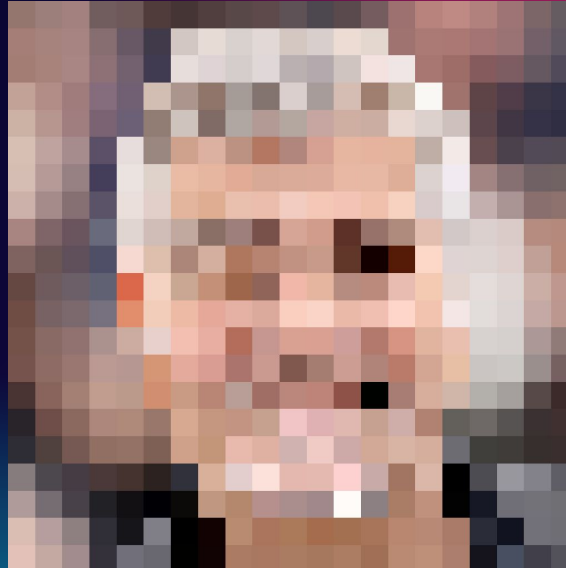


WHY

- In many real case scenarios we may have to work with low resolution images:
 - Cheap camera sensor
 - Subject is distant from capturing device
 - Typical in video surveillance
- Recognizing low-res faces is hard



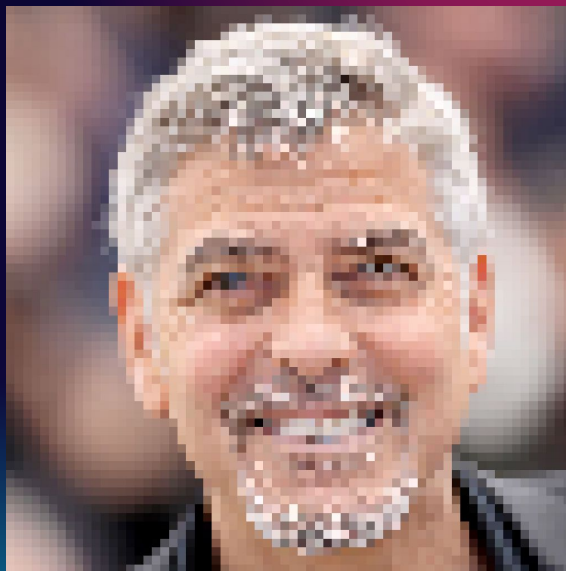
CAN YOU RECOGNIZE HIM?



CAN YOU RECOGNIZE HIM?



CAN YOU RECOGNIZE HIM?



CAN YOU RECOGNIZE HIM?

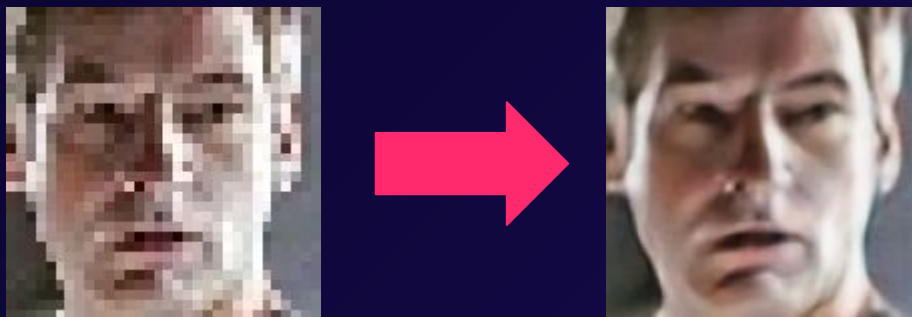


George
Clooney



Super Resolution

- Can we help face recognition by increasing image resolution?
- **Task:** transform low-resolution image to high-resolution
- Tries to synthesize new details



01 – System Architecture

Face Localization

- Localizes and crops the face in the image

Super-Resolution

- Increases image resolution
- In our case $32 \times 32 \rightarrow 128 \times 128$

Face Recognition

- Extracts feature vector
- Match it with another template

02 – Face Localization

OpenCV Haar Cascade Classifier

- Frontal images only, others ignored
- We took highest score
- Very fast, many false positives

