

CSE 891-002: Deep Learning in Biometrics

Cunjian Chen

Department of Computer Science and Engineering

Michigan State University

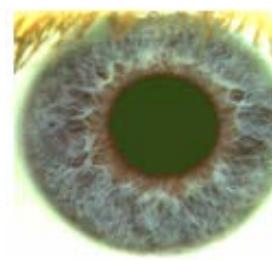
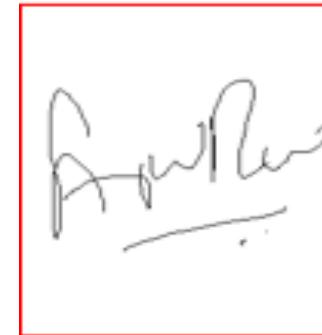
1/6/2020

Biometric Recognition

- Automated recognition of individuals based on their **biological** and **behavioral** characteristics.
- Biological and behavioral characteristic of an individual from which distinguishing, repeatable biometric features can be extracted.



Biometric Traits



Biometric Applications



Face: Boston Airport



Face: Smile to Pay @ Alipay



Face: FaceID

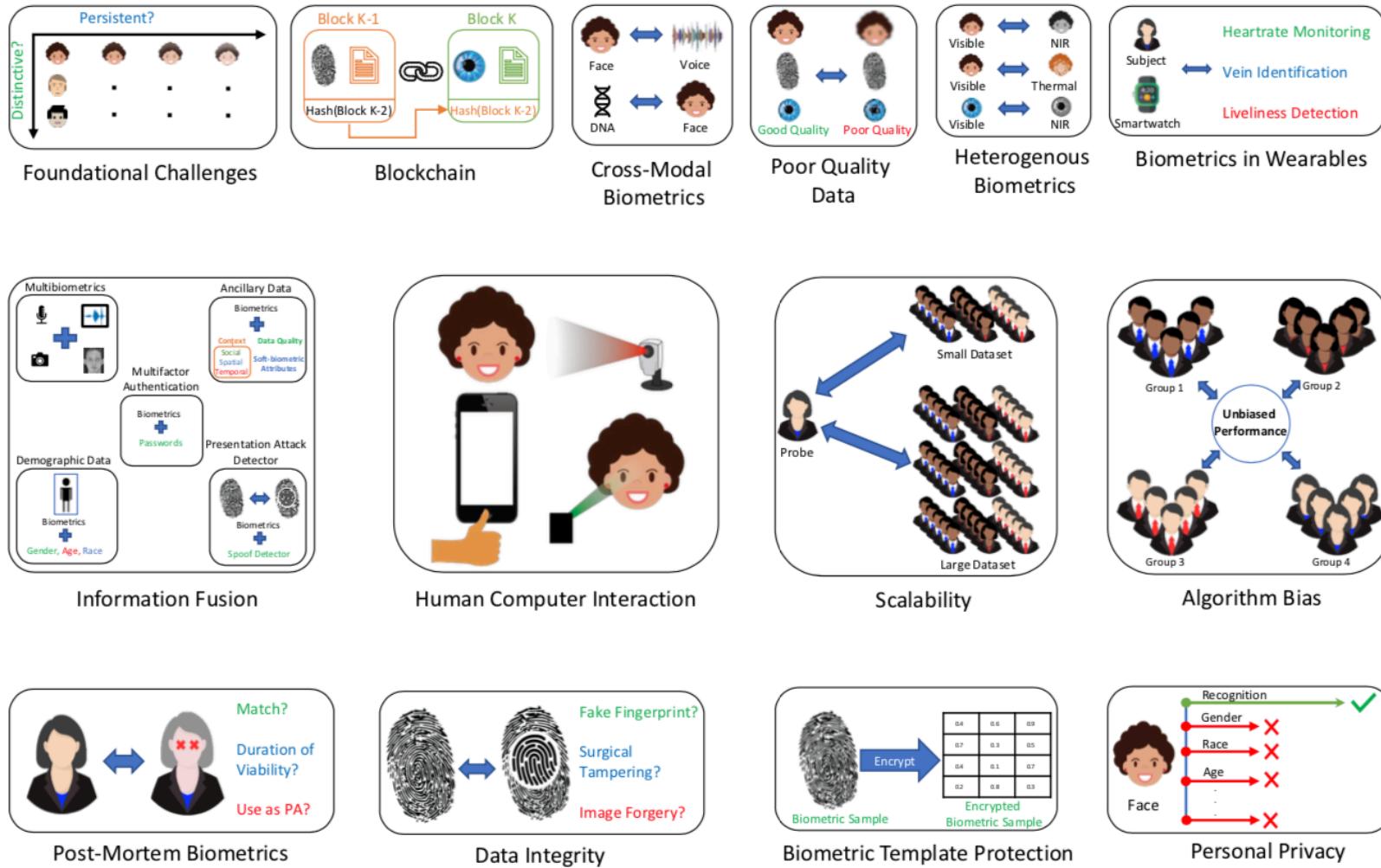


Iris: Mission impossible

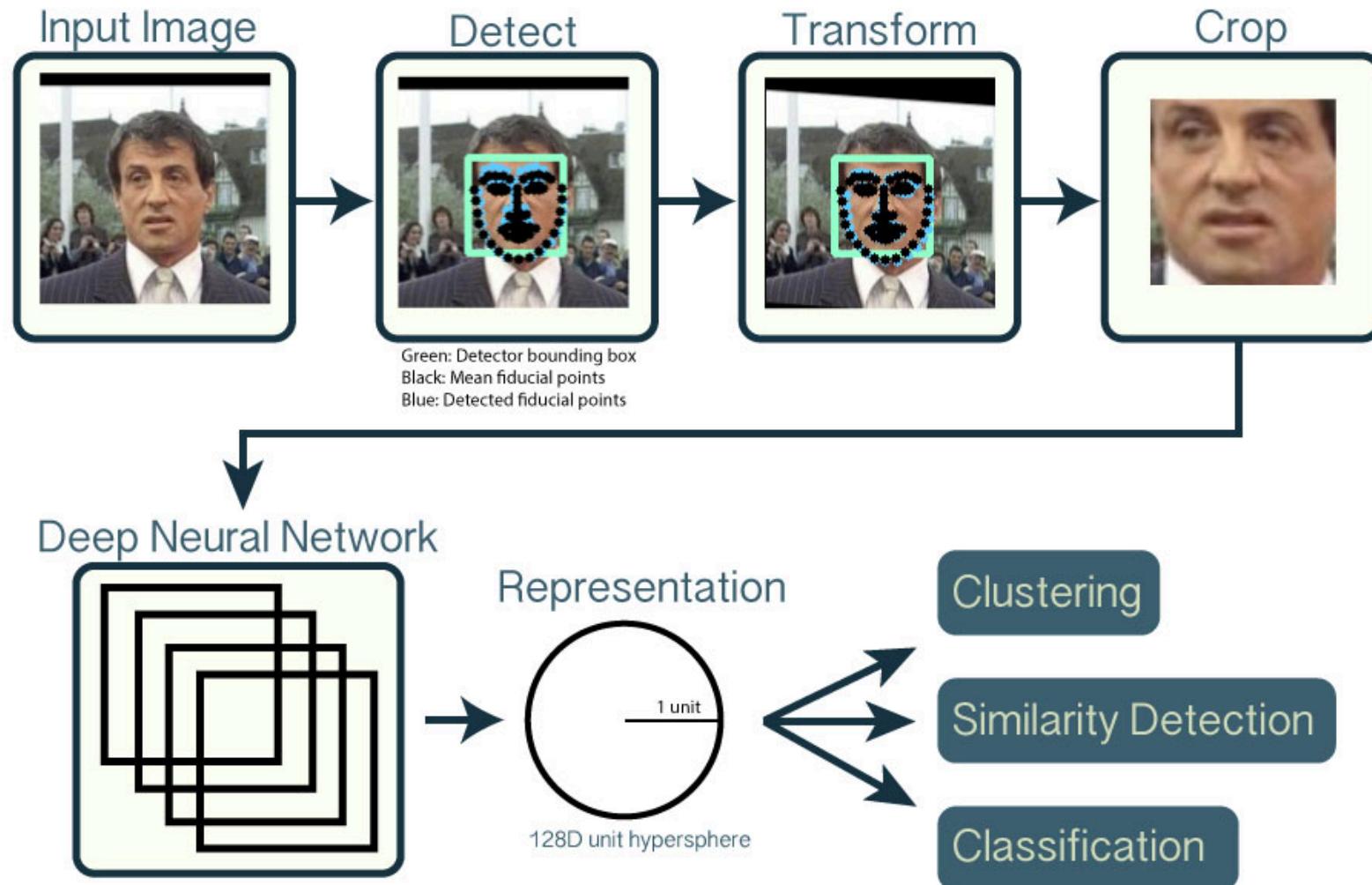


Finger vein: biometric ATM

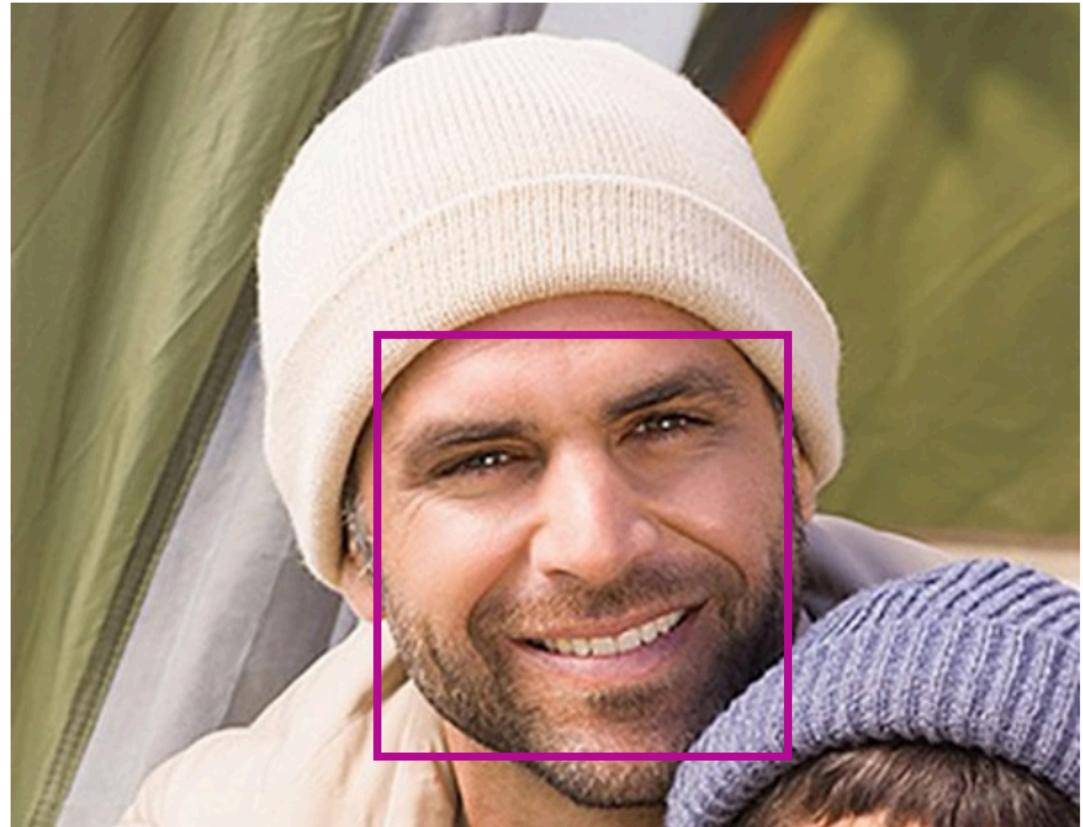
Biometric Research Problems



What is Face Recognition?



