



Department of Computer Science  
& Information Engineering

資 訊 工 程 系

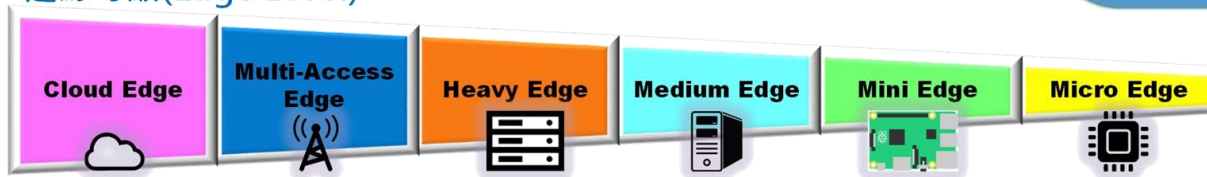
# 人工智慧與邊緣運算實務

## 7.3

### 邊緣智慧案例實作 【人臉辨識】

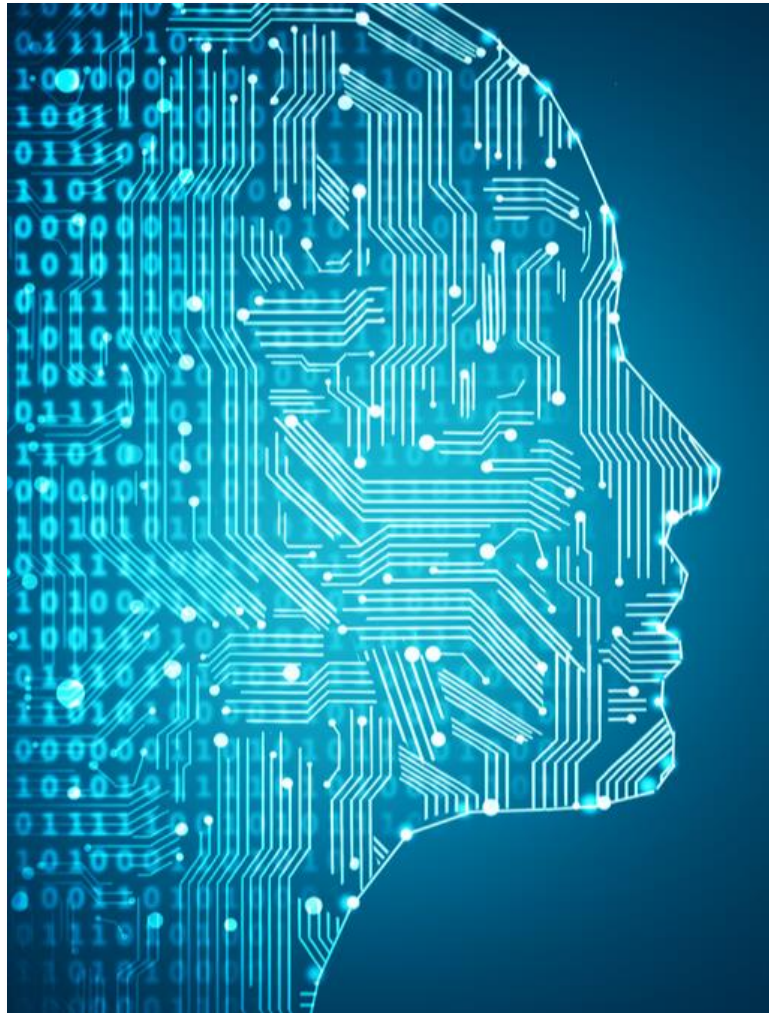


邊緣等級(Edge Level)