Multi-Task Cascaded CNN (MTCNN)

- Frontal and profile images
- Outputs face landmarks too
- We took highest score
- Not so fast, more robust

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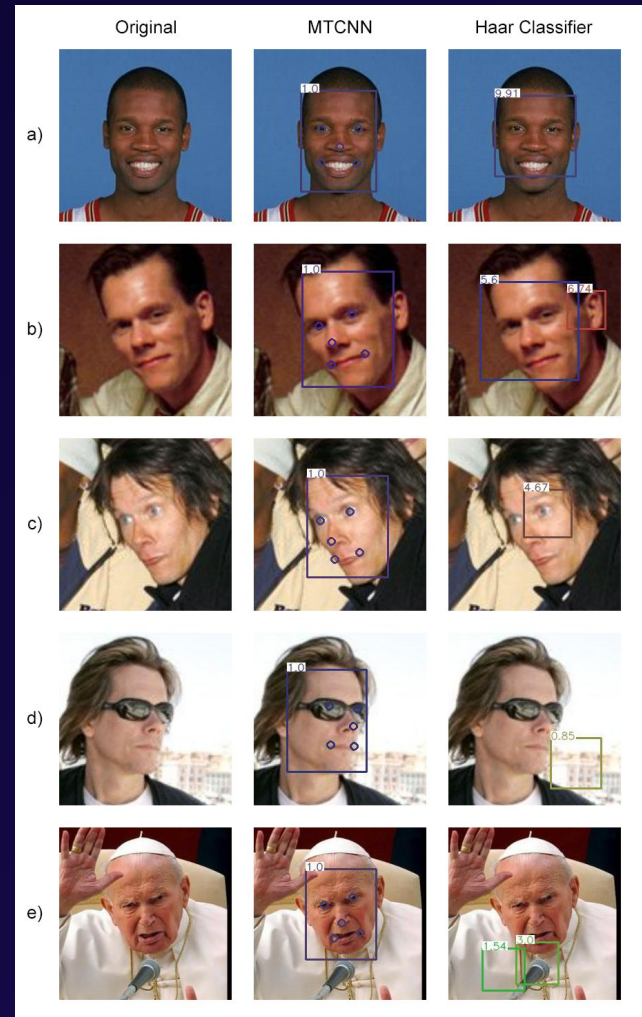
Multi-Task Cascaded CNN (MTCNN)

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02 - Face Localization

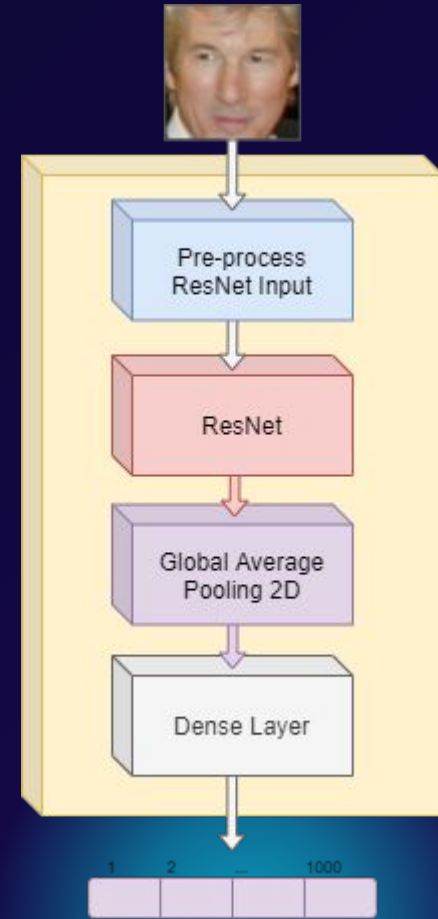
COMPARISON AND ERRORS

- a) Similar performance most of the time
- b) Correct face but lower confidence score
- c) Wrong detection since profile picture
- d) Accessories problems
- e) Error even if image is normal



03 – Face Recognition

- Extracts feature vector and predicts identity
- Deep Learning model based on ResNet-50 with fine tuning from ImageNet
- Trained for 10 epochs with 1.000 identities of CASIA-WebFace (~73.000 high-res images)
- 62% Accuracy on validation set
 - Model fixed for different super-resolution techniques