What is Face Recognition?

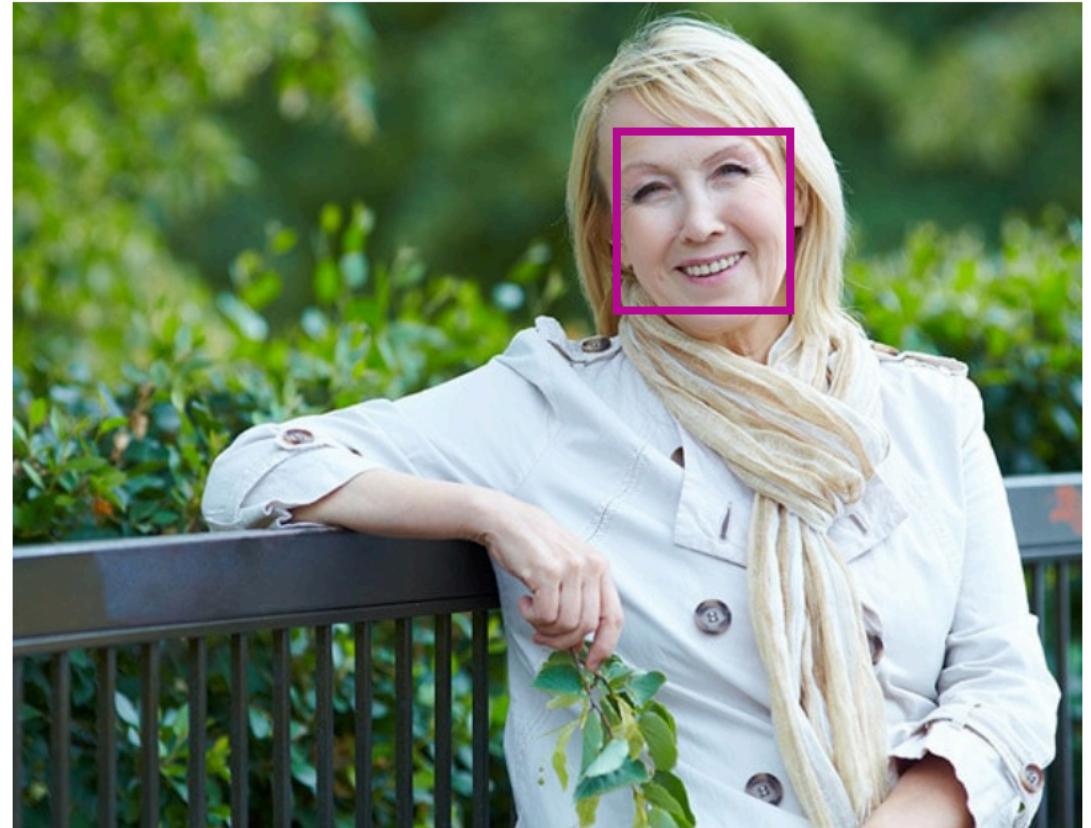
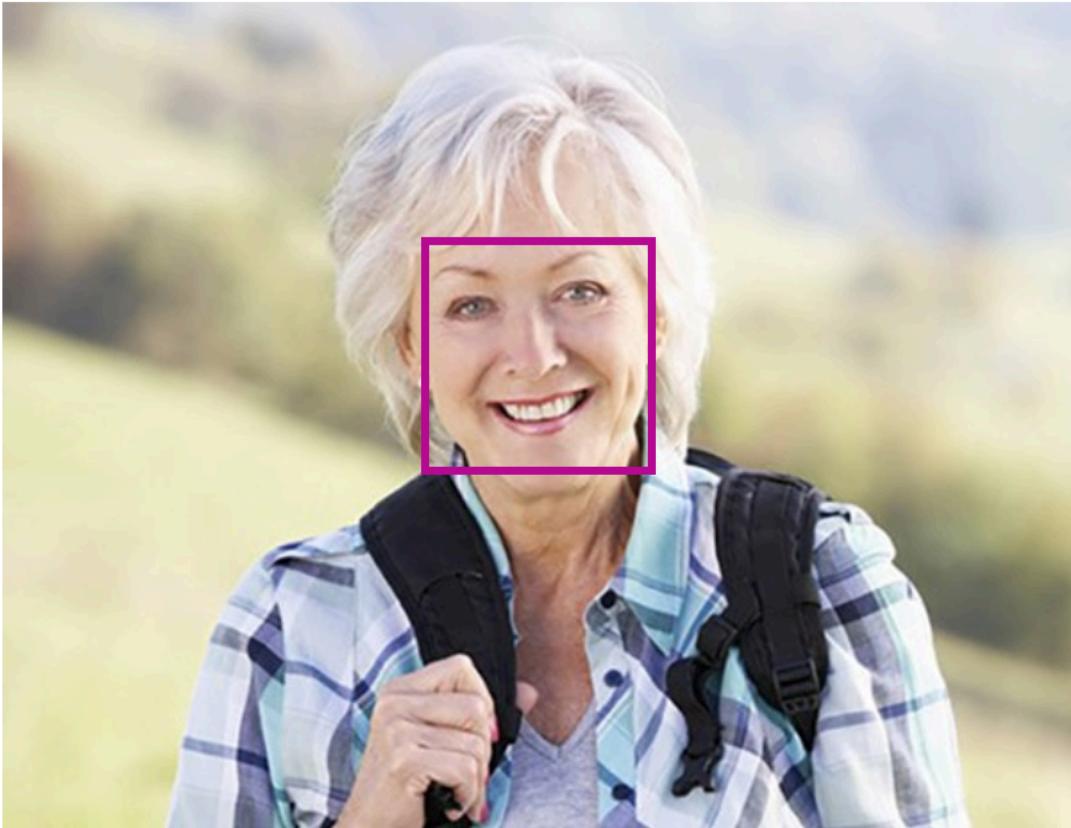


Face API from Microsoft Azure

Verification result: The two faces belong to the same person. **Confidence is 0.92199.**

Face Verification: 1 vs 1

What is Face Recognition?

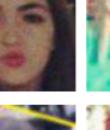


Face API from Microsoft Azure

Verification result: The two faces belong to different people. **Confidence is 0.29593.**

Face Verification: 1 vs 1

What is Face Recognition?

Method	Probe	Top 10 most similar retrieved images from an 80M face gallery										
Deep Features	1a											
Deep Features	1b											
Deep Features	2a											
Deep Features	2b											
Deep Features	2c											
DF→COTS @10K												

What are Face Recognition Challenges?



jennifer grey



(a) Pose



(b) Illumination



(c) Expression



(d) Plastic Surgery



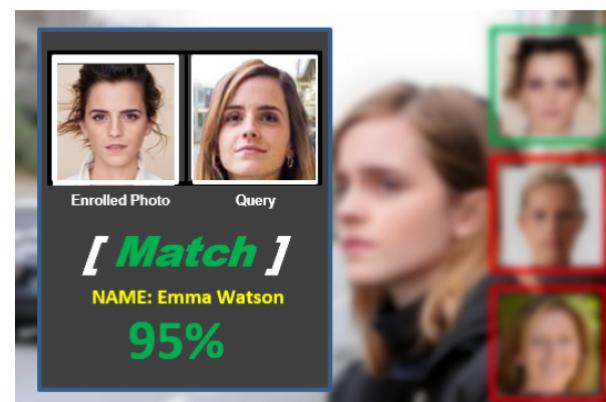
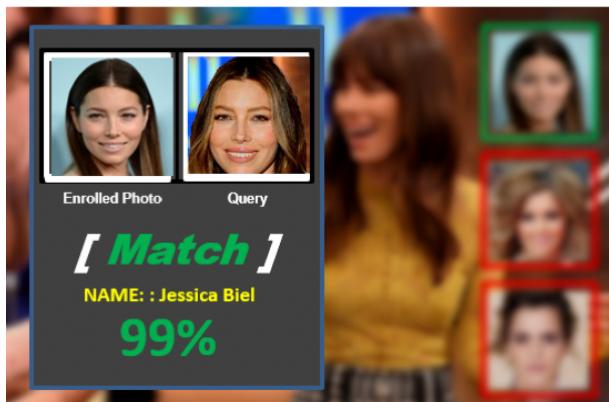
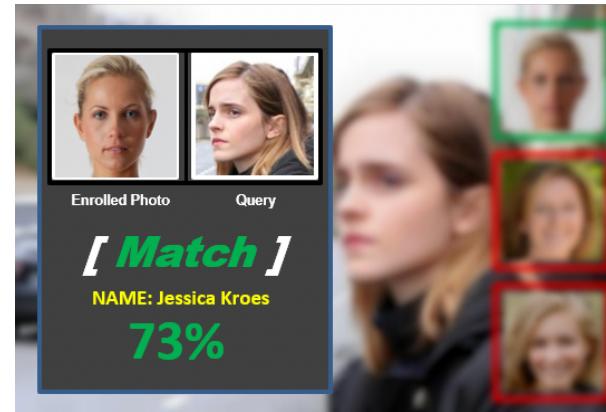
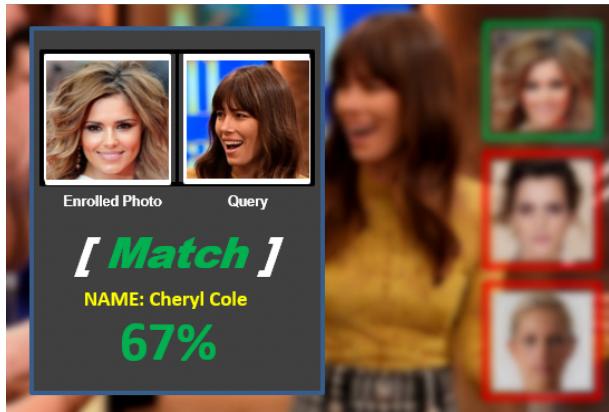
(e) Aging



(f) Makeup

What are Face Recognition Challenges?