資訊工程系 許哲豪 助理教授

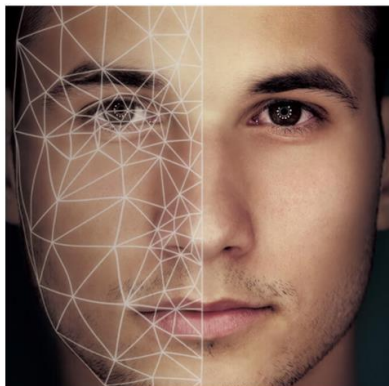
## 7.3 人臉辨識



- 基本介紹
- 評量方式
- OpenCV
- OpenVINO



# 人臉辨識應用領域



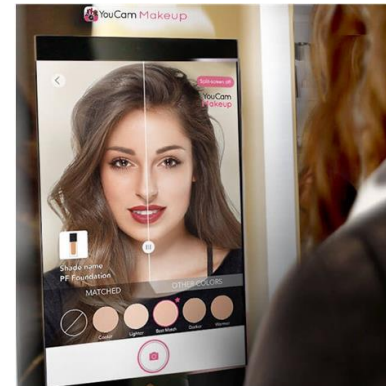
身份/性別/年齡辨識



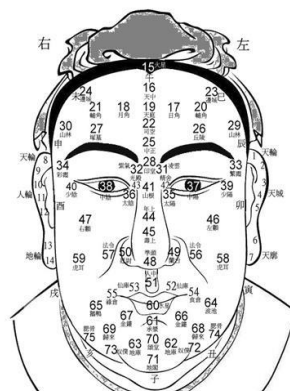
表情辨識/測謊



口罩偵測



虛擬彩妝



面相/行運/氣色



成年→兒童



女生→男生

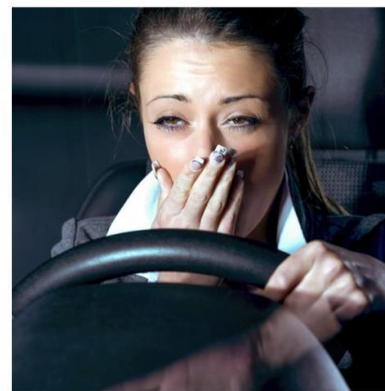


成年→老年



真實→卡通

趣味換臉



疲勞/眨眼/哈欠偵測



虛擬偶像/人機互動

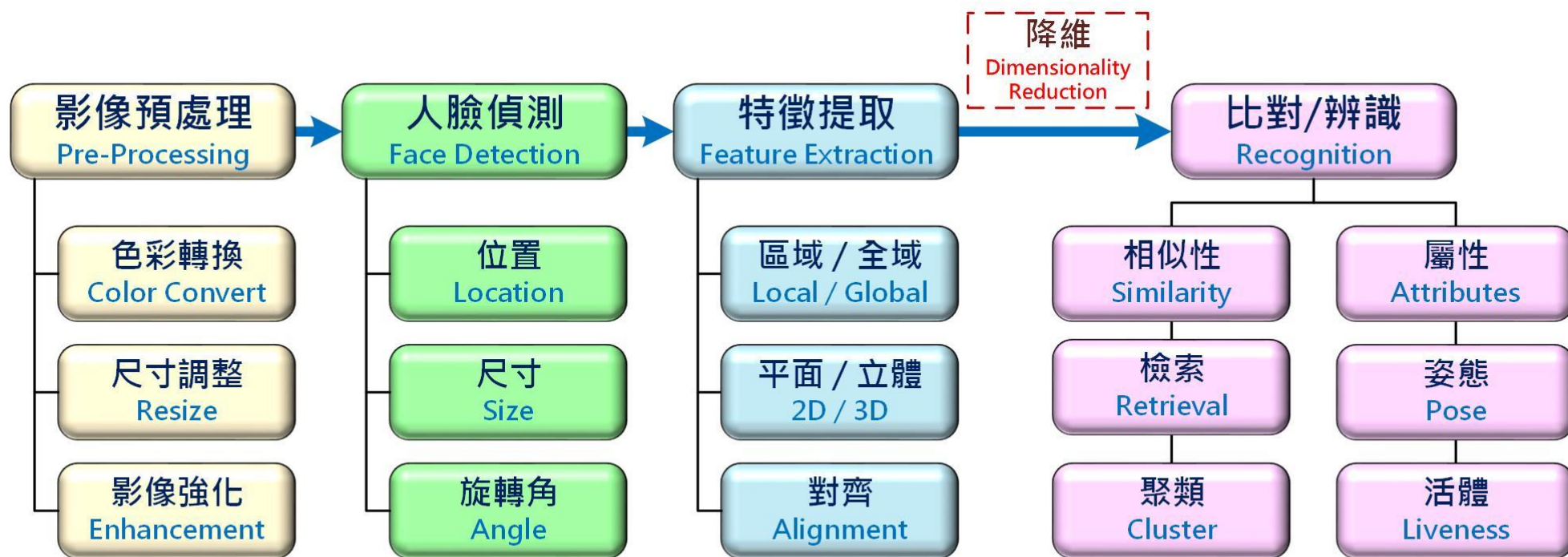
資料來源：<https://omnixri.blogspot.com/2021/02/edge-ai1-edge-ai.html>

# 人臉辨識應用場景



圖片來源：<https://youtu.be/w28AGkE4pNo>

# 人臉辨識主要技術



OmniXRI Feb. 2021整理製作

資料來源：<https://omnixri.blogspot.com/2021/02/edge-ai1-edge-ai.html>



# 人臉辨識技術發展

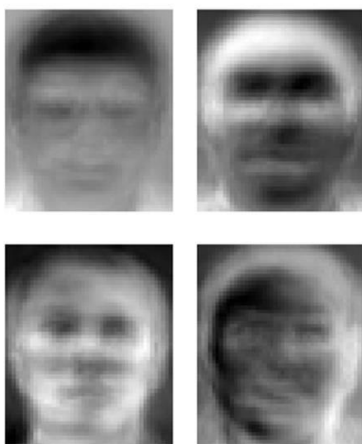
統計式

模板式

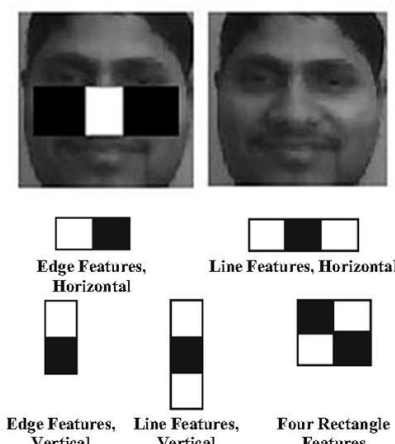
特徵式

外觀式

神經網路式



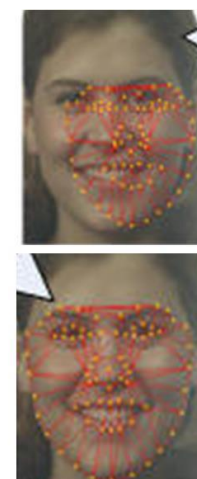
特徵臉  
Eigenface(PCA Based)  
Fisherfaces(LDA Based)



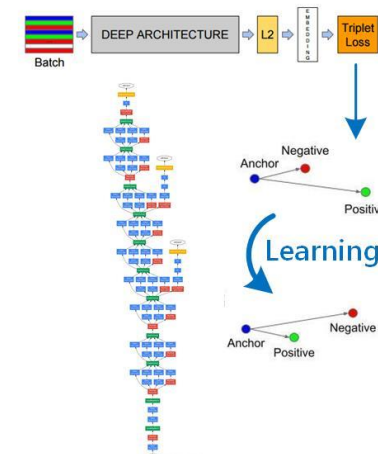
Viola-Jones聯級法  
Harr Features +  
Adaboost