04 – Super Resolution

OpenCV Resize

- Bilinear interpolation
- Fastest

EDSR

- ResNet without BatchNorm
- 2x, 3x, 4x input resolution
- Very slow (~30s for one image)

SRGAN

- GAN based on ResNet
- Perceptual loss based on VGG features map

ESRGAN

- Improved SRGAN
- Changes in architecture, discriminator and loss



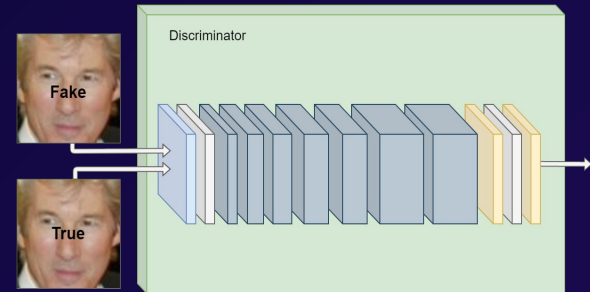
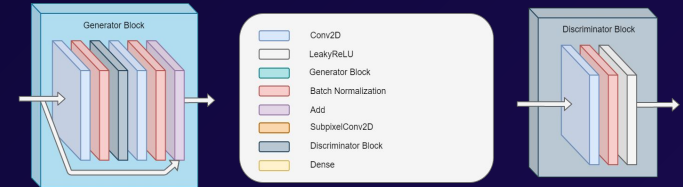
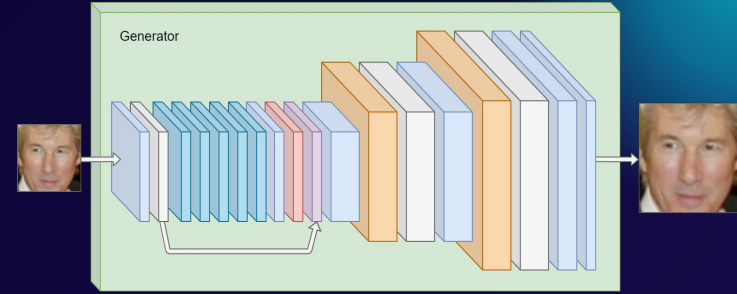
However... they are all general purpose,
“Why not train with just face images?”



04 – Super Resolution

Initial model

- GAN based on SRGAN architecture
- Trained for 100 epochs with 5.000 high quality images selected from CASIA-WebFace
 - Threshold-based method on sharpness