- **Pose:** Pose-Invariant face recognition



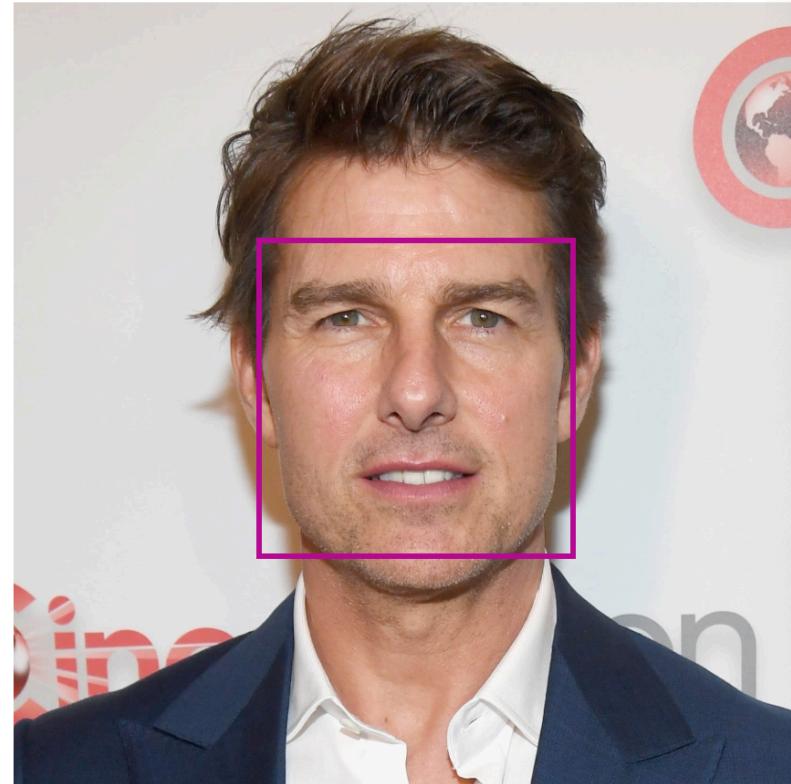
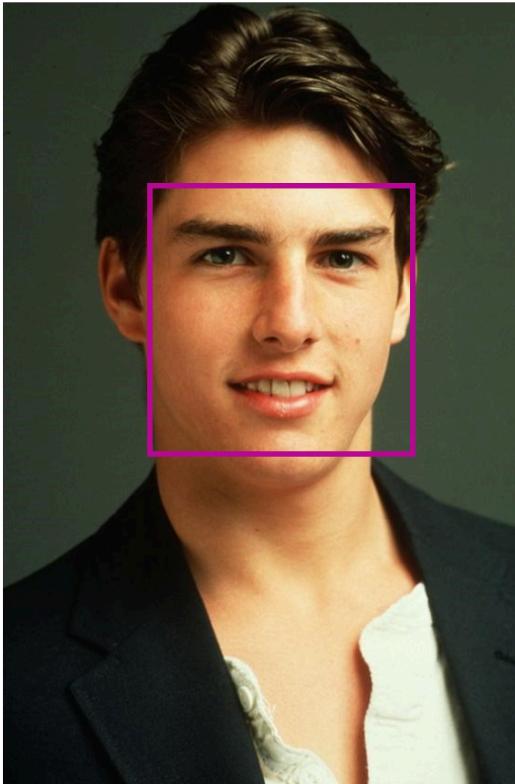
What are Face Recognition Challenges?

- **Aging:** Age-Invariant Face Recognition



What are Face Recognition Challenges?

- **Aging:** Age-Invariant Face Recognition



Verification result: The two faces belong to the same person. **Confidence is 0.76389.**

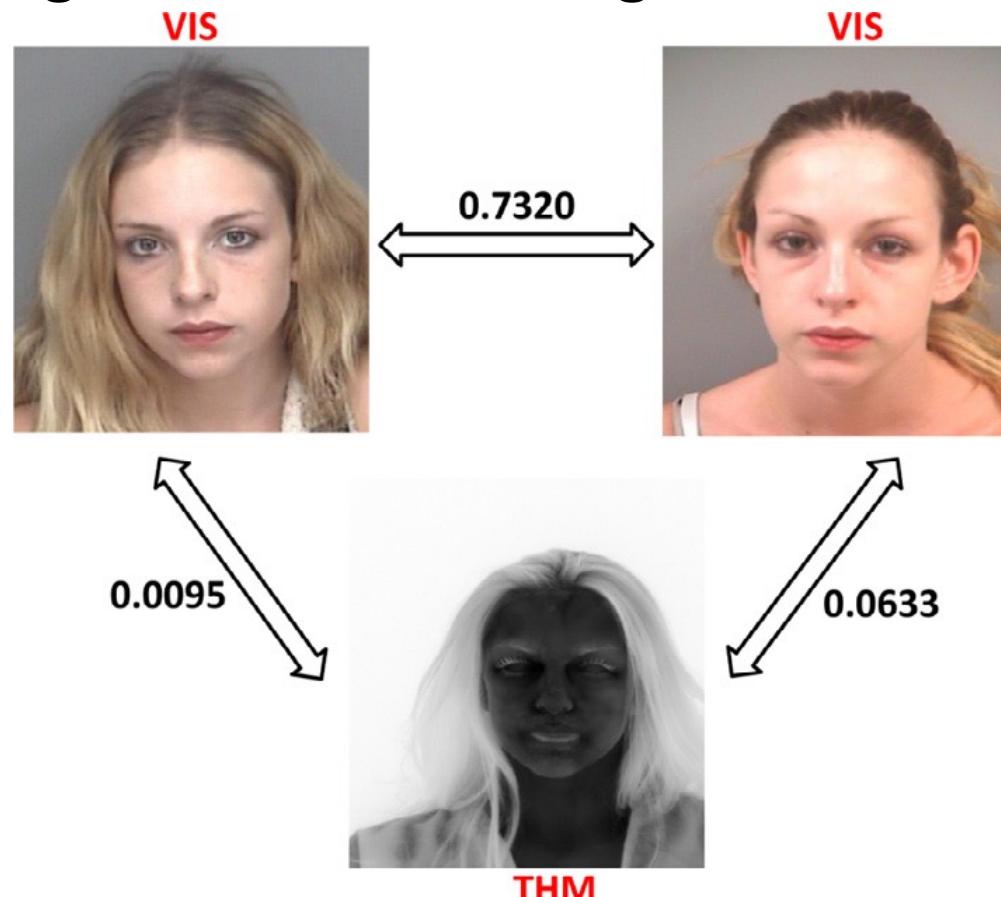
What are Face Recognition Challenges?

- **Makeup**: Makeup-Invariant Face Recognition



What are Face Recognition Challenges?

- **Spectrum:** Heterogeneous Face Recognition

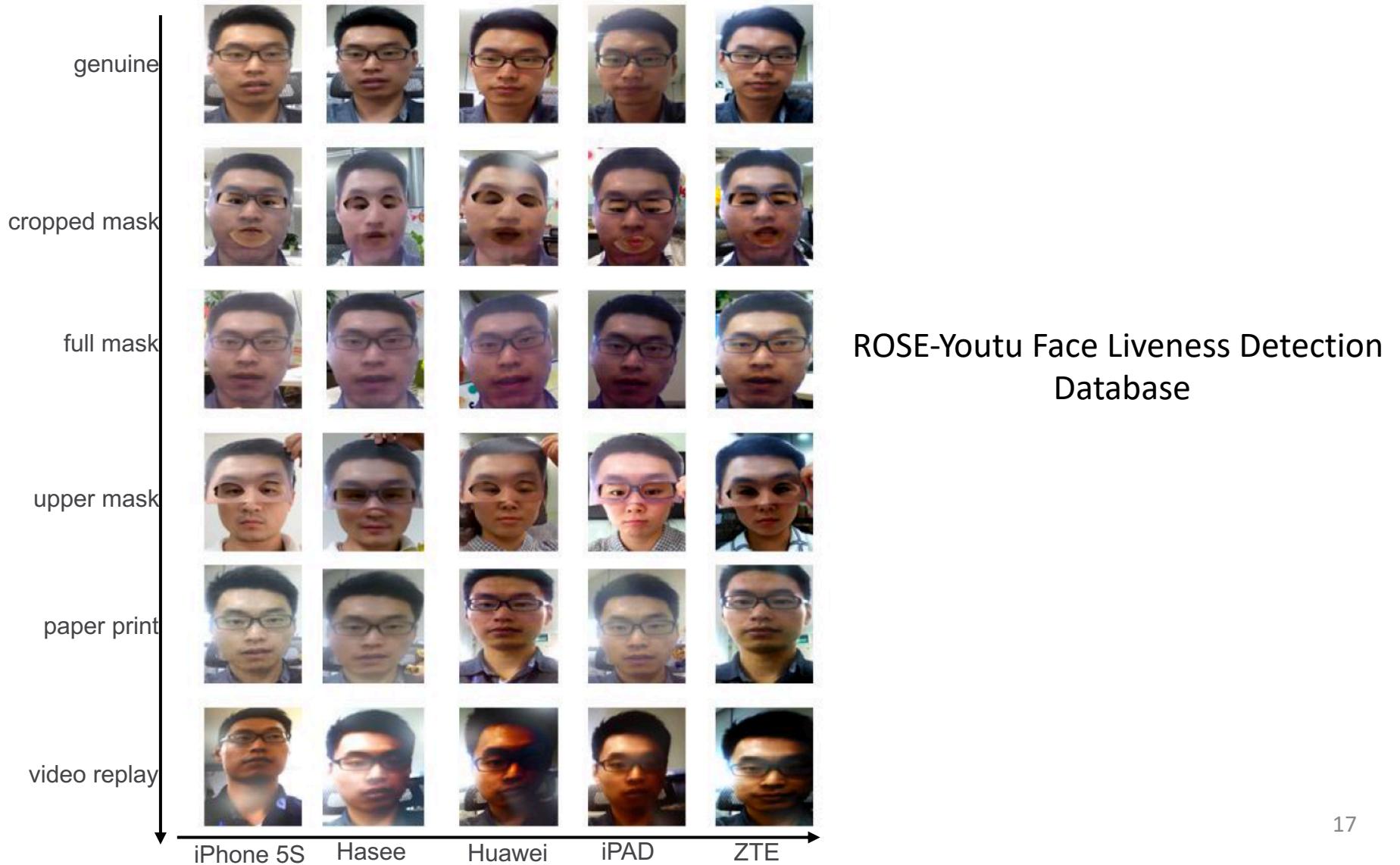


Are Face Recognition Vulnerable?

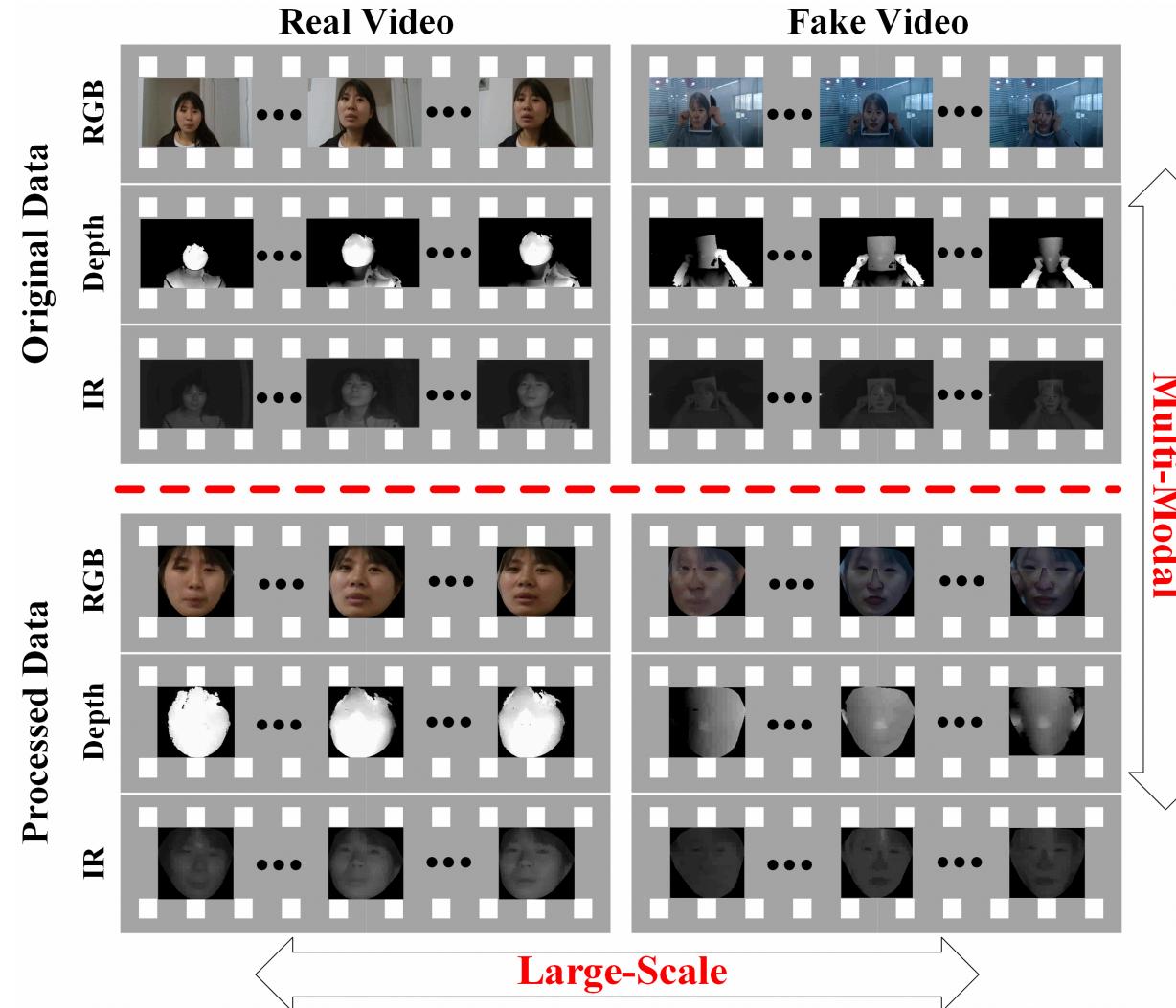
- **Spoofing:** Altering one's trait or creating a physical artifact in order to “spoof” another person's trait.