主動形狀模型  
Active Shape  
Model



主動外觀模型  
Active Appearance  
Model

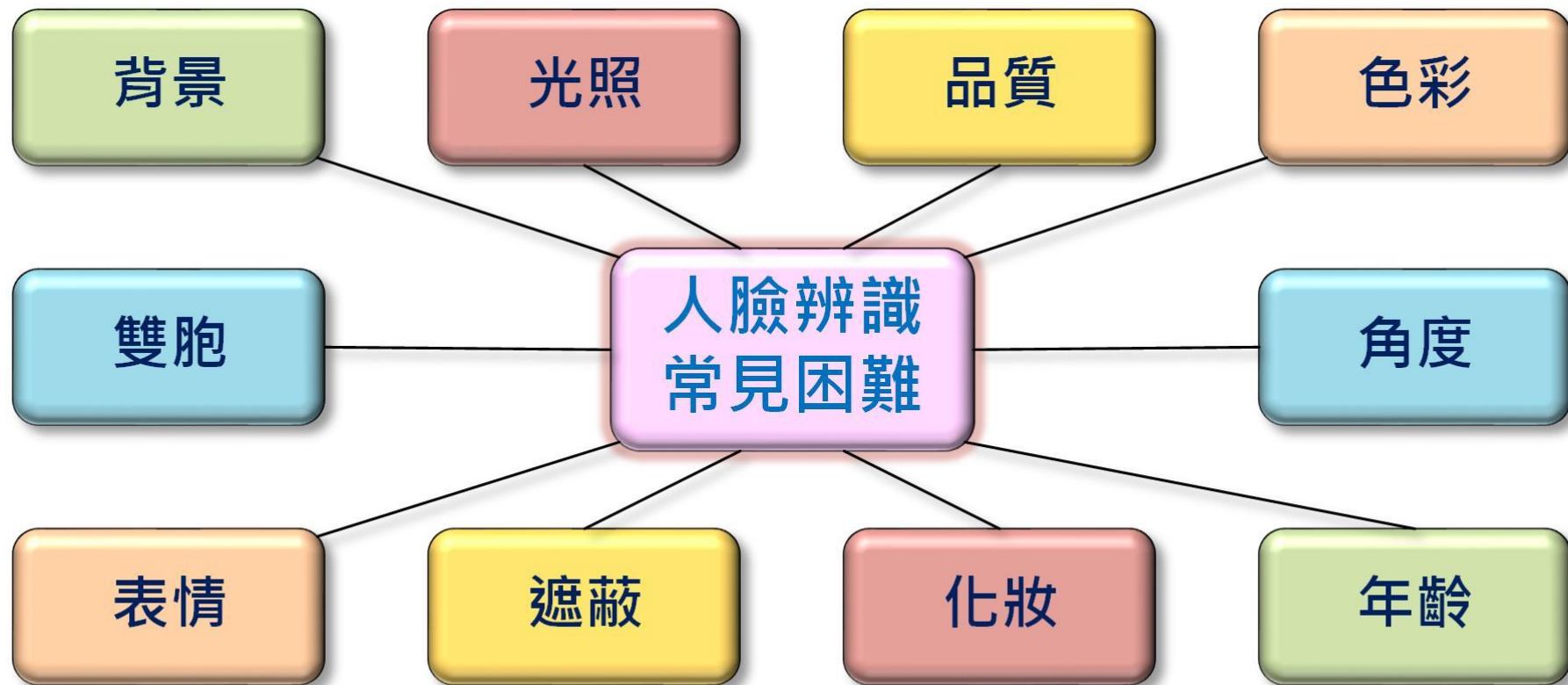


深度學習神經網路  
Google Facenet

OmniXRI Feb. 2021整理製作

資料來源：<https://omnixri.blogspot.com/2021/02/edge-ai1-edge-ai.html>

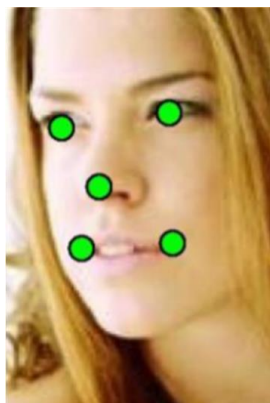
# 人臉辨識常見困難



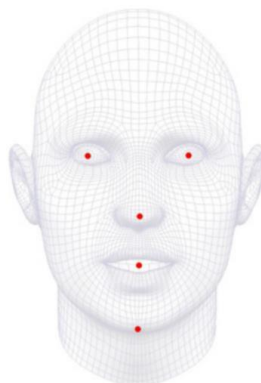
OmniXRI Feb. 2021整理製作

資料來源：<https://omnixri.blogspot.com/2021/02/edge-ai1-edge-ai.html>

# 人臉特徵點(Facial Landmark)(1/2)



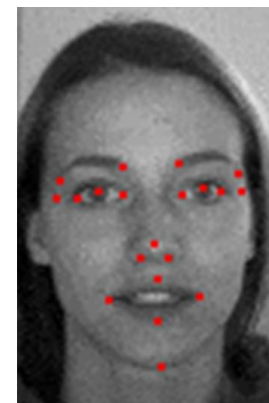
MTFL (5pt)



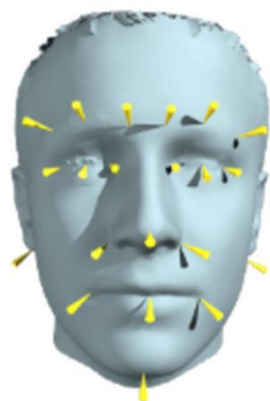
FRGC-V2 (5pt)



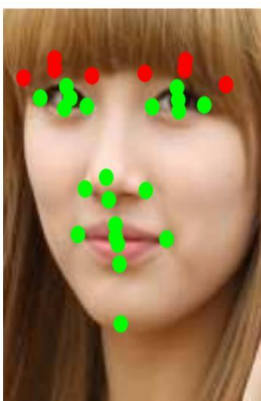
AFW (6pt)



BioID (20pt)



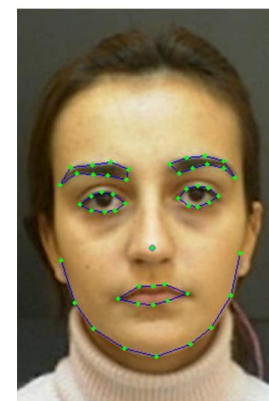
AFLW (21pt)



COFW (29pt)



LFPW (29/35pt)

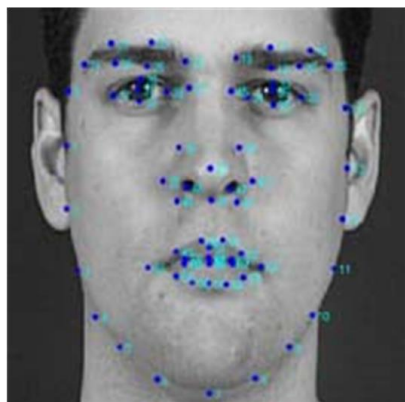


BUHMAP (52pt)

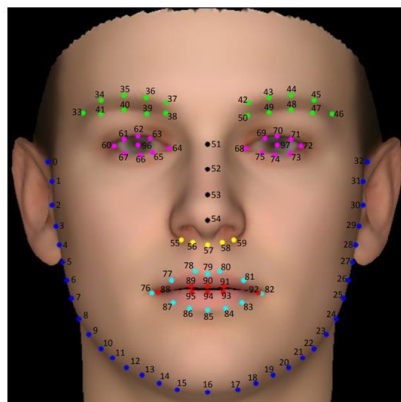
資料來源：<https://omnixri.blogspot.com/2021/02/edge-ai1-edge-ai.html>



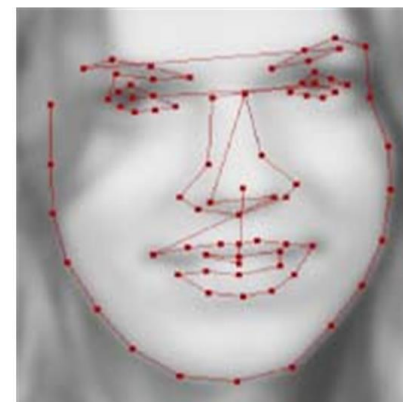
# 人臉特徵點(Facial Landmark)(2/2)



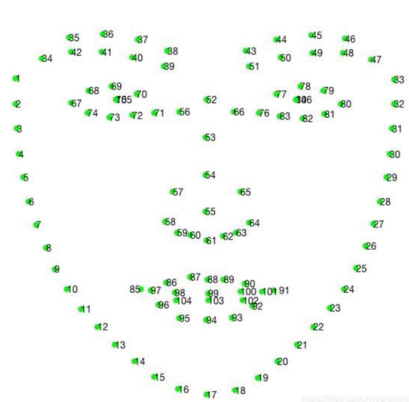
XM2VTS / 300W (68pt)



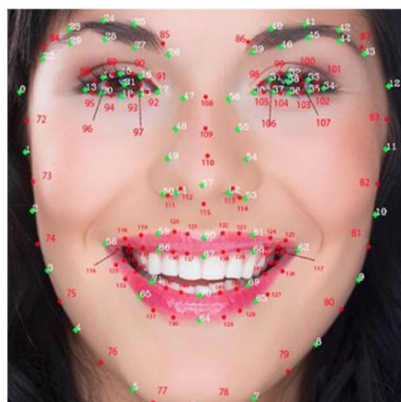
XM2VTS / 300W (68pt)