04 - Super Resolution

Initial model

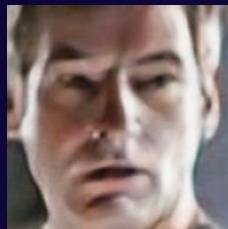
Low-res



Generator

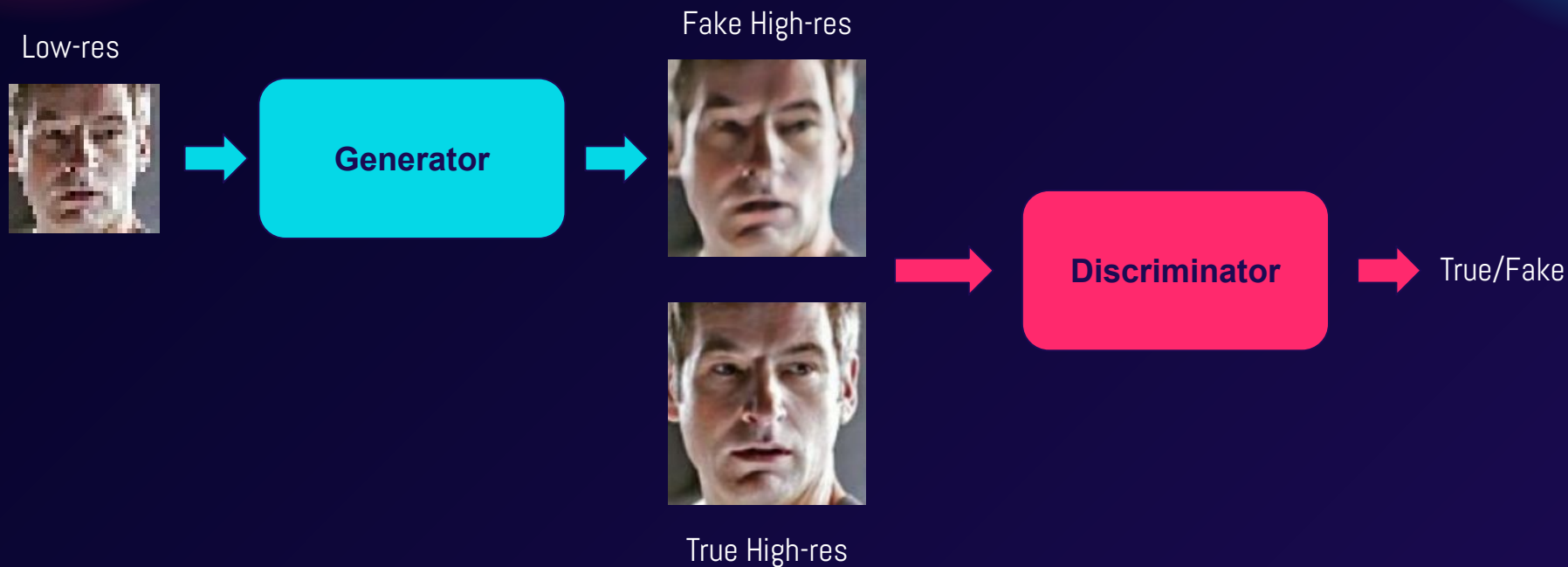


Fake High-res



04 - Super Resolution

Initial model



04 - Super Resolution

Initial model

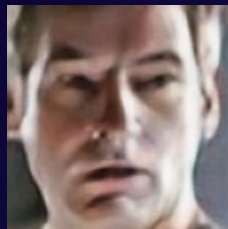
Low-res



Generator



Fake High-res



Discriminator



True/Fake



True High-res

Loss

$$\alpha \cdot Adv(\theta) + \beta \cdot MSE(\theta)$$



Lack of sharpness in details...
What can we do about it?

MULTI-TASK LEARNING!