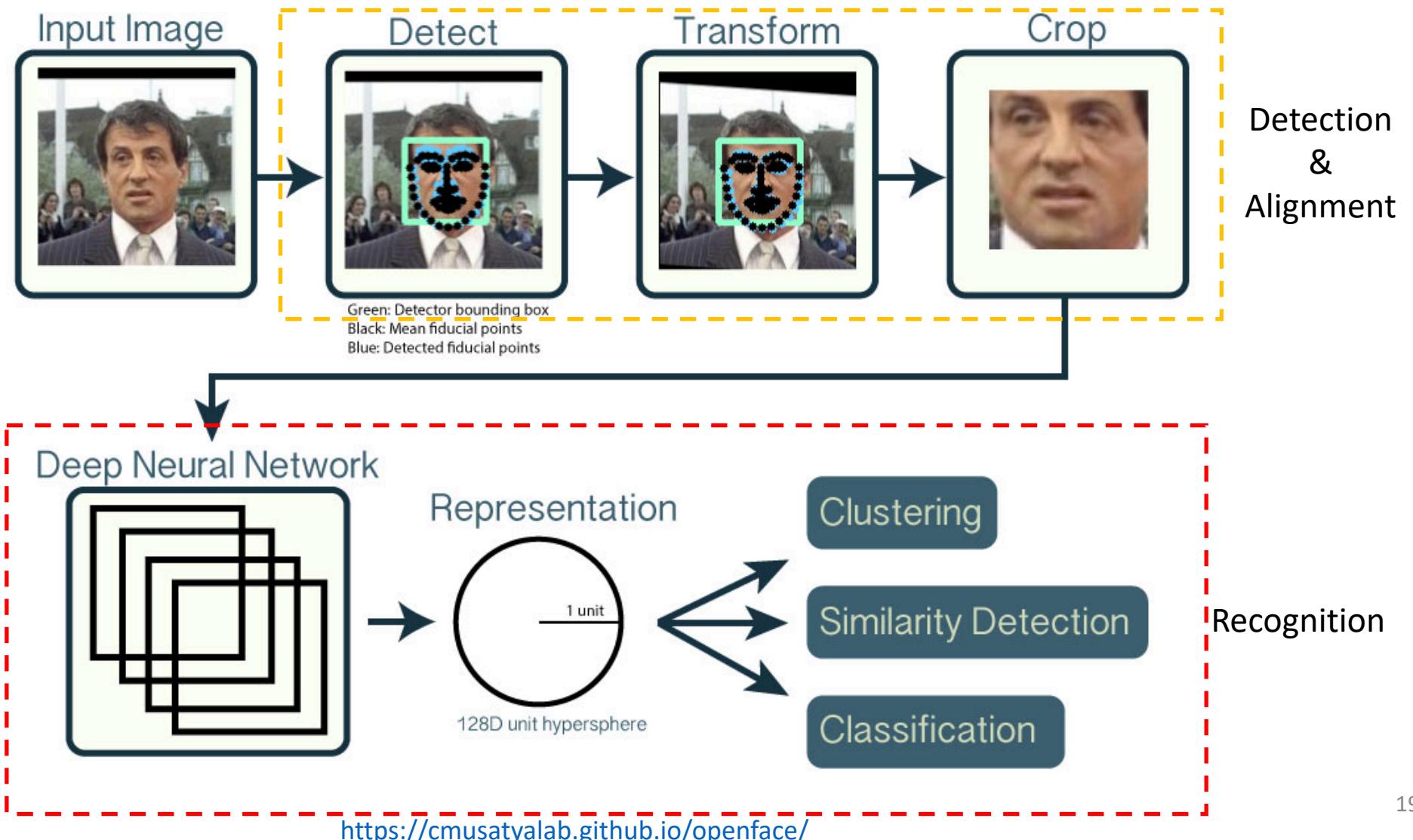
Are Face Recognition Vulnerable?



Any Anti-Spoofing Measures?



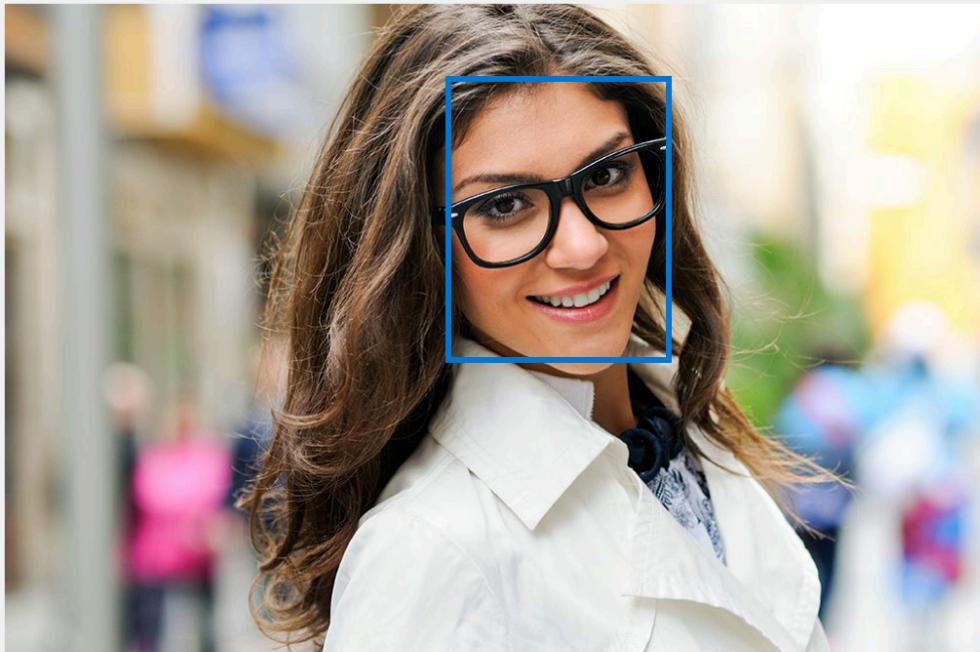
Anything Else?



What is Face Detection?

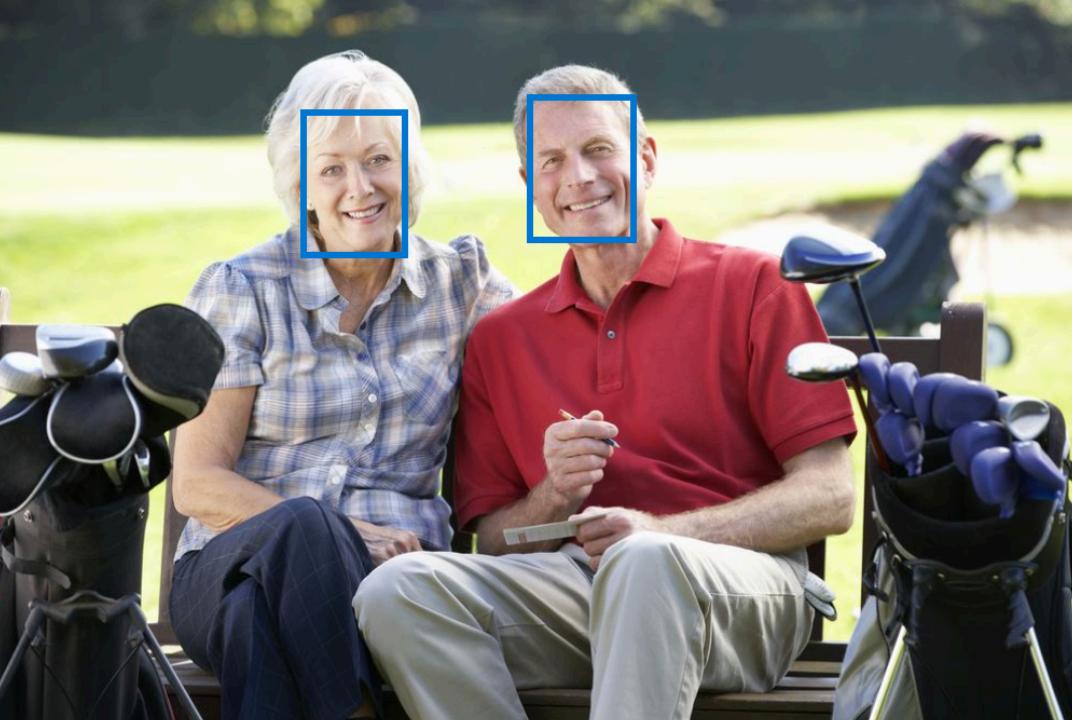
- Definition: Face detection is an approach used to find human faces in digital images.

Azure
microsoft



```
Detection result:  
detection_02  
JSON:  
[  
  {  
    "faceId": "0d498227-7387-455e-9450-408b2da86e08",  
    "faceRectangle": {  
      "top": 76,  
      "left": 446,  
      "width": 226,  
      "height": 284  
    },  
    "faceAttributes": null,  
    "faceLandmarks": null  
  }  
]
```

What is Face Detection?



```
Detection result:  
detection_02  
JSON:  
[  
  {  
    "faceId": "5477b4db-ec2a-467e-b09f-7f1b7e4c566a",  
    "faceRectangle": {  
      "top": 88,  
      "left": 489,  
      "width": 103,  
      "height": 133  
    },  
    "faceAttributes": null,  
    "faceLandmarks": null  
  },  
  {  
    "faceId": "d7b9b131-c35d-4f37-a07a-8d1e57deef25",  
    "faceRectangle": {  
      "top": 100,  
      "left": 279,  
      "width": 99,  
      "height": 131  
    },  
    "faceAttributes": null,  
    "faceLandmarks": null  
  }  
]
```

What Are Face Detection Challenges?