MUCT (76pt)



ICME (106pt)



Baidu (72/150pt)



Helen (192pt)

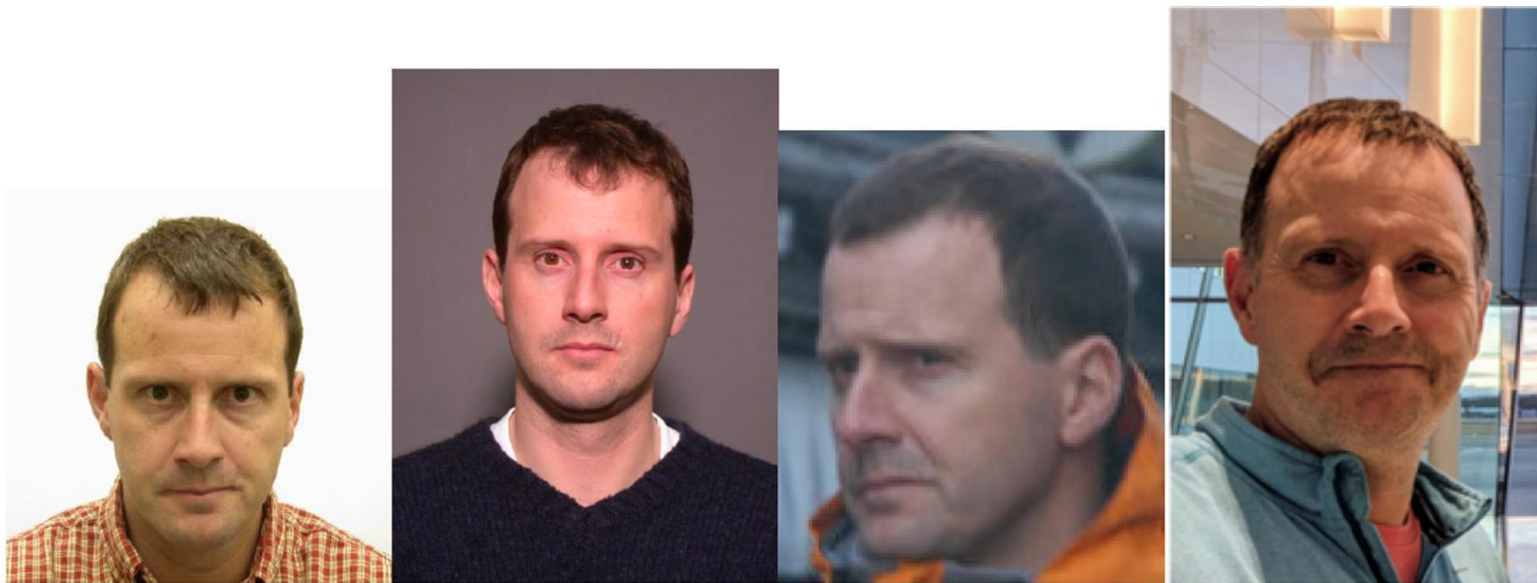
資料來源：<https://omnixri.blogspot.com/2021/02/edge-ai1-edge-ai.html>

# 人臉辨識測試基準

The logo for the National Institute of Standards and Technology (NIST), consisting of the letters "NIST" in a bold, black, sans-serif font.The logo for the Face Recognition Vendor Test (FRVT), featuring the text "FRVT" in large, light gray letters, with "FACE RECOGNITION VENDOR TEST" in smaller, red, serif letters below it. To the right of the text is a wireframe illustration of a human head.

美國國家標準暨技術研究院 (NIST)  
人臉辨識供應商測試  
(Face Recognition Vendor Test, FRVT)

# FRVT測試集影像定義



(a)

(b)

(c)

(d)

(a)簽證照片(VISA) , (b) 嫌疑人照片(Mugshot) ,  
(c) 實境照(Wild) , (d)過境查驗照片(Border),  
(e)兒童照片(Child exploitation)



# FRVT人臉測試項目

**1 : 1**

- 單張對單張辨識

**1 : N**

- 單張於資料集中辨識及檢索

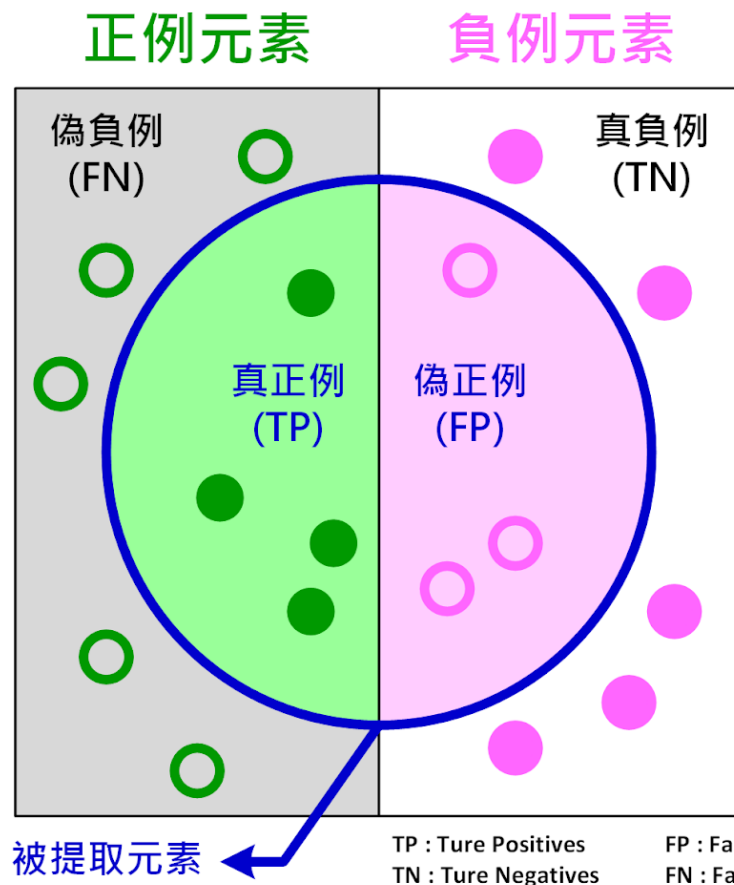
**Morph**

- 影像變形（偽造）

**Quality**

- 質量評估

# 通用評量指標



(真正例 + 真負例) / 總樣本數

正確率  
(Accuracy)



真正例 / 被提取總數

精確率  
(Precision)