04 - Super Resolution

Canny model

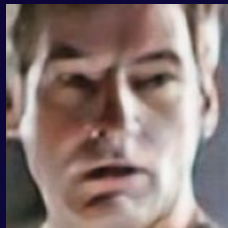
Low-res



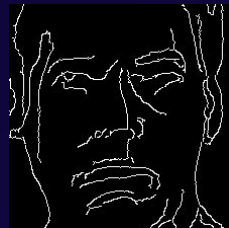
Generator



Fake High-res



Fake Canny
High-res



True High-res



True Canny
High-res



Discriminator

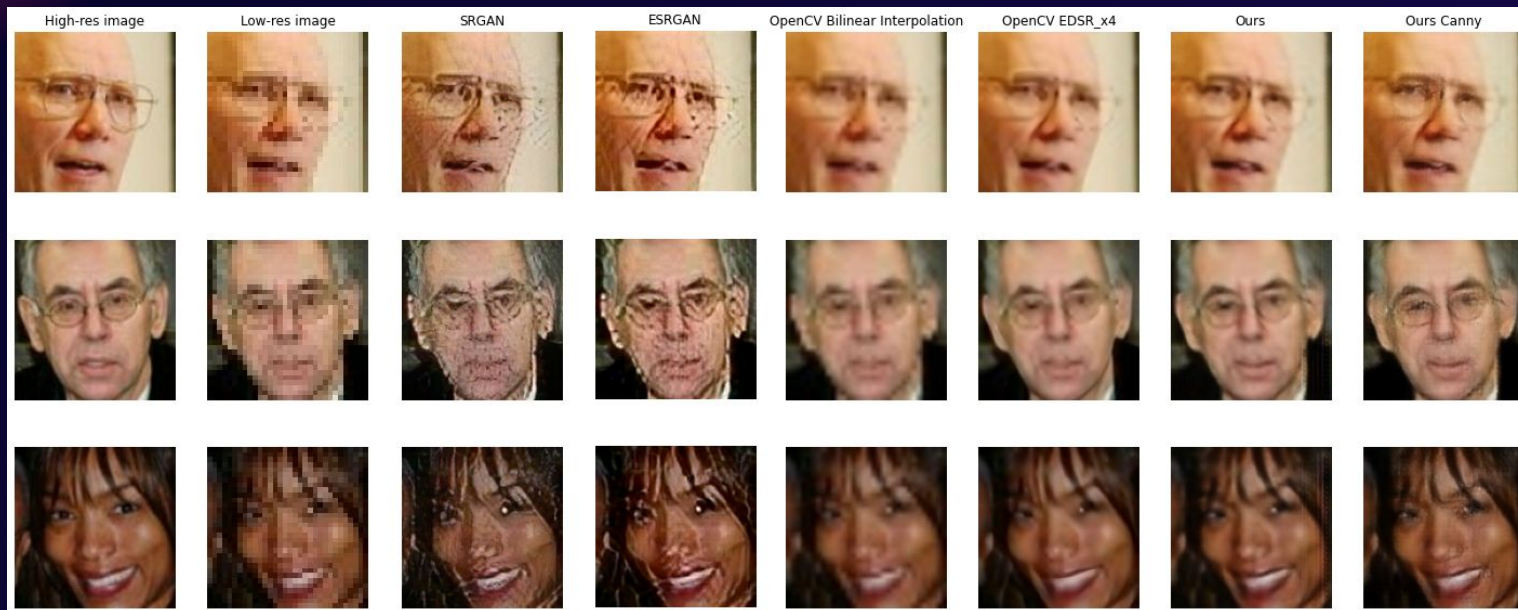


True/Fake

Loss

$$\alpha \cdot Adv(\theta) + \beta \cdot MSE(\theta) + Canny(\theta)$$

04 – Super Resolution



*

*

* intended for hi-res images

05 – Evaluation

- Evaluation Dataset: LFW
- Two evaluation methodology:
 - All-Against-All
 - Standard LFW Evaluation



05 – Evaluation

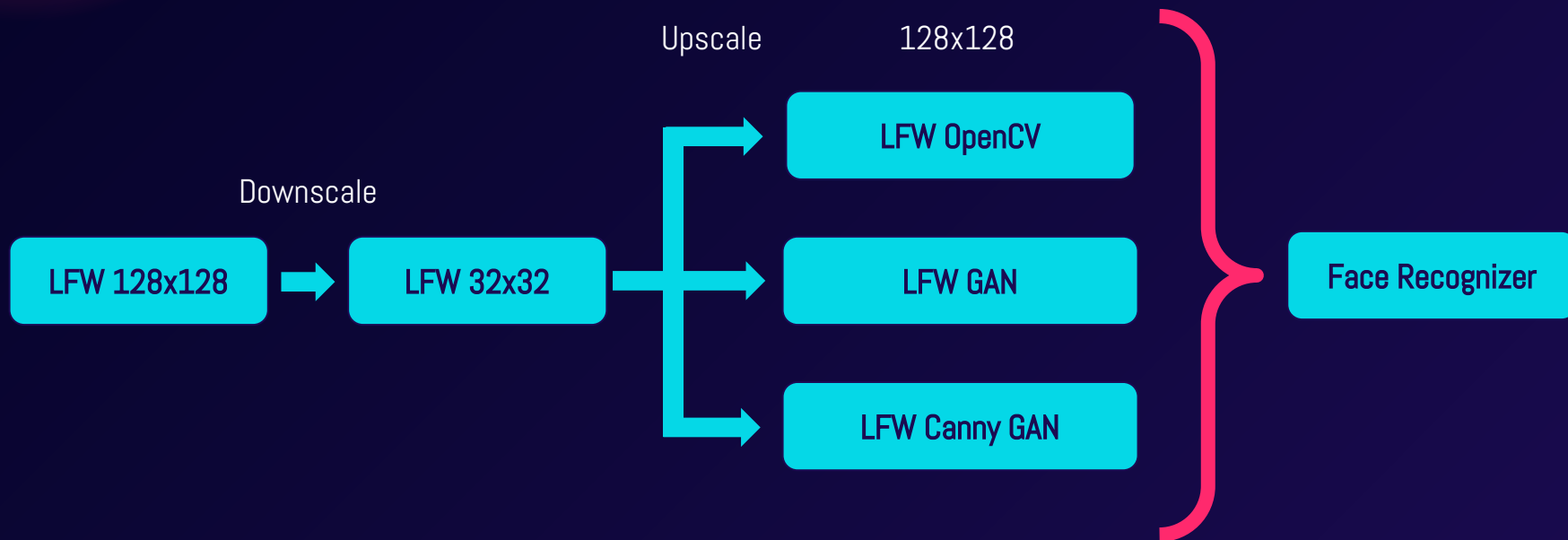
All-Against-All (AAA)