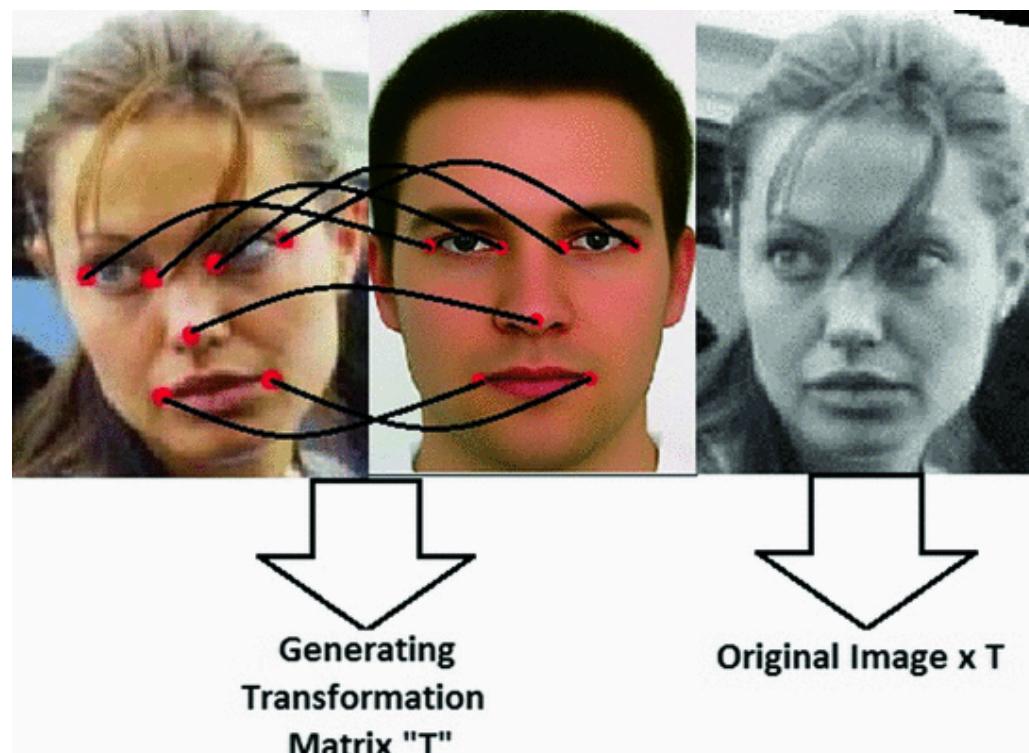


What Are Face Detection Challenges?



What is Face Alignment?

- Definition: Face alignment is the task of localizing the landmarks of faces and generating a canonical alignment of the face based on **translation, scale, and rotation**.



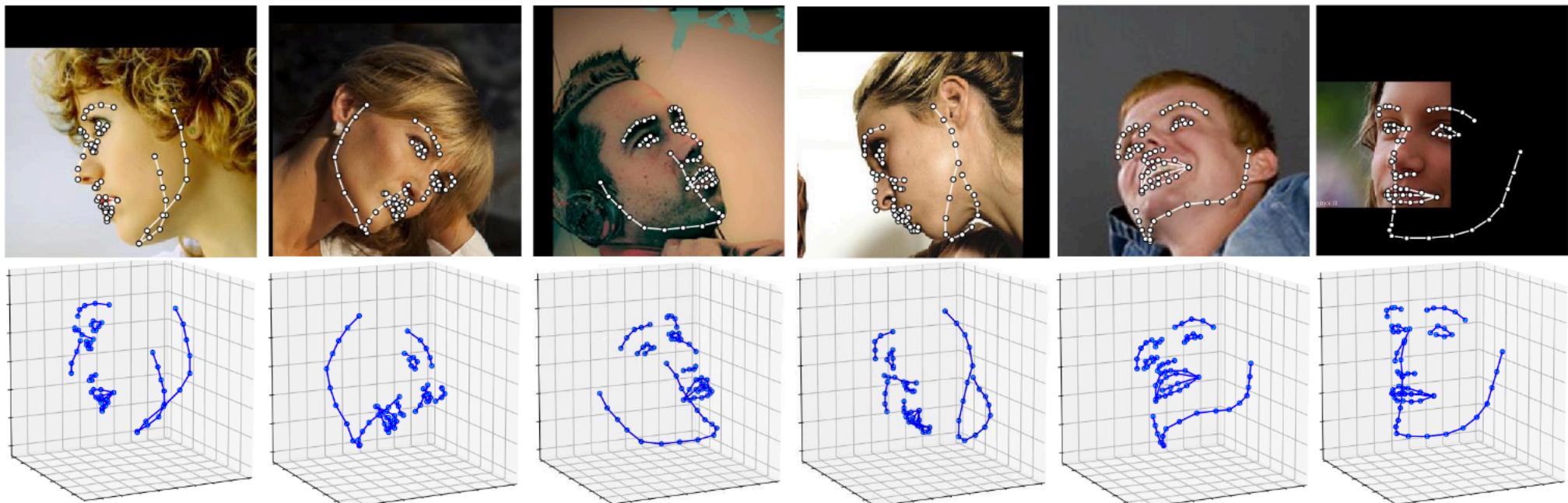
What is Face Alignment?

- 2D Face Alignment



What is Face Alignment?

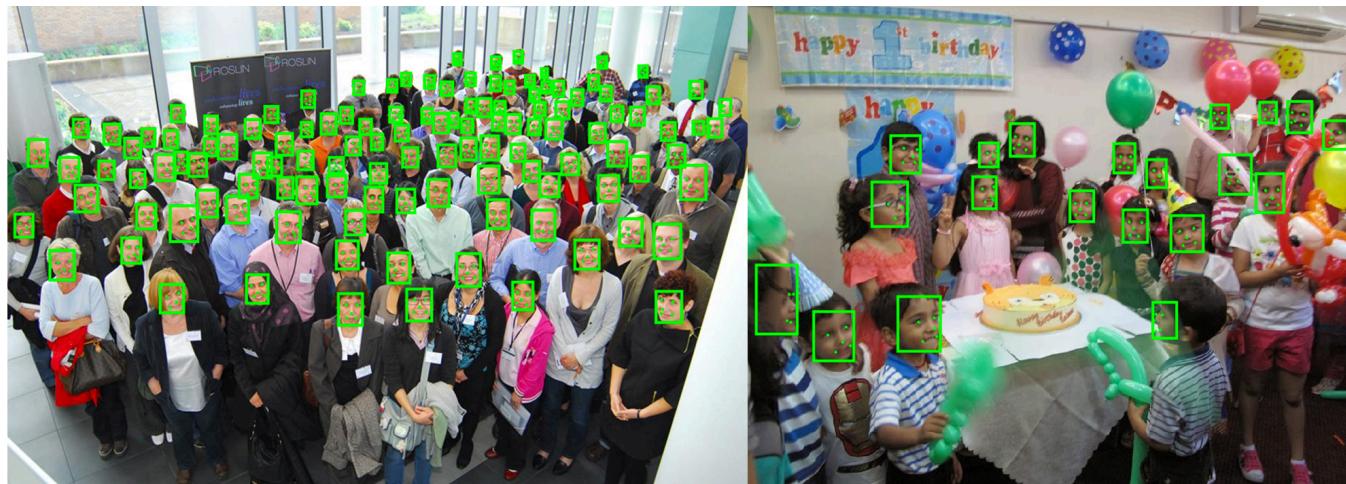
- 3D Face Alignment



Can Face Detection & Alignment Combine?



(a) Examples of results on FDDB



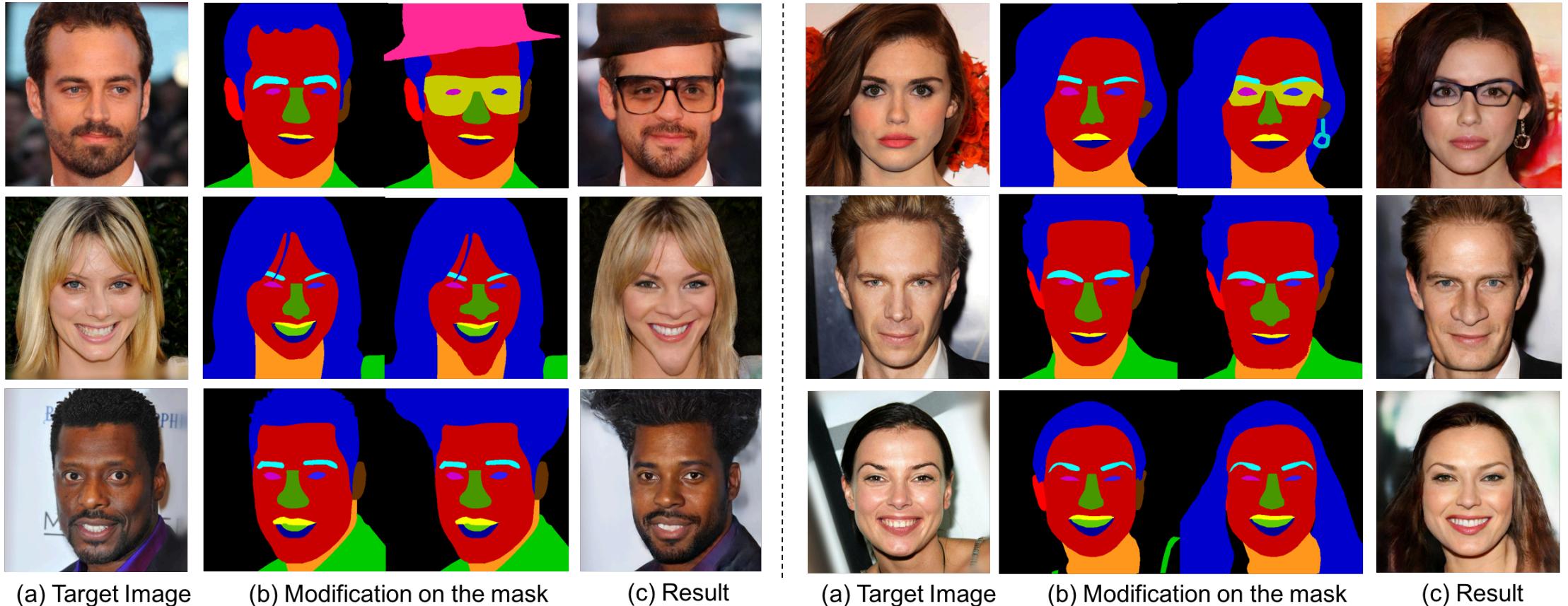
(b) Examples of results on WIDER FACE

Zhang et al., Joint Face Detection and Alignment using Multi-task Cascaded Convolutional Neural Networks, IEEE Signal Processing Letters, 2016

What Other Face Applications?