真正例 / 正例元素總數

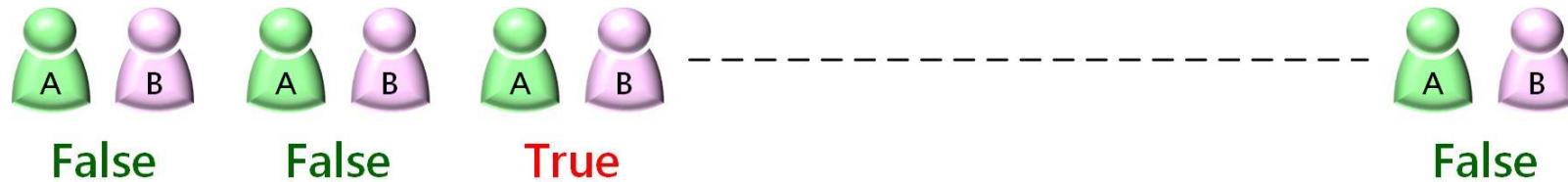
召回率  
(Recall)



$$\frac{1}{F_1} = \frac{1}{P} + \frac{1}{R} \rightarrow F_1 = \frac{2PR}{P + R} = \frac{2TP}{2TP + FP + FN}$$

資料來源：<http://omnixri.blogspot.com/2019/07/aigoai.html>

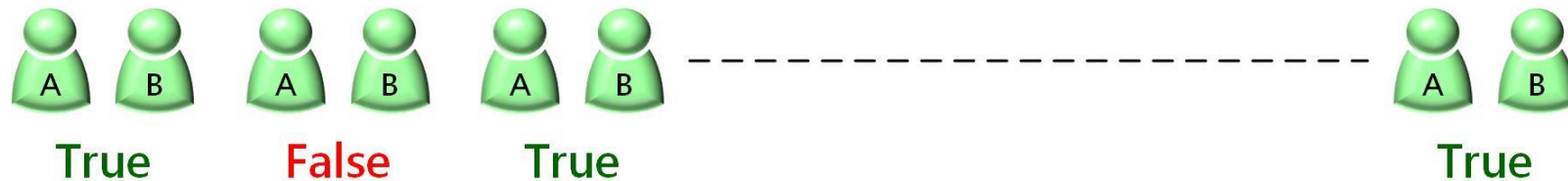
# FRVT評量指標【誤識率、拒識率】



誤識率(FMR)  
False Match Rate

$$= \frac{\text{應判False但判True數量}}{\text{所有應判False數量}}$$

( 不同人當成同一人，  
錯的人當成對的人 )



拒識率(FNMR)  
False Non-Match Rate

$$= \frac{\text{應判True但判False數量}}{\text{所有應判True數量}}$$

( 同一人當成不同人，  
對的人當成錯的人 )

OmniXRI Feb. 2021整理製作

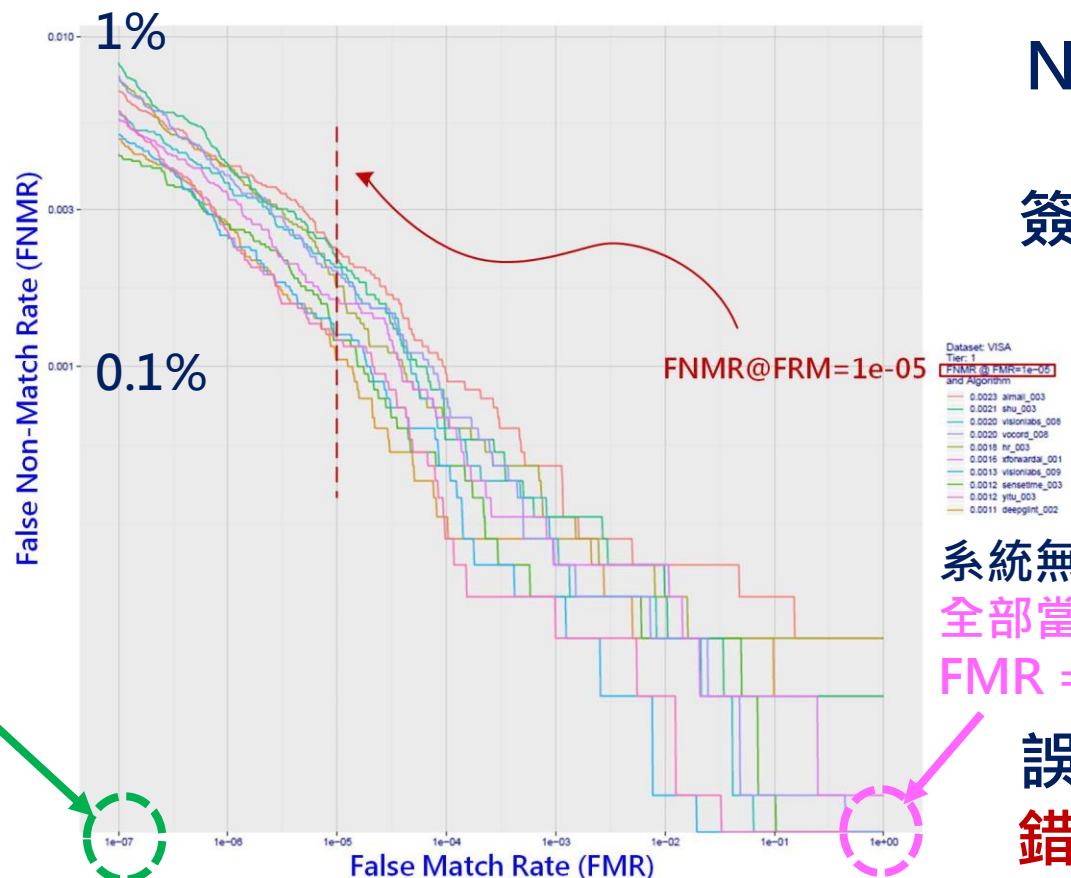
資料來源：<https://omnixri.blogspot.com/2021/02/edge-ai1-edge-ai.html>



# 誤識率與拒識率關係變化

拒識率(FNMR)  
對的被當錯的

超級完美區  
誤識率極低下  
完全沒有認錯  
FMNR = 0.0 &  
FMR = 1e-07



NIST FRVT 1:1  
Report  
簽證照片(VISA)

系統無用區  
全部當成對的  
FMR = 1.0

誤識率(FMR)  
錯的被當對的

Source: NIST FRVT 1 : 1 Latest Report, 2020-10-9

圖片來源 : [https://pages.nist.gov/frvt/reports/11/frvt\\_11\\_report.pdf](https://pages.nist.gov/frvt/reports/11/frvt_11_report.pdf)

# 研華FaceView測試結果

測試設備：研華Ei-A100 (Intel Atom E3950 + Movidius Myriad X VPU MA2485)