- Open-Set Identification
- In turns, each template as probe
- Rest is gallery set
- Simulate impostor attempts
- Several thresholds

Standard LFW Evaluation

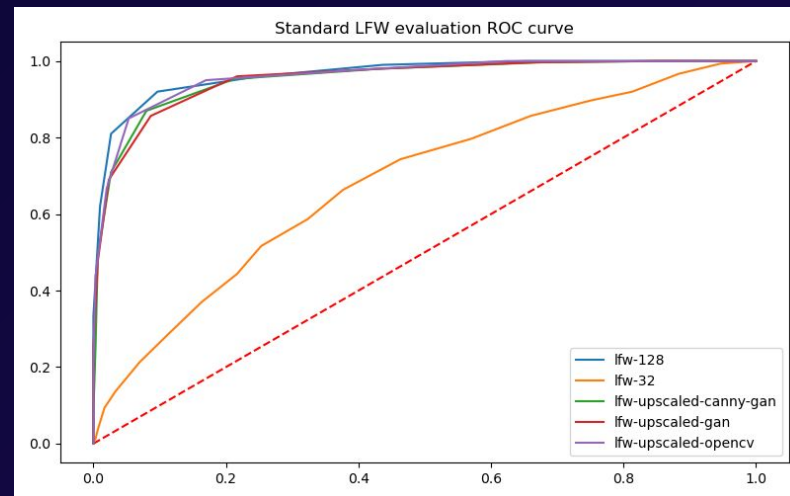
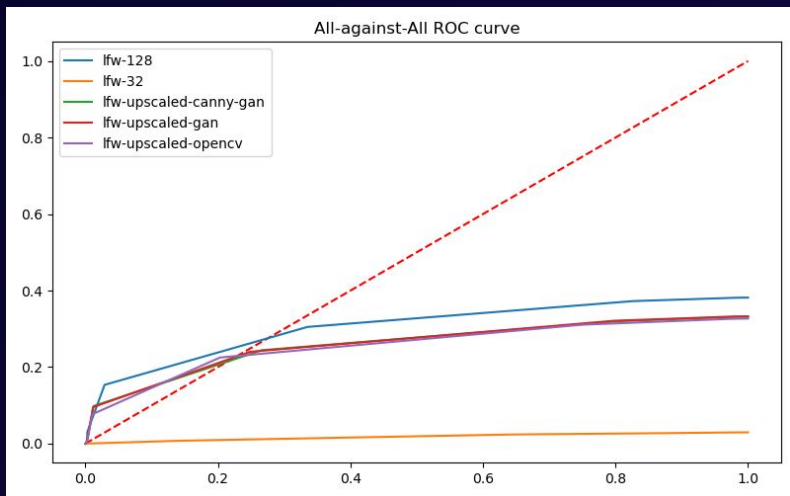
- Test set is given
- Pairs of face images
- System needs to recognize if same identity
- Results are averaged over 10 different folds