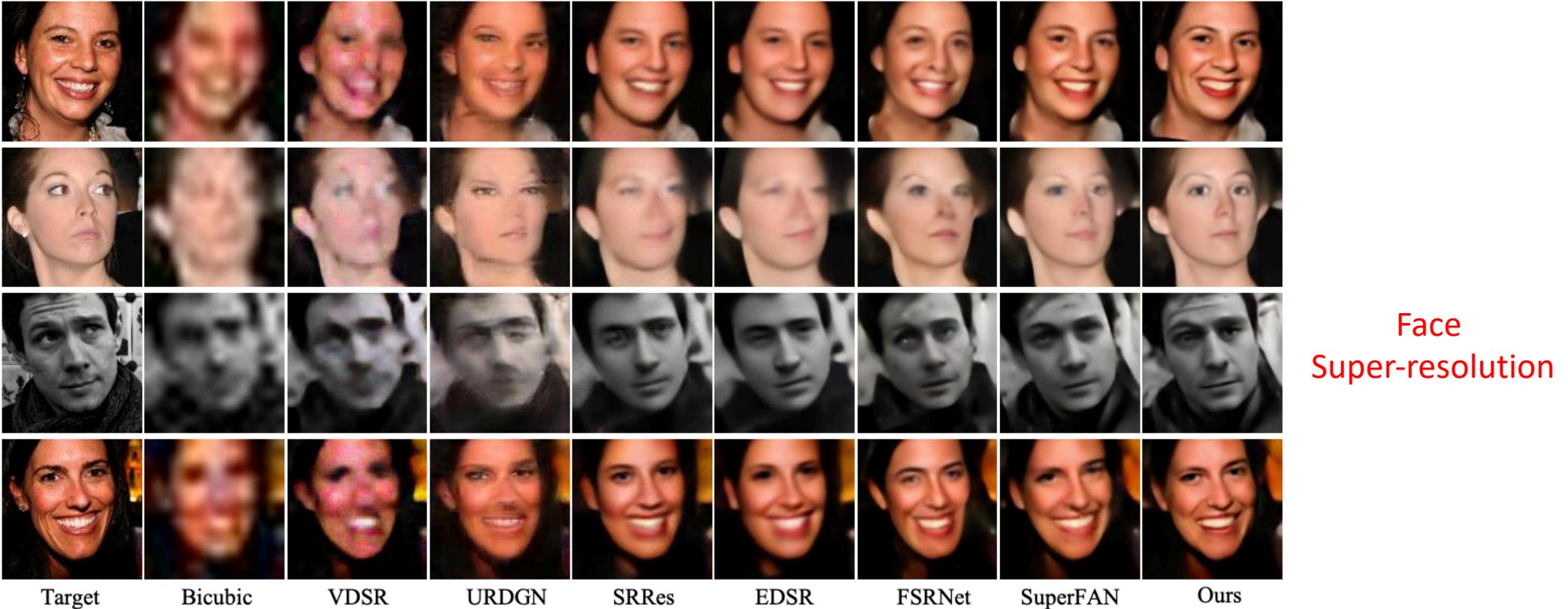


What Other Face Applications?

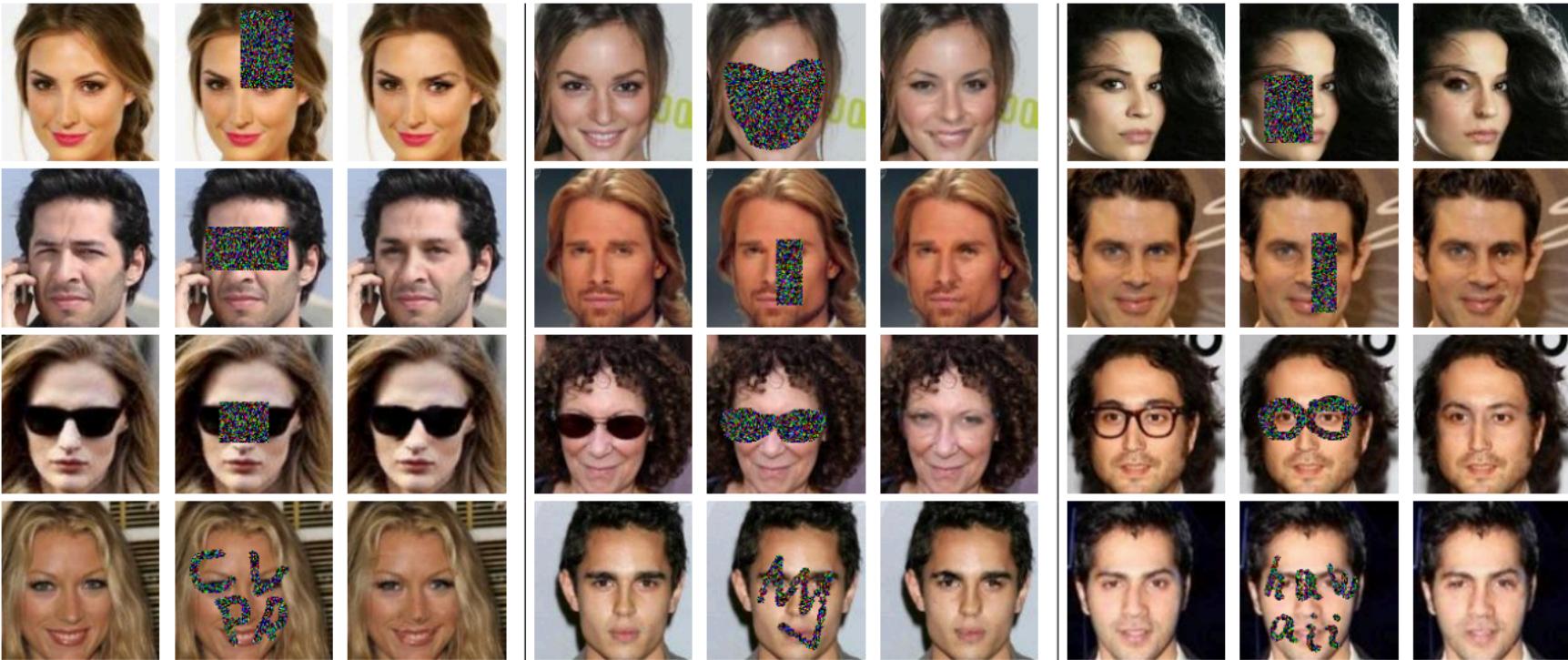


Face Parsing and Manipulation

What Other Face Applications?



What Other Face Applications?



Face
Completion

What Other Face Applications?

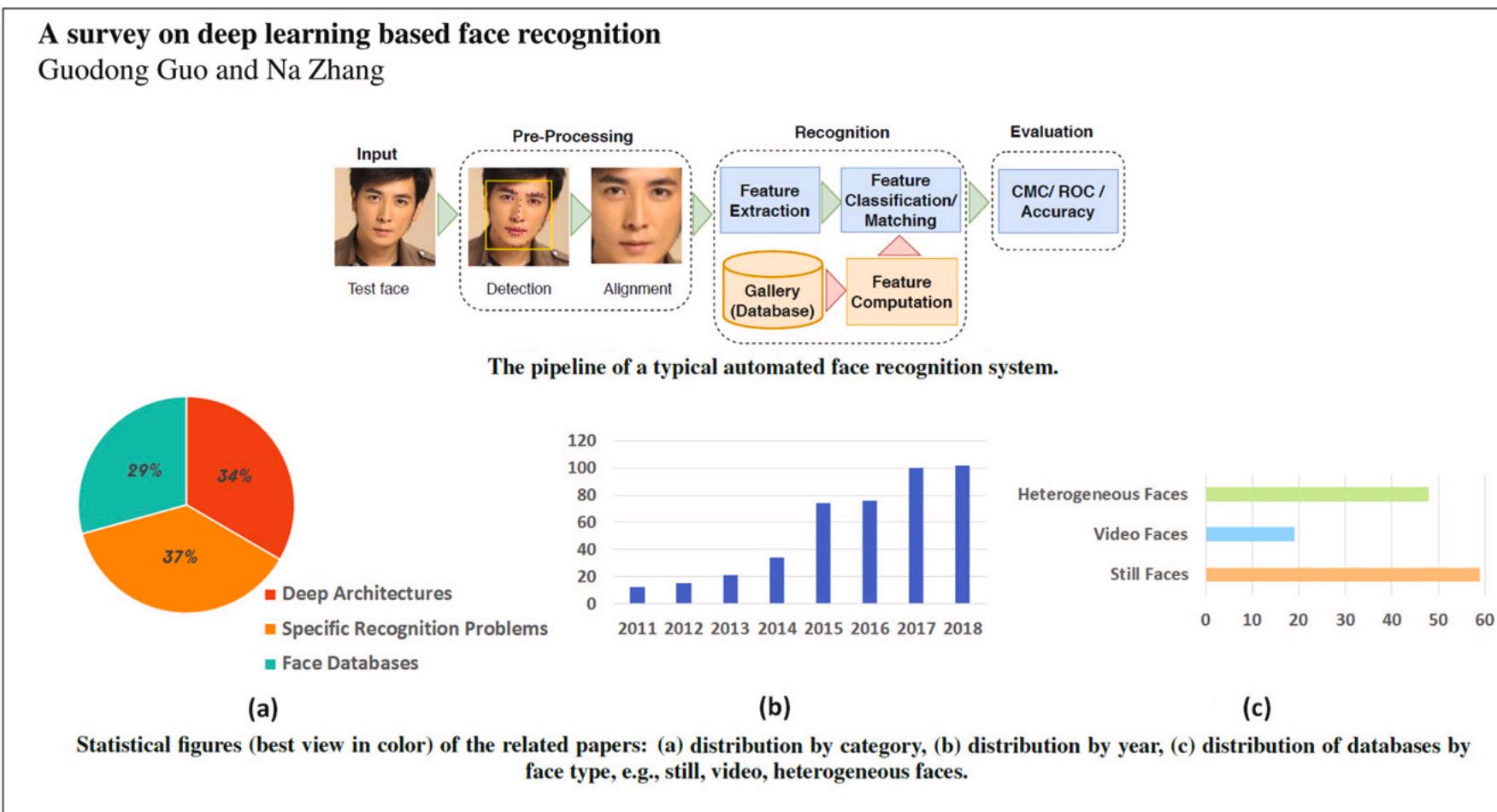
- Can other attributes be inferred from faces except identity?



What Powers Face Recognition?