測試環境：訊連科技FaceMe + Intel OpenVINO

檢測項目：訪客身份、性別、年齡、表情



以頭像檔案進行人臉辨識結果圖。

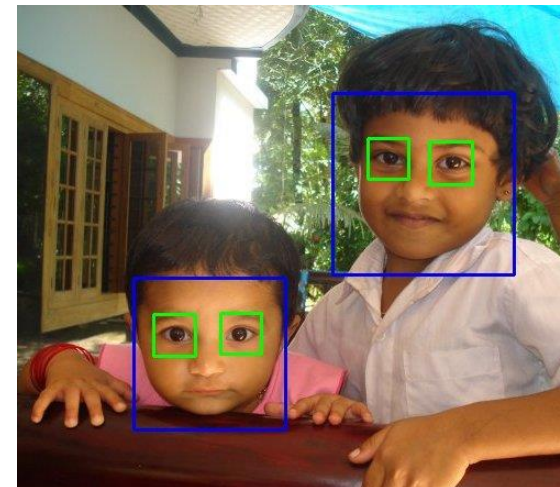
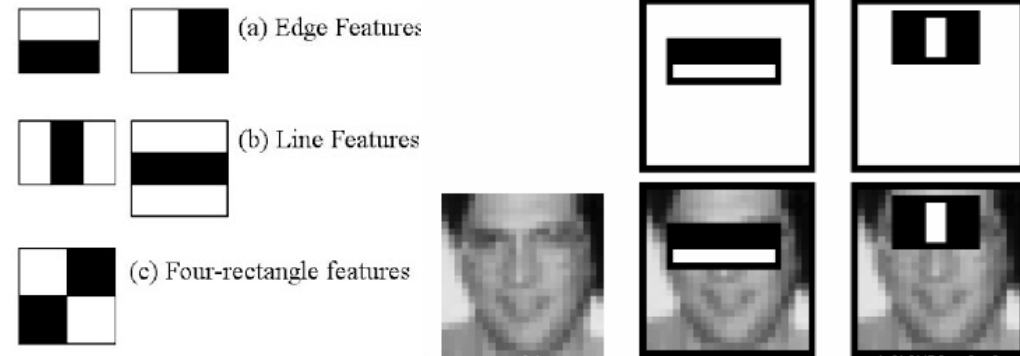


以網路攝影機取得頭像進行人臉辨識結果圖

資料來源：<https://omnixri.blogspot.com/2020/12/ai.html>

# OpenCV 人臉偵測

- 物件偵測模組(Class)
  - cv::CascadeClassifier
- Viola-Jones
- 積分影像(Integral Image)
- Adaboost(Harr-Cascade)
- /data/haarcascades/
  - Frontalface
  - Eye (left / right)
  - Body
  - Smile

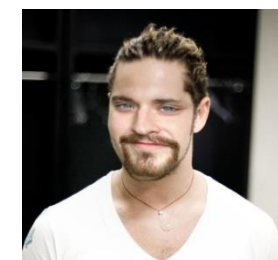
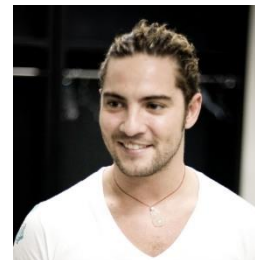
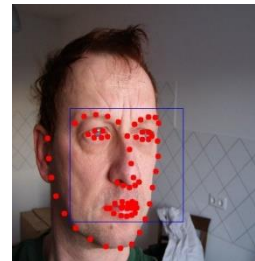
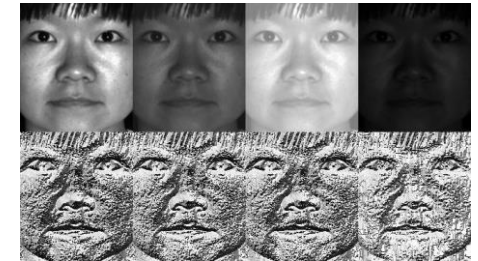
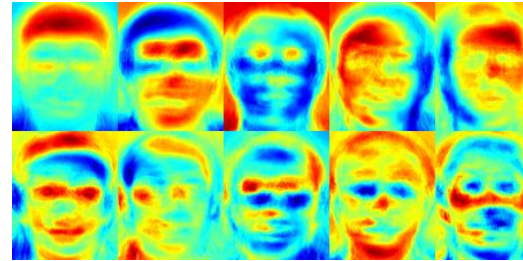


資料來源：[https://docs.opencv.org/4.0.0/db/d28/tutorial\\_cascade\\_classifier.html](https://docs.opencv.org/4.0.0/db/d28/tutorial_cascade_classifier.html)



# OpenCV 人臉辨識

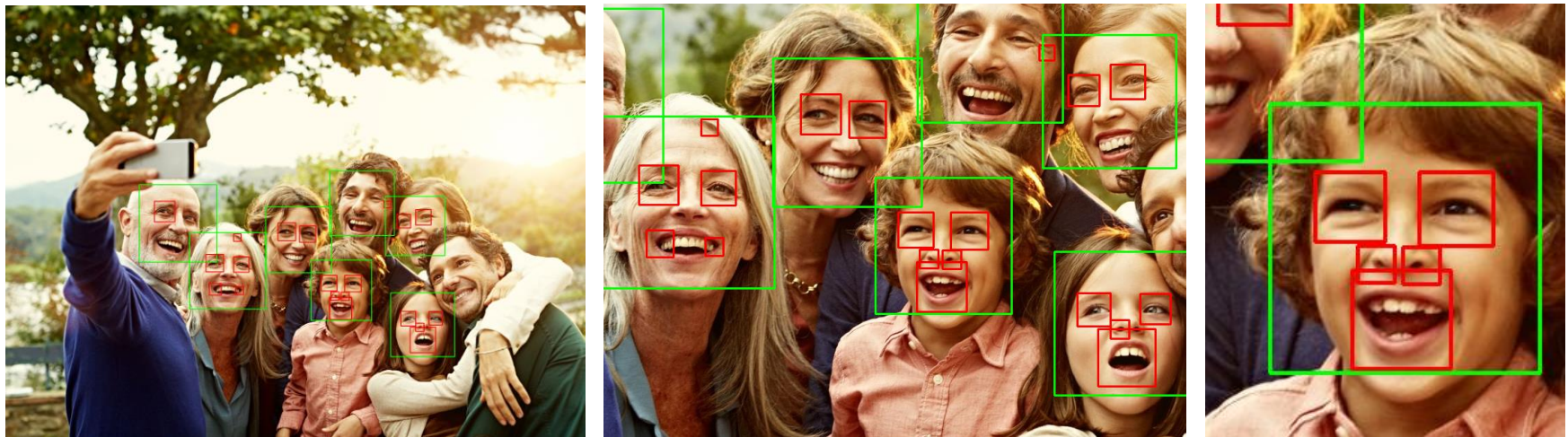
- contrib modules(Class)
  - cv::face
- 目前可用算法
  - Eigenfaces
  - Fisherfaces
  - Local Binary Patterns Histograms
- 參考範例
  - Landmark Detection
  - Swap Face



資料來源：[https://docs.opencv.org/4.0.0/de/d27/tutorial\\_table\\_of\\_content\\_face.html](https://docs.opencv.org/4.0.0/de/d27/tutorial_table_of_content_face.html)