05 - Evaluation



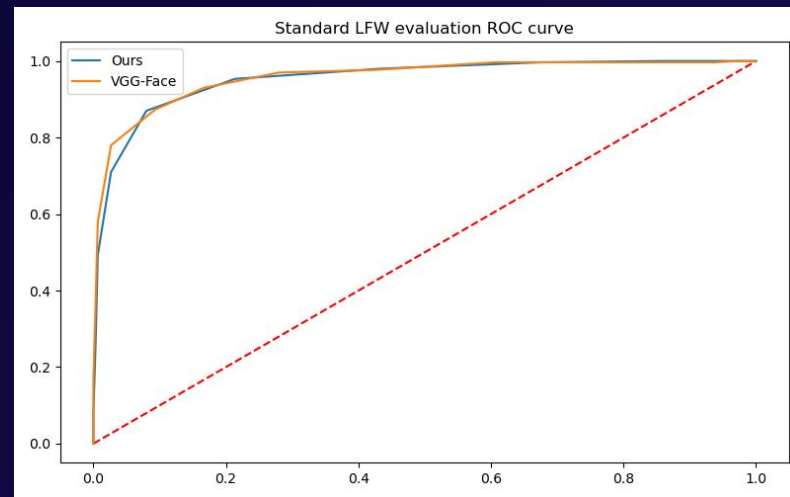
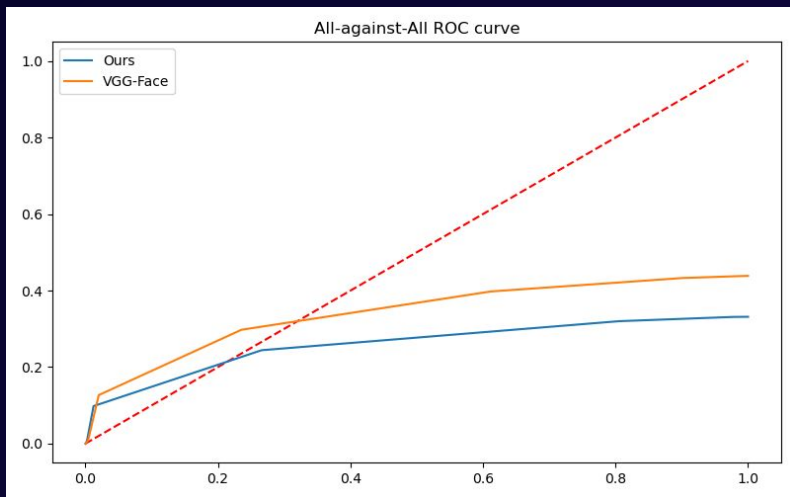
05 - Evaluation

SR Comparison

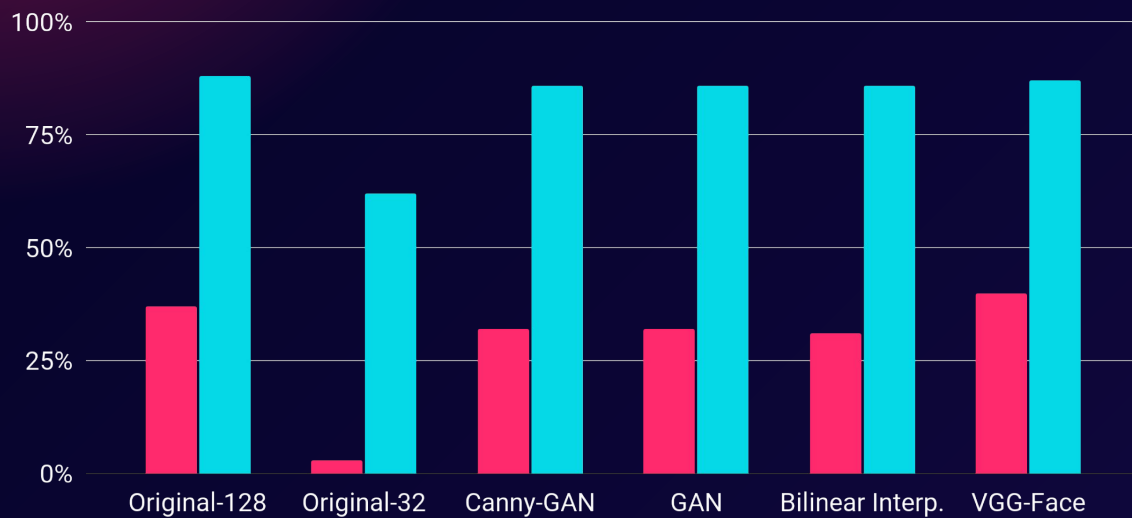


05 - Evaluation

SOTA Comparison



05 - Evaluation



All-Against-All
Recognition Rate

Standard LFW
Accuracy



**THANKS FOR THE
ATTENTION!**