1. Face Recognition

주제	
0. Introduction	강의 커리큘럼 소개
1. Face Recognition	1-1. Face Recognition 이론 소개
	1-2. Face Detection - 대표 모델 및 코드 소개
	1-3. [실습1] Dlib 및 Retina Face 코드 구현
	1-4. Face Alignment - 대표 모델 및 코드 소개
	1-5. [실습2] 황금비율 계산
	1-6. Face Recognition - 대표 모델 및 코드 소개
	1-7. [실습3] 그룹 가수 사진에서 각각 멤버 인식하기
2. Object Detection	2-1. Object Detection 이론 소개
	2-2. 대표 모델 – Yolov8 소개
	2-3. [실습1] 마스크 착용 유무 프로젝트
	2-4. [실습2] Tensor-RT 기반의 Yolov8, 표지판 신호등 검출
	2-5. 대표 모델 - Complex-Yolov4
	2-6. [실습3] Lidar Data 기반의 차량 Detection

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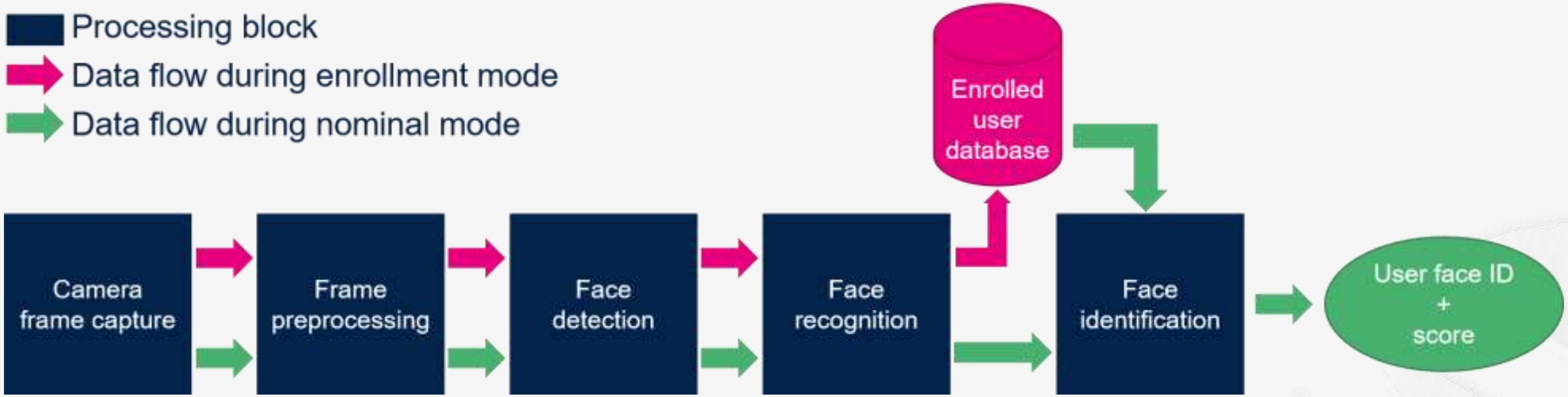
Face Recognition

Face Recognition

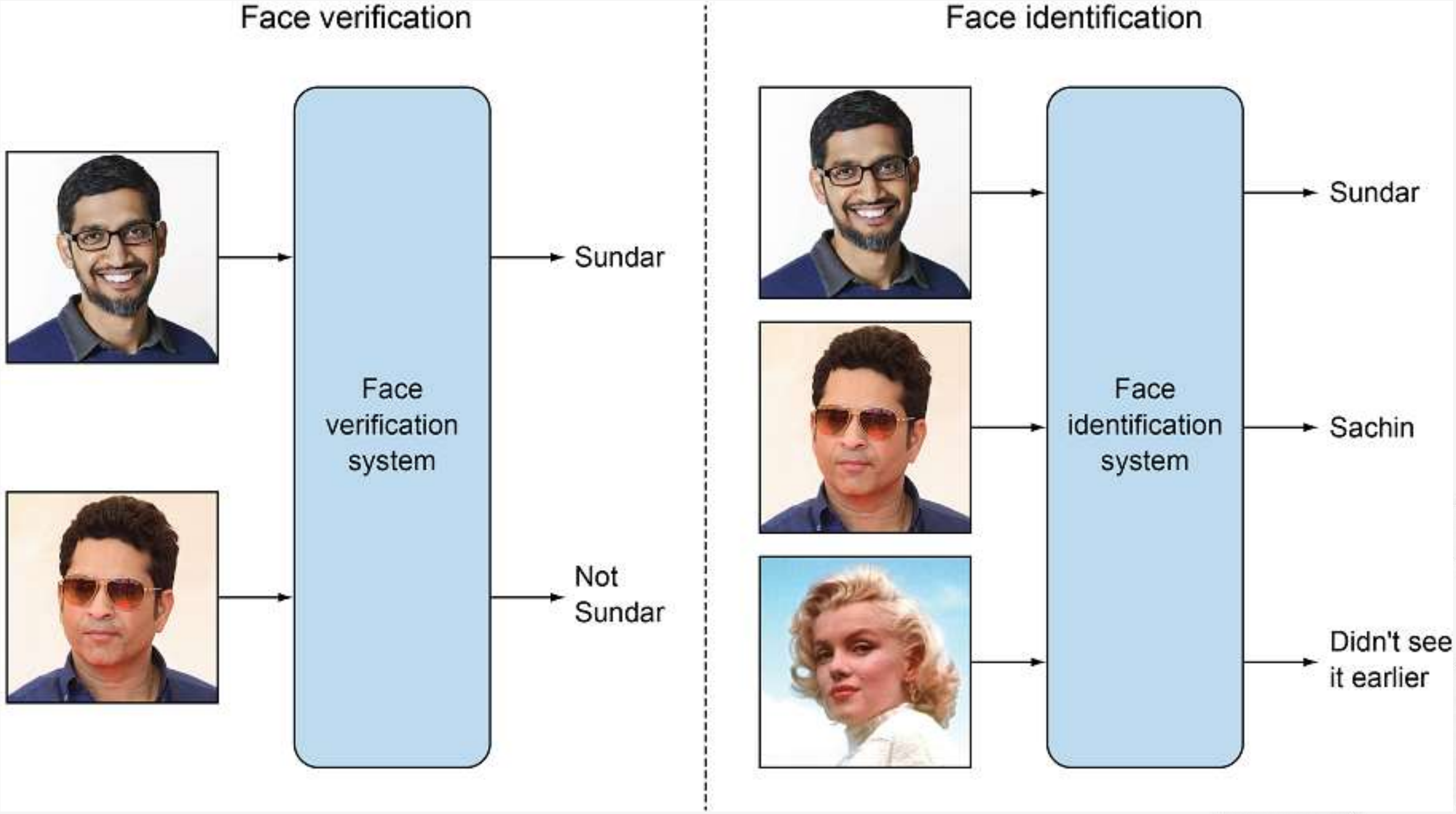
얼굴을 포함하는 입력 정지 영상 또는 비디오에 대해 얼굴 영역의 자동적인 검출 및 분석을 통해 해당 얼굴이 어떤 인물인지 판별해 내는 기술

- 얼굴 검증 (Face Verification)
- 얼굴 식별 (Face Identification)



References
https://wiki.st.com/stm32mpu/wiki/TFLite_Cpp_face_recognition
https://wikidocs.net/151311

얼굴 검증 (Face Verification) vs 얼굴 식별 (Face Identification)



References
http://lacienciadelcafe.com.ar/kids-jbl-headphones/parka-arm%C3%A9e-de-l//iproov-on-twitter-what-s-the-difference-between-face-pp-24027720

Face Recognition의 활용

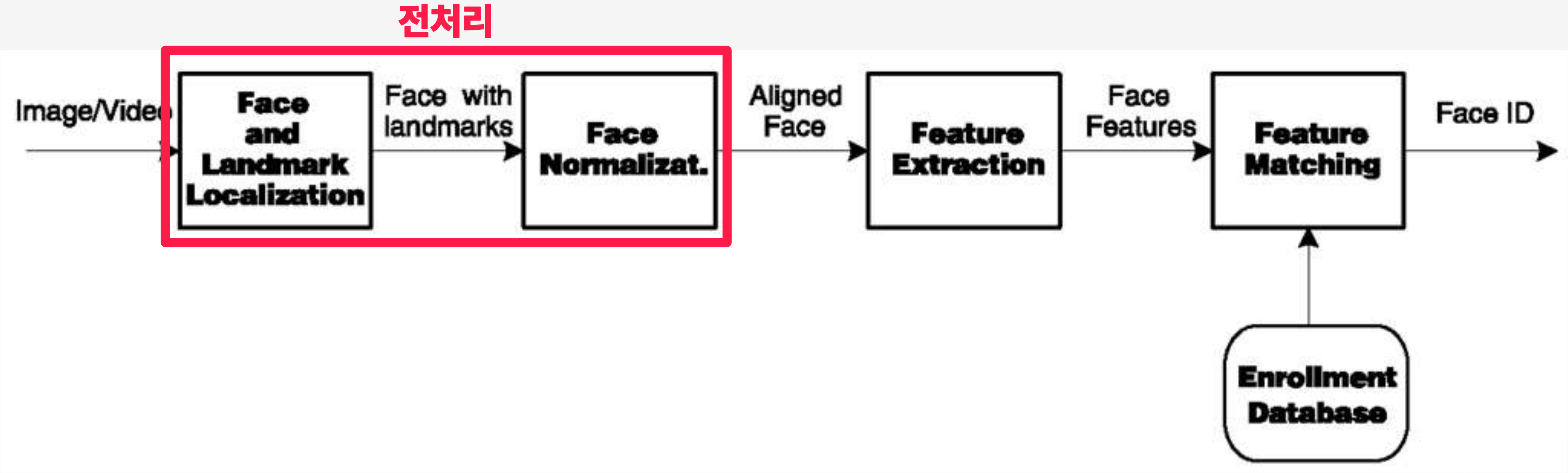
Application of Face Recognition

12:07
Cancel
How to Set Up Face ID
First, position your face in the camera frame. Then move your head in a circle to show all the angles of your face.
Get Started

References
(Left) https://www.iphonetricks.org/2-tricks-to-make-face-id-unlock-the-iphone-x-even-faster/
(Middle) https://news.nate.com/view/20230728n23619
(Right) http://www.monews.co.kr/news/articleView.html?idxno=209395

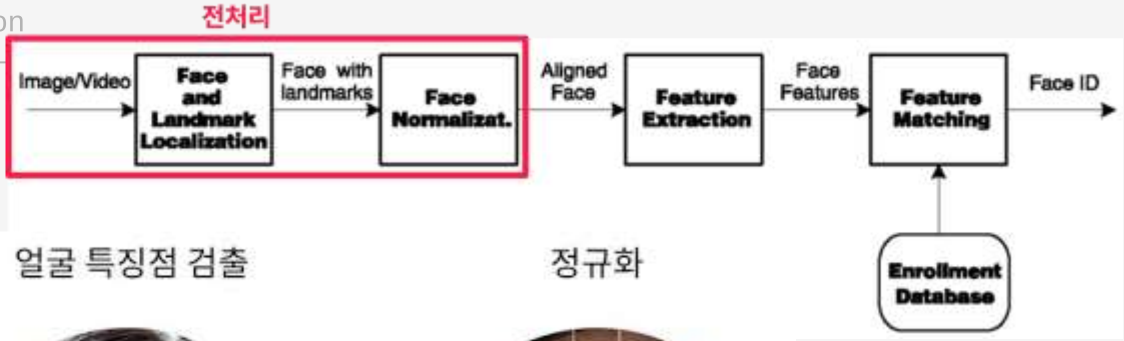
Face Recognition Diagram

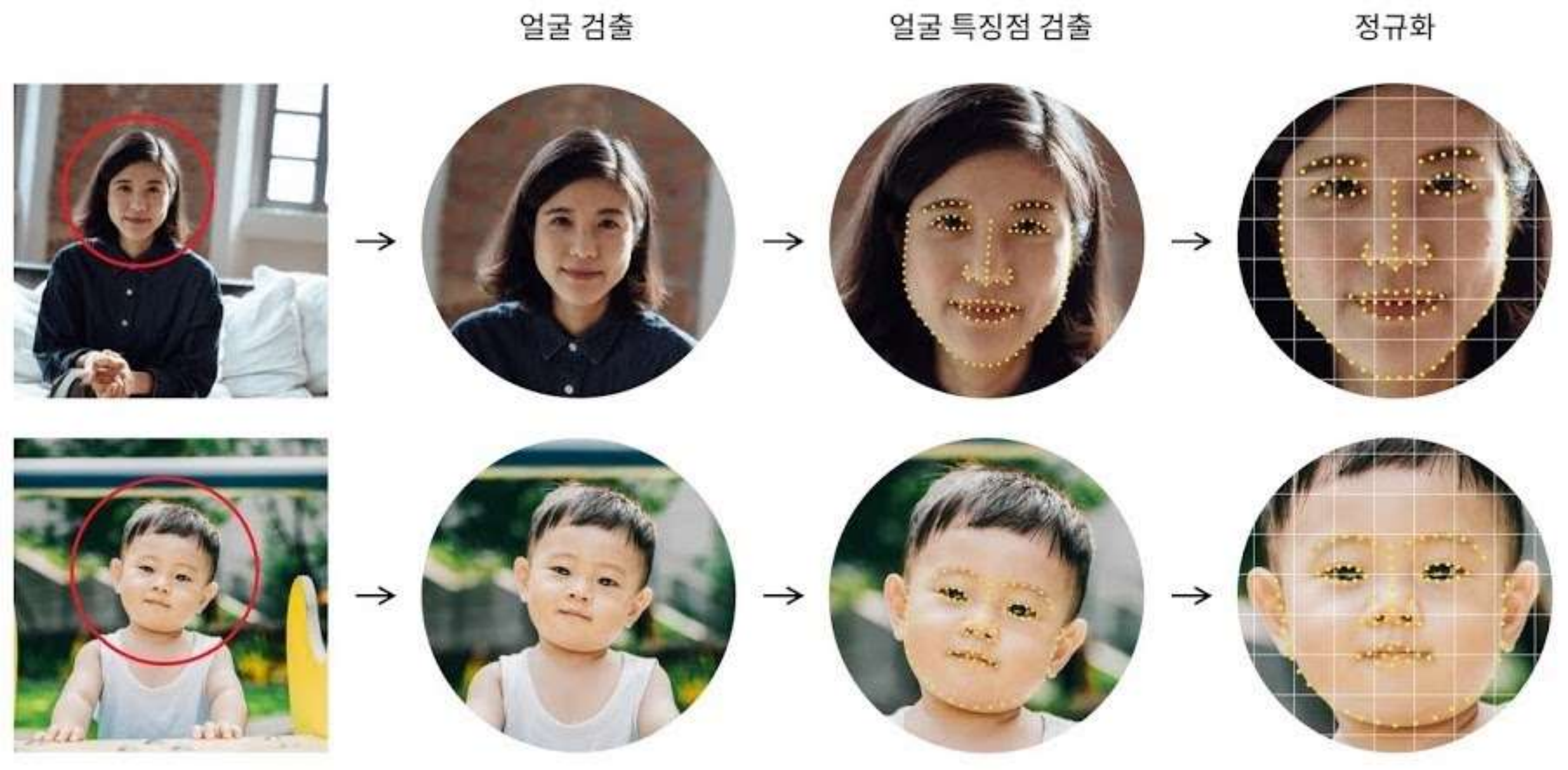
Face Recognition Diagram



References
http://what-when-how.com/face-recognition/introduction-to-face-recognition-part-1/

Face Recognition Diagram



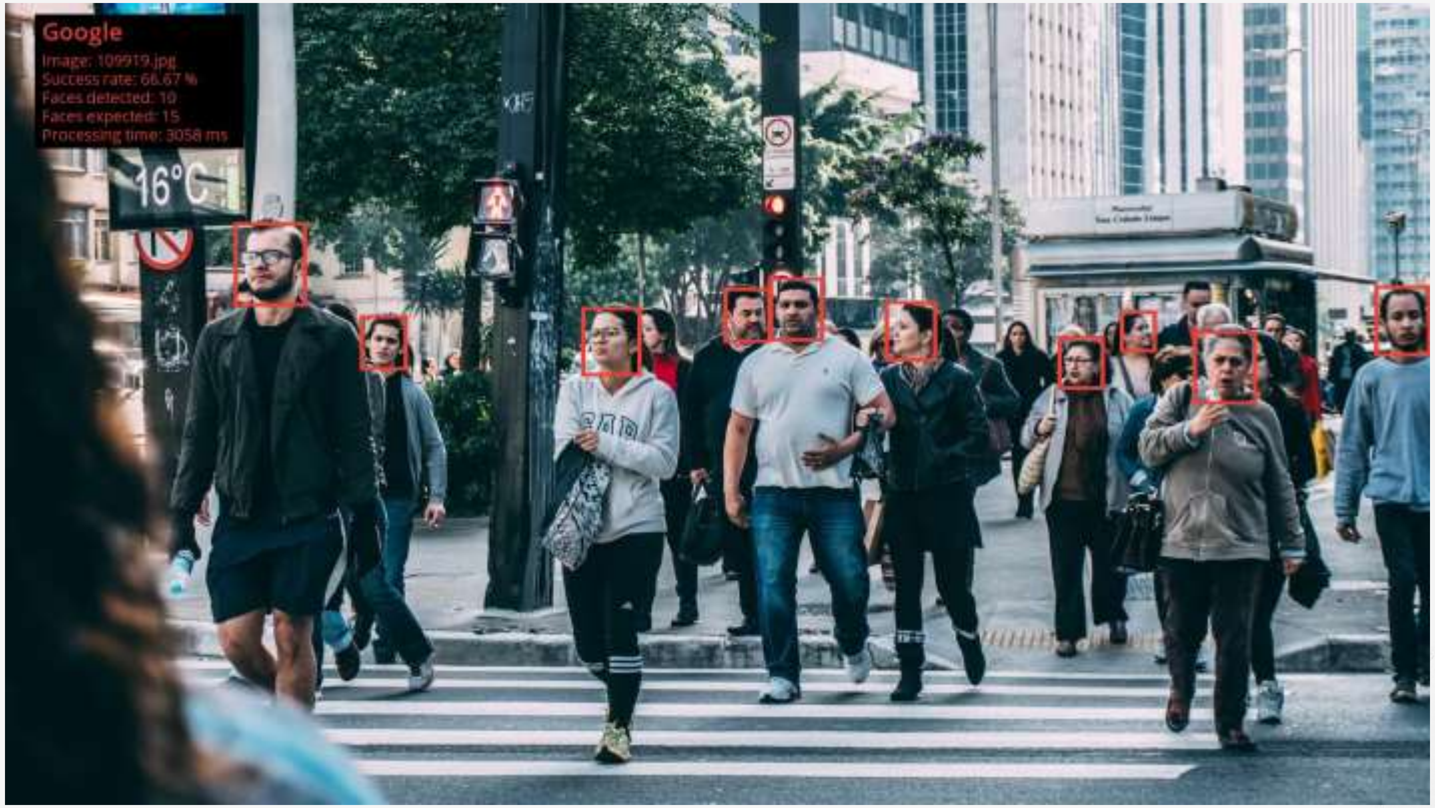


References
https://tech.kakaoenterprise.com/63

Face Detection

Face Detection

The most basic task on Face Recognition is of course, “Face Detecting”. Before anything, you must “capture” a face in order to recognize it, when compared with a new face captured on future.



References
https://www.liip.ch/en/blog/face-detection-an-overview-and-comparison-of-different-solutions-part1

Face Detection

The most basic task on Face Recognition is of course, “Face Detecting”. Before anything, you must “capture” a face in order to recognize it, when compared with a new face captured on future.

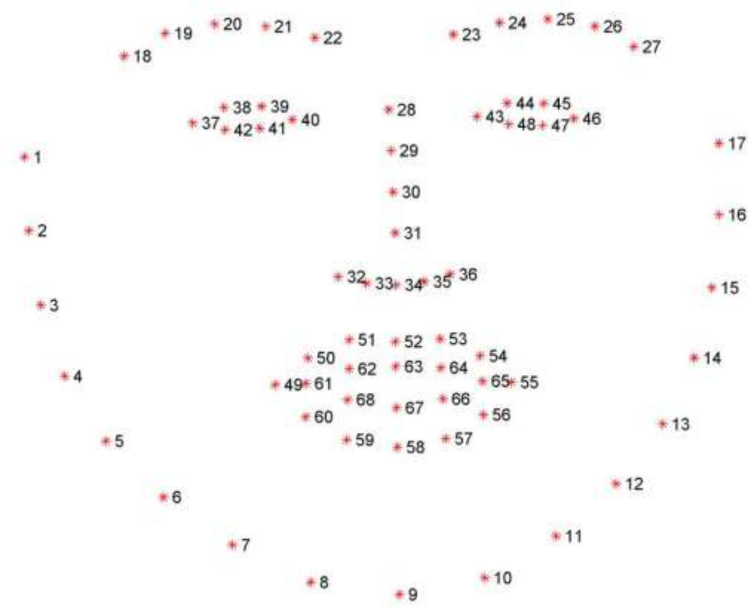
References
https://search.pstatic.net/common/?src=http%3A%2F%2Fimgnews.naver.net%2Fimage%2F5526%2F2021%2F03%2F17%2F0000277472_001_20210611182813796.jpg&type=sc960_832

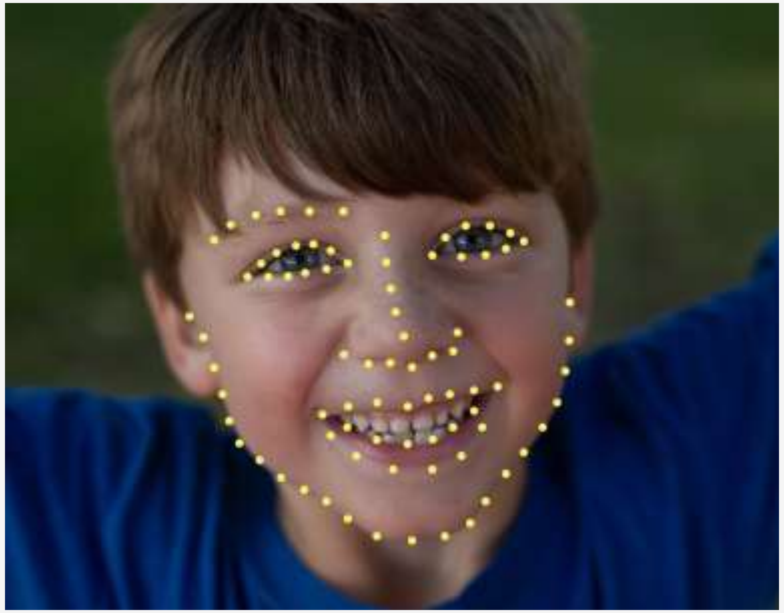
Face Landmark Detection

Face Landmark Detection

Detecting and localizing specific points or landmarks on a face, such as the eyes, nose, mouth, and chin.

사람의 상태를 파악할 수 있음 (표정, 고개의 기울어짐 등)





References
(Left) https://prlabhotelshoe.tistory.com/4
(Middle) https://www.plugger.ai/blog/the-top-7-use-cases-for-facial-landmark-detection
(Right) http://blog.dlib.net/2018/01/correctly-mirroring-datasets.html
https://paperswithcode.com/task/facial-landmark-detection

Face Landmark Detection

Detecting and localizing specific points or landmarks on a face, such as the eyes, nose, mouth, and chin.

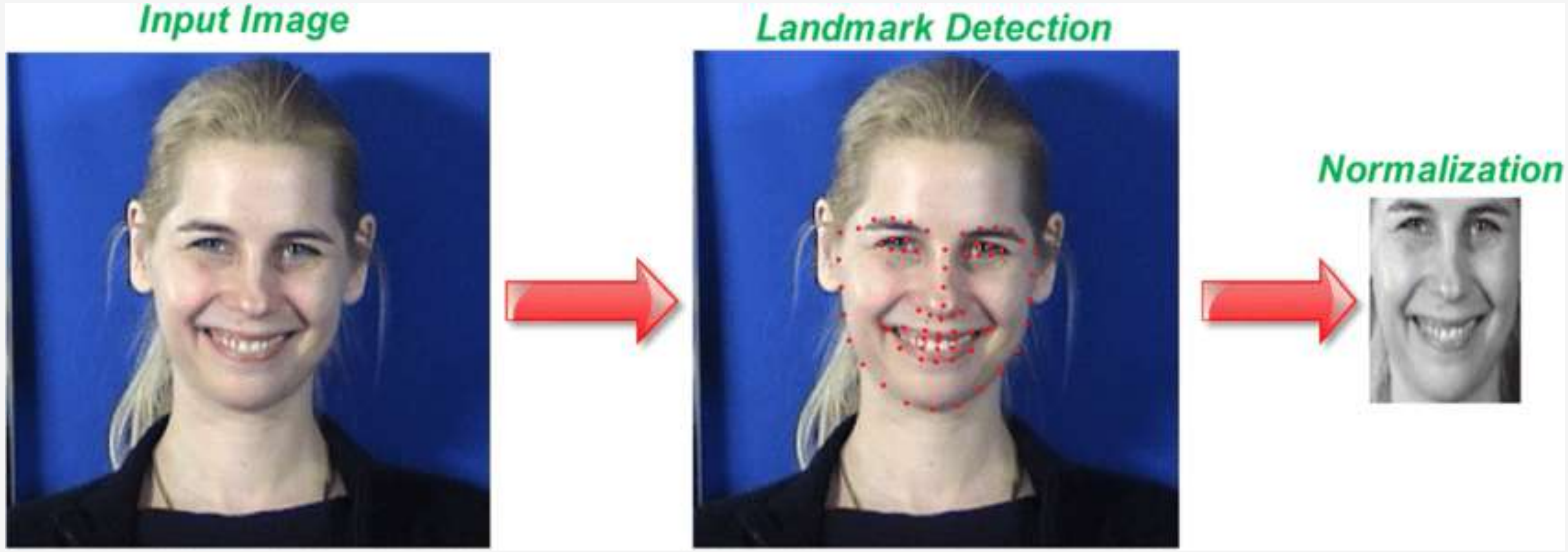
SNOW

References
(Left) https://www.openads.co.kr/content/contentDetail?contsId=6879
(Right, Top) https://www.hankyung.com/article/201911275620Y
(Right, Bottom) Startupbeat
https://paperswithcode.com/task/facial-landmark-detection

Face Normalization

Face Normalization

검출된 얼굴 영역을 동일한 크기와 형태로 만드는 과정



References
https://www.researchgate.net/figure/Face-localization-and-normalization_fig4_333700124

Embedding

Embedding