# 範例7-3-1 OpenCV人臉辨識

- 使用Haar聯級法(Cascade)偵測速度極快，但正確率不佳，有很多干擾因素，包括人臉尺寸、歪斜、轉動、光影、部份重疊、複雜背景等。



- 直接以Google Colab開啟範例，可點擊下列連結：

[https://colab.research.google.com/github/OmniXRI/NTUST\\_EdgeAI\\_2022/blob/main/Ch7\\_Implementations/Ch7-3\\_Face\\_Recognition/Ch7-3-1\\_OpenCV\\_Face\\_Detection/OpenCV\\_Haar\\_Face\\_Detection.ipynb](https://colab.research.google.com/github/OmniXRI/NTUST_EdgeAI_2022/blob/main/Ch7_Implementations/Ch7-3_Face_Recognition/Ch7-3-1_OpenCV_Face_Detection/OpenCV_Haar_Face_Detection.ipynb)

# Intel OpenVINO 人臉偵測

## ➤ Pre-Trained Models

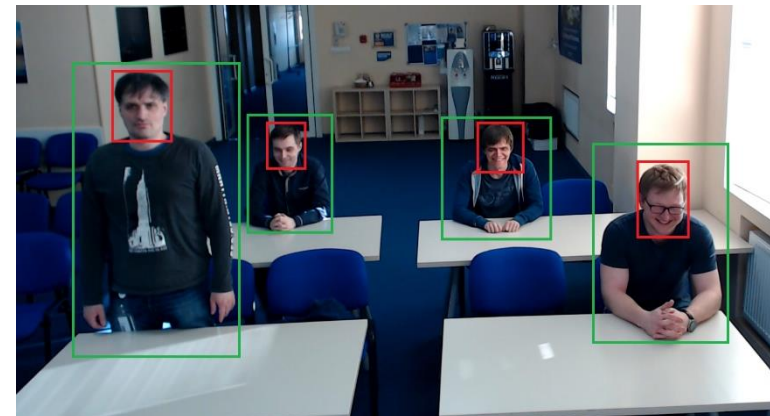
### ➤ Object Detection

- face-detection-adas-xxxx
- face-detection-retail-xxxx
- face-detection-xxxx

## ➤ Open Model Zoo

### ➤ Face Recognition

- FaceNet
- MobileFaceNet
- Face-recognition-rsesnet34-arcface
- SphereFace

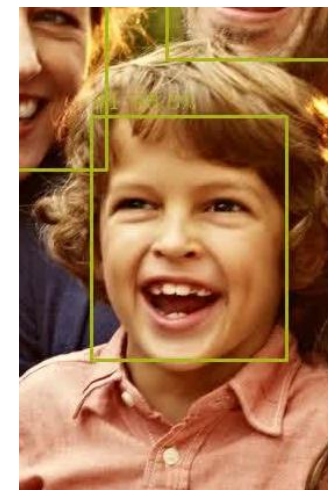


資料來源：[https://docs.openvinotoolkit.org/latest/omz\\_models\\_intel\\_index.html](https://docs.openvinotoolkit.org/latest/omz_models_intel_index.html)



# 範例7-3-2 OpenVINO人臉辨識

- 使用OpenVINO加上人臉偵測預訓練模型及物件偵測範例完成人臉偵測應用，本範例對於各種角度的人臉皆有不錯的偵測能力。



- 直接以Google Colab開啟範例，可點擊下列連結：

[https://colab.research.google.com/github/OmniXRI/NTUST\\_EdgeAI\\_2022/blob/main/Ch7\\_Implementations/Ch7-3\\_Face\\_Recognition/Ch7-3-2\\_OpenVINO\\_Face\\_Detection/Colab\\_OpenVINO\\_Face\\_Detection.ipynb](https://colab.research.google.com/github/OmniXRI/NTUST_EdgeAI_2022/blob/main/Ch7_Implementations/Ch7-3_Face_Recognition/Ch7-3-2_OpenVINO_Face_Detection/Colab_OpenVINO_Face_Detection.ipynb)

# Intel OpenVINO 人臉辨識

## ➤ Pre-Trained Model

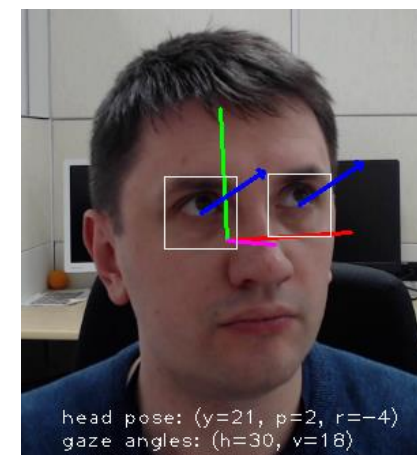
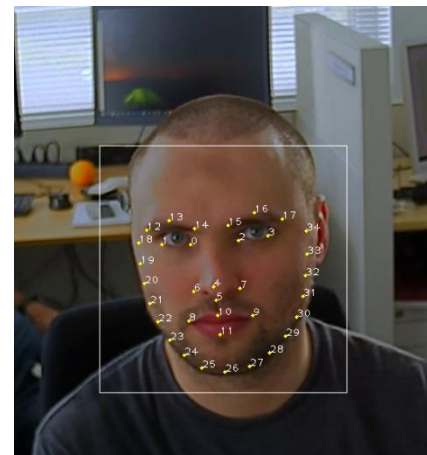
### ➤ Object Recognition

- Age-gender-recognition-retail-xxxx
- Head-pose-estimation-adas-xxxx
- Emotions-recognition-retail-xxxx
- Landmarks-regression-reteail-xxxx
- Facial-landmarks-35-adas-xxxx
- Gaze-estimation-adas-xxxx

年齡、性別、身份、頭部姿態、  
特徵點、表情、注視點等應用。



Female,18.97,Happiness,



資料來源：[https://docs.openvinotoolkit.org/latest/omz\\_models\\_intel\\_index.html](https://docs.openvinotoolkit.org/latest/omz_models_intel_index.html)

# OpenVINO ADAS人臉辨識展示

An ADAS Demo in 10 Minutes | OpenVINO™ toolkit | Ep. 60 | Intel Software



駕駛面

gaze-estimation-adas-0002  
face-detection-adas-0001  
head-pose-estimation-adas-0001  
facial-landmarks-35-adas-0002