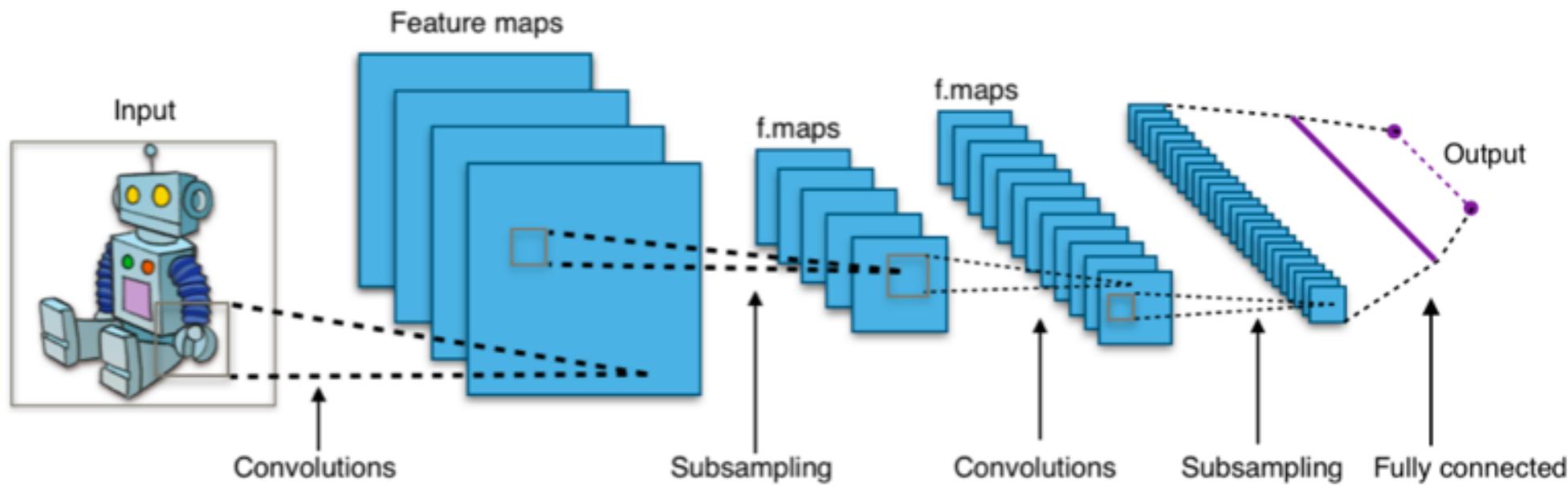


Deep Learning-based Face Recognition

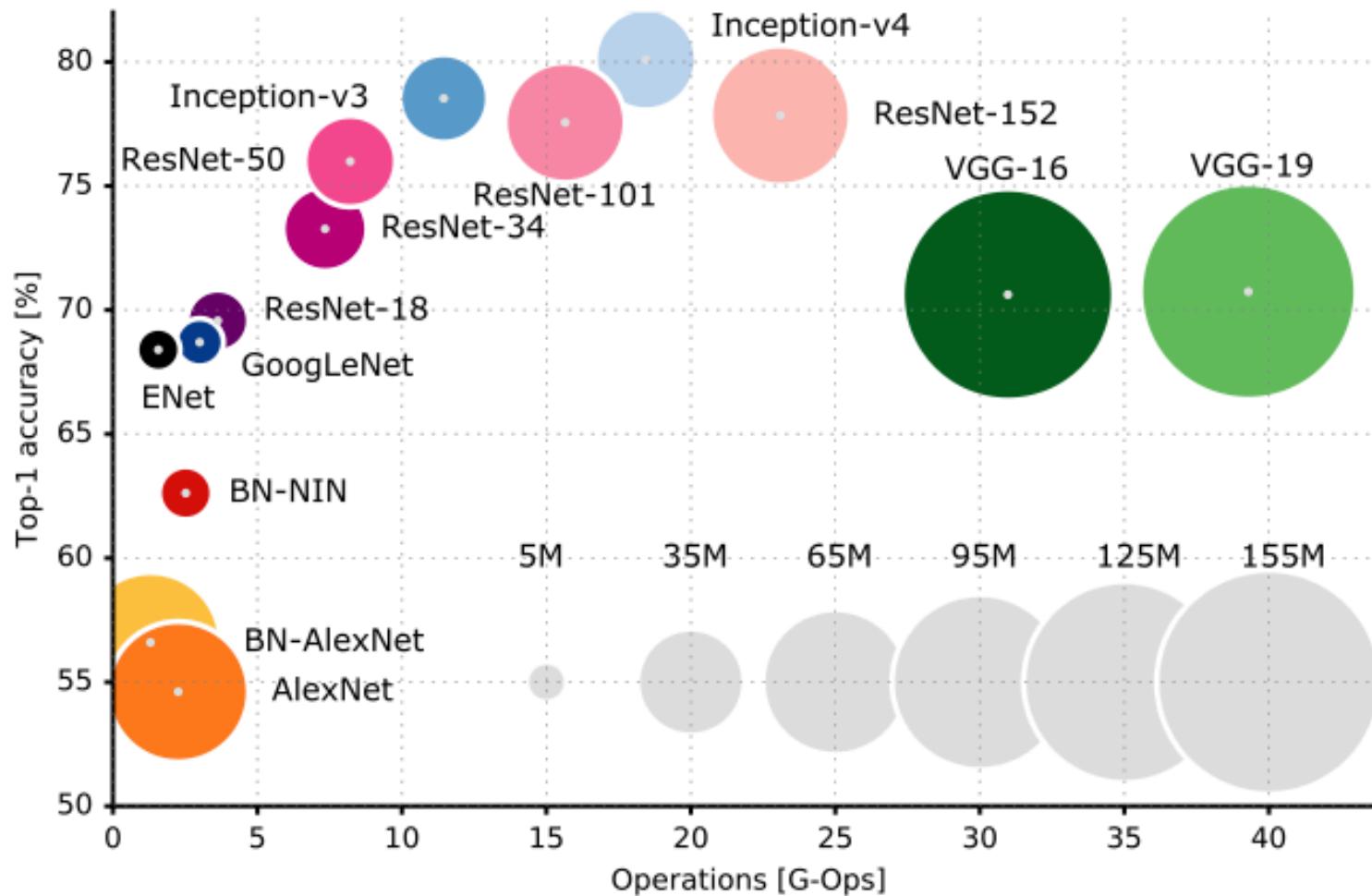


What Are Convolutional Neural Networks?

- A convolutional neural network (CNN) is a class of deep neural networks that consists of basic building blocks of convolution, pooling and fully connected operations.

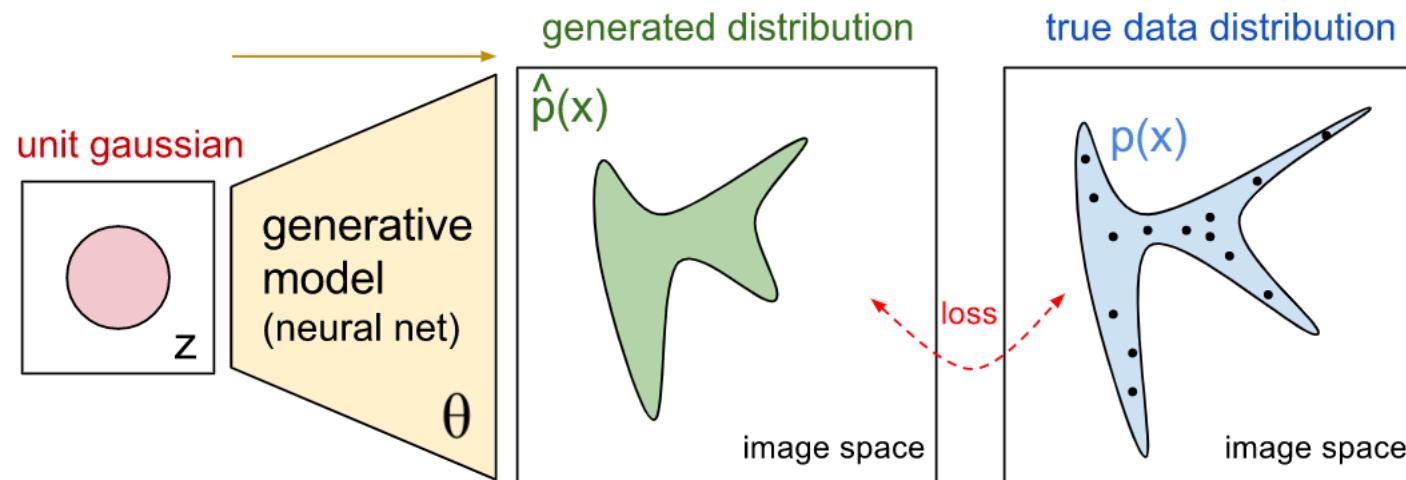


History of Convolutional Neural Networks



What Are Generative Adversarial Networks?

- Generative Adversarial Networks (GANs): GANs are a model architecture that are used to train a generative model.

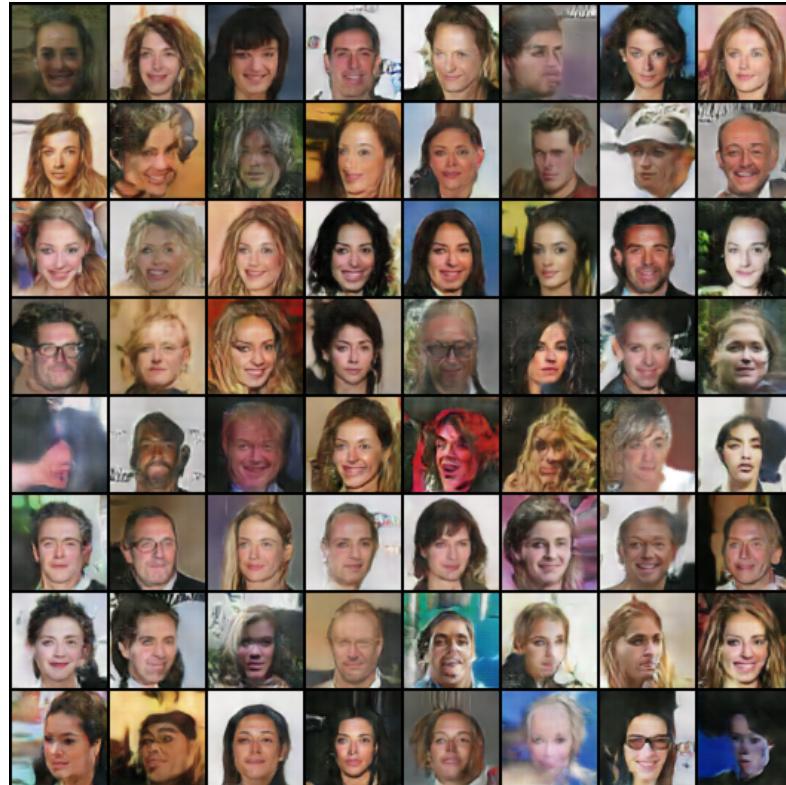


<https://openai.com/blog/generative-models/>

What Are Generative Adversarial Networks?

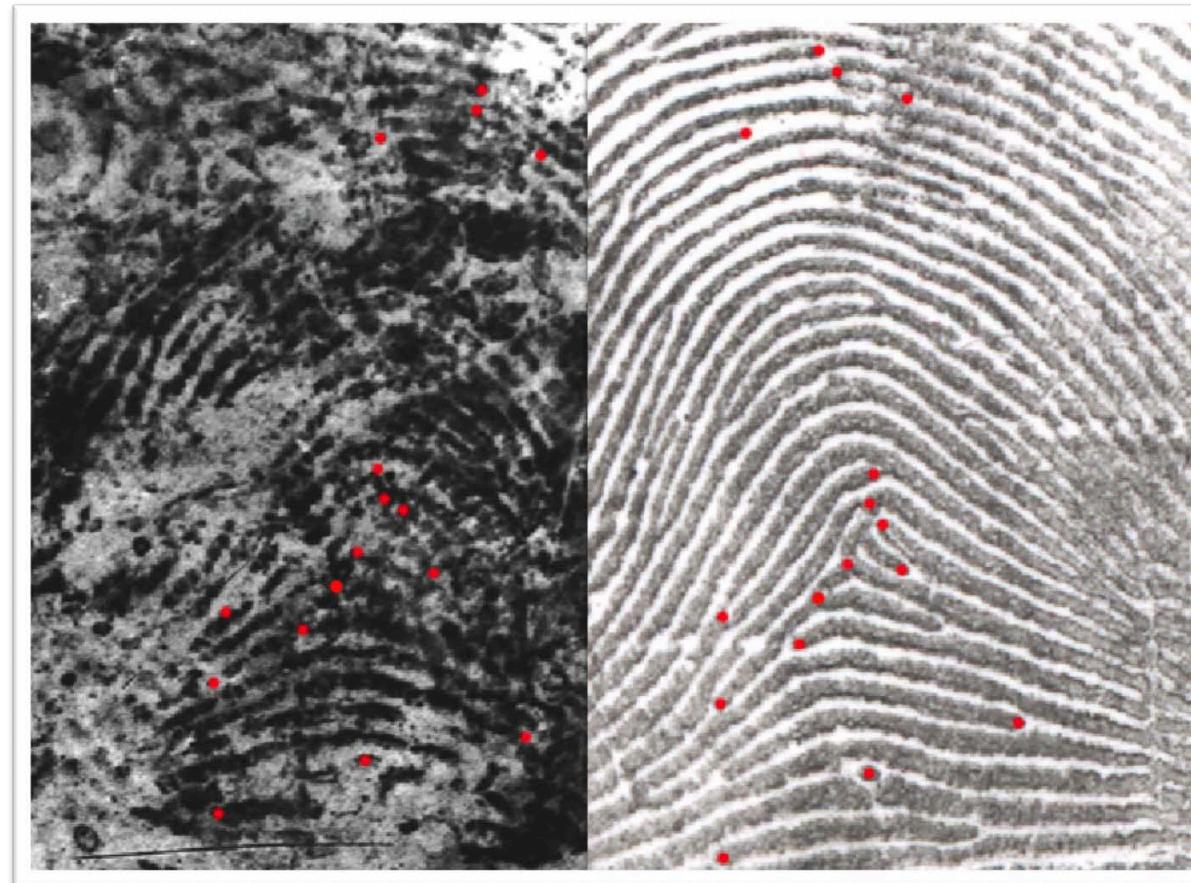


Real images
(CelebA)

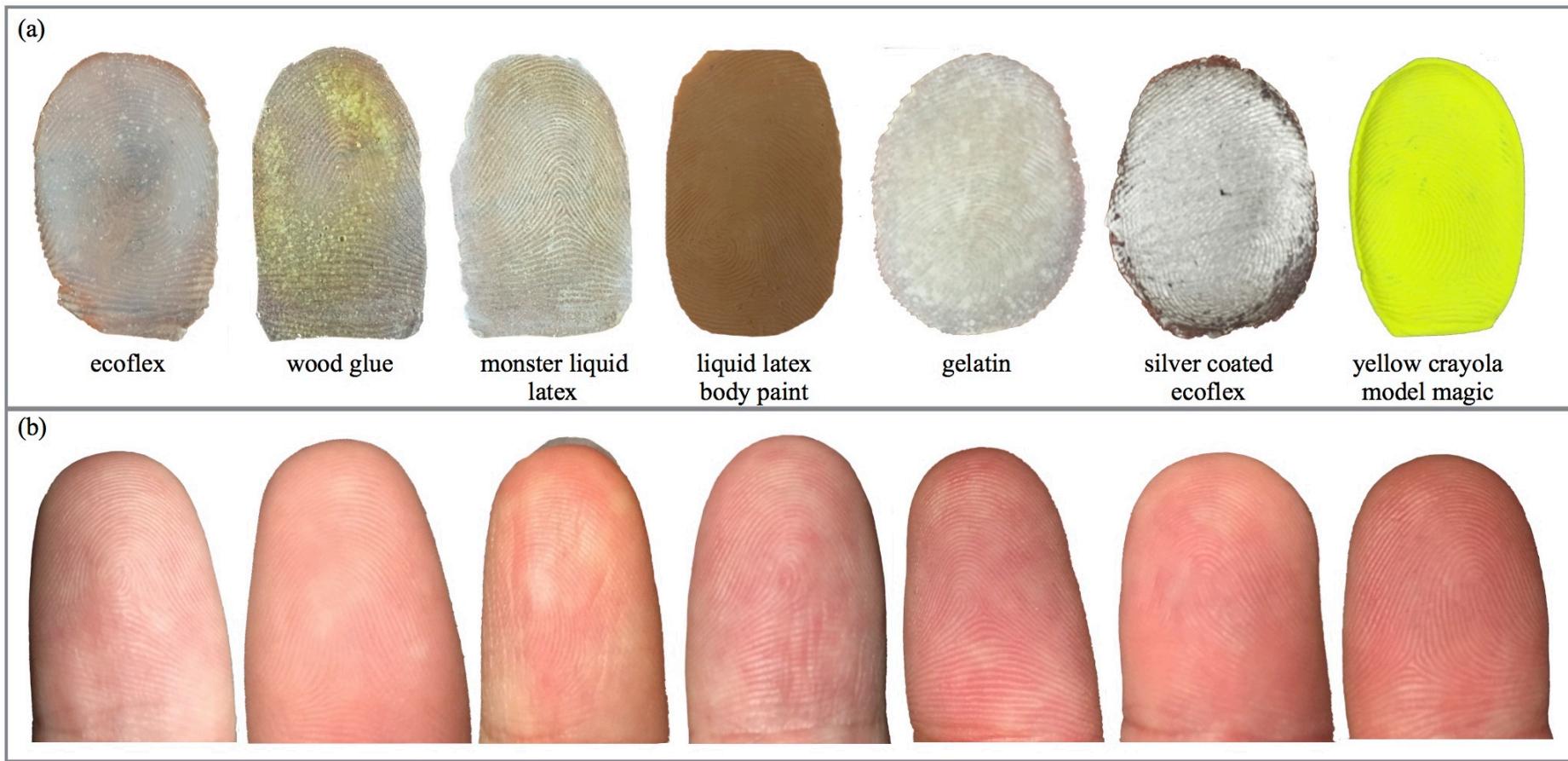


Generated images

Are these two prints from the same finger?

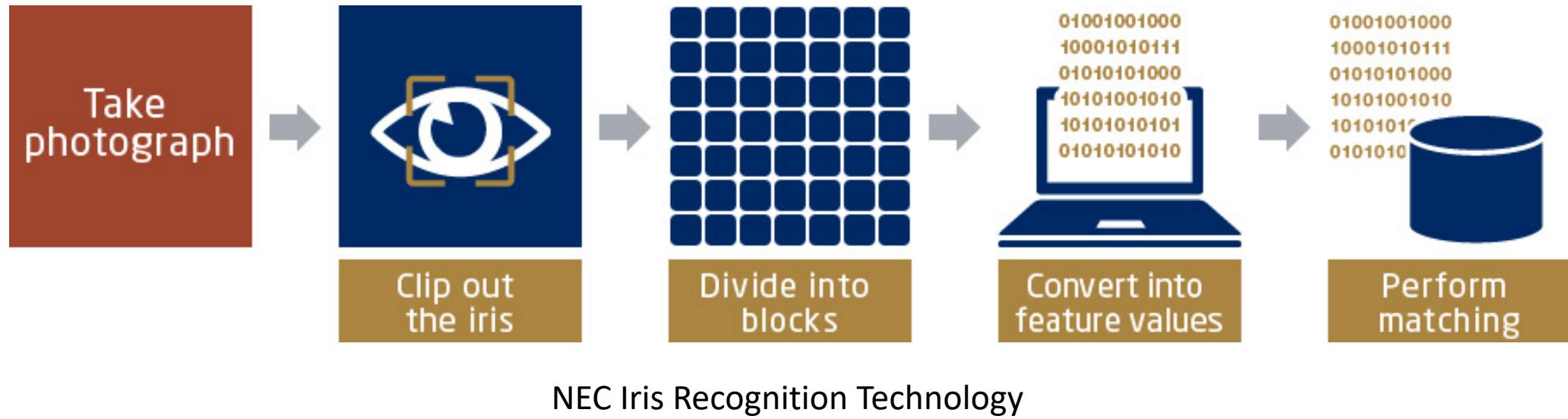


How about other Biometrics Problems?

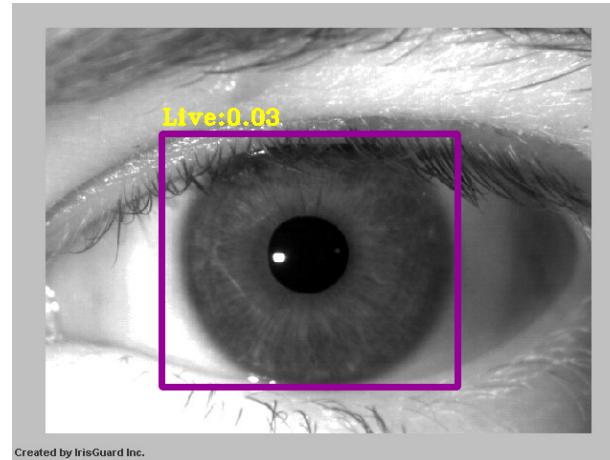


Fingerprint Presentation Attack Detection

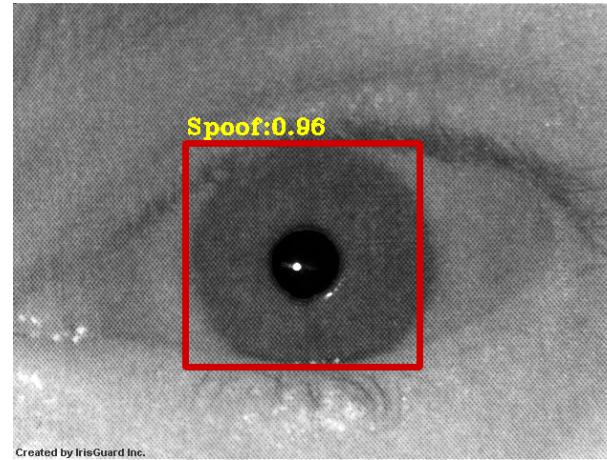
How about other Biometrics Problems?



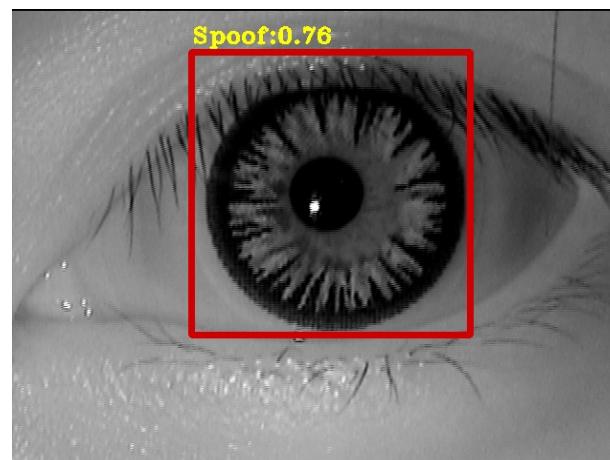
How about other Biometrics Problems?



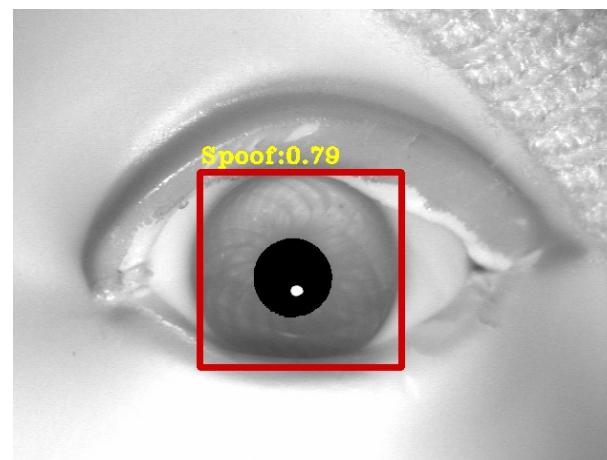
(a) Real Live Iris



(b) Printed Iris Image



(c) Contact Lens



(d) Artificial Eye Model

Iris Presentation Attack
Detection