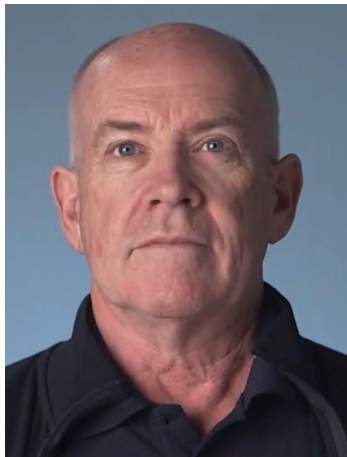
街道面

instance-segmentation-security-0050

<https://youtu.be/LtspLbUogZI>

# 範例7-3-3 OpenVINO身份辨識

- 使用OpenVINO加上人臉偵測、人臉特徵點及身份辨識預訓練模型完成身份辨識應用。



人臉資料庫



測試靜態影像 / 動態影片



測試結果

- 直接以Google Colab開啟範例，可點擊下列連結：

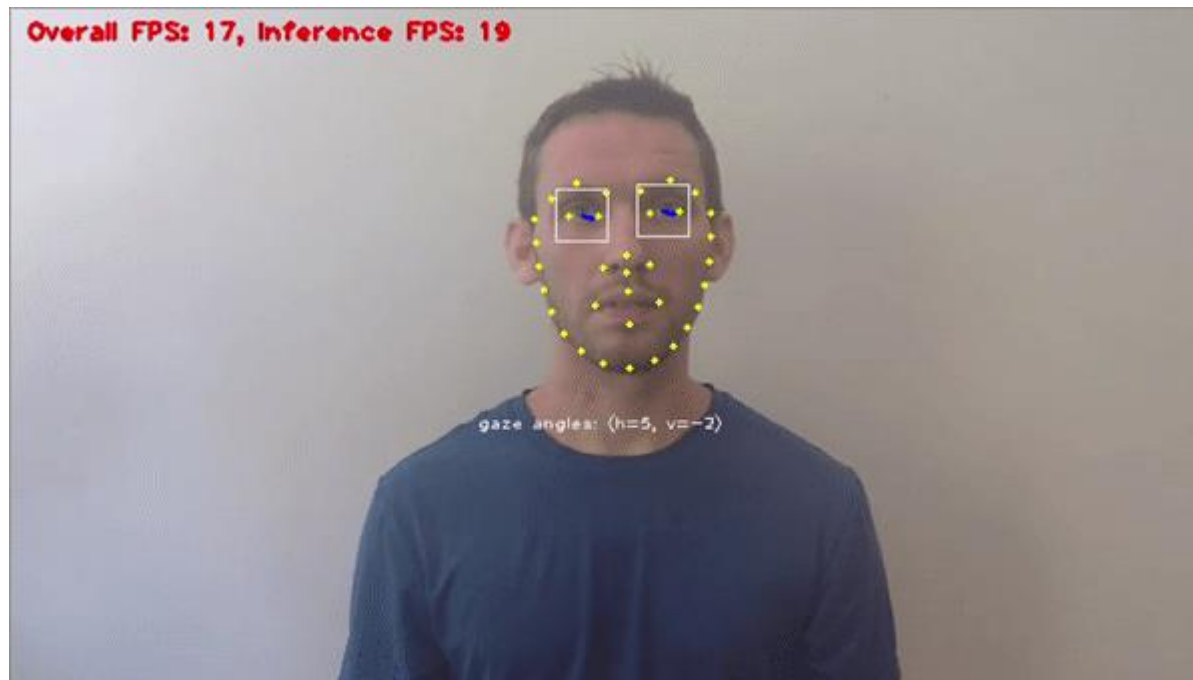
[https://colab.research.google.com/github/OmniXRI/NTUST\\_EdgeAI\\_2022/blob/main/Ch7\\_Implementations/Ch7-3\\_Face\\_Recognition/Ch7-3-3\\_OpenVINO\\_Face\\_Identification/Colab\\_OpenVINO\\_Face\\_Identification.ipynb](https://colab.research.google.com/github/OmniXRI/NTUST_EdgeAI_2022/blob/main/Ch7_Implementations/Ch7-3_Face_Recognition/Ch7-3-3_OpenVINO_Face_Identification/Colab_OpenVINO_Face_Identification.ipynb)



# 範例7-3-4 OpenVINO注視點偵測

- 只有支援C++，可偵測人臉特徵點(Lankmark)及眼睛注視點(Gaze)。

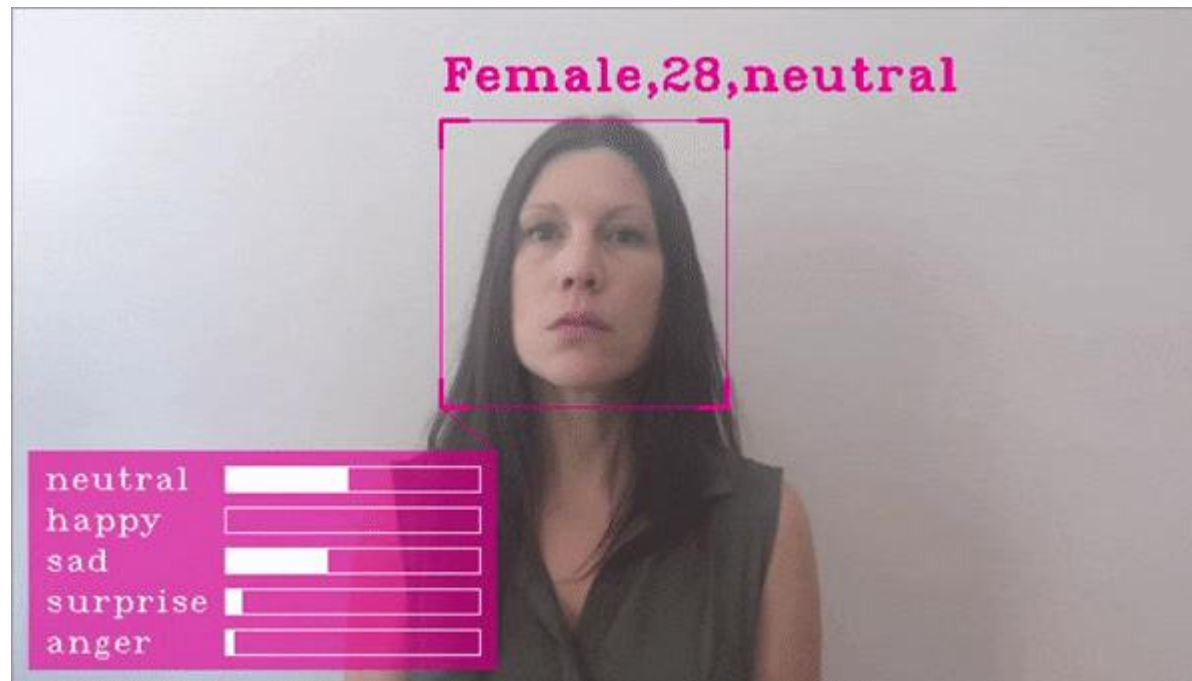
[https://docs.openvino.ai/2021.4/omz\\_demos\\_gaze\\_estimation\\_demo\\_cpp\\_gapi.html](https://docs.openvino.ai/2021.4/omz_demos_gaze_estimation_demo_cpp_gapi.html)



# 範例7-3-5 OpenVINO表情偵測

- 只有支援C++，可偵測人臉性別、年齡、表情（含程度）。

[https://docs.openvino.ai/2021.4/omz\\_demos\\_interactive\\_face\\_detection\\_demo\\_cpp.html](https://docs.openvino.ai/2021.4/omz_demos_interactive_face_detection_demo_cpp.html)



# 參考文獻

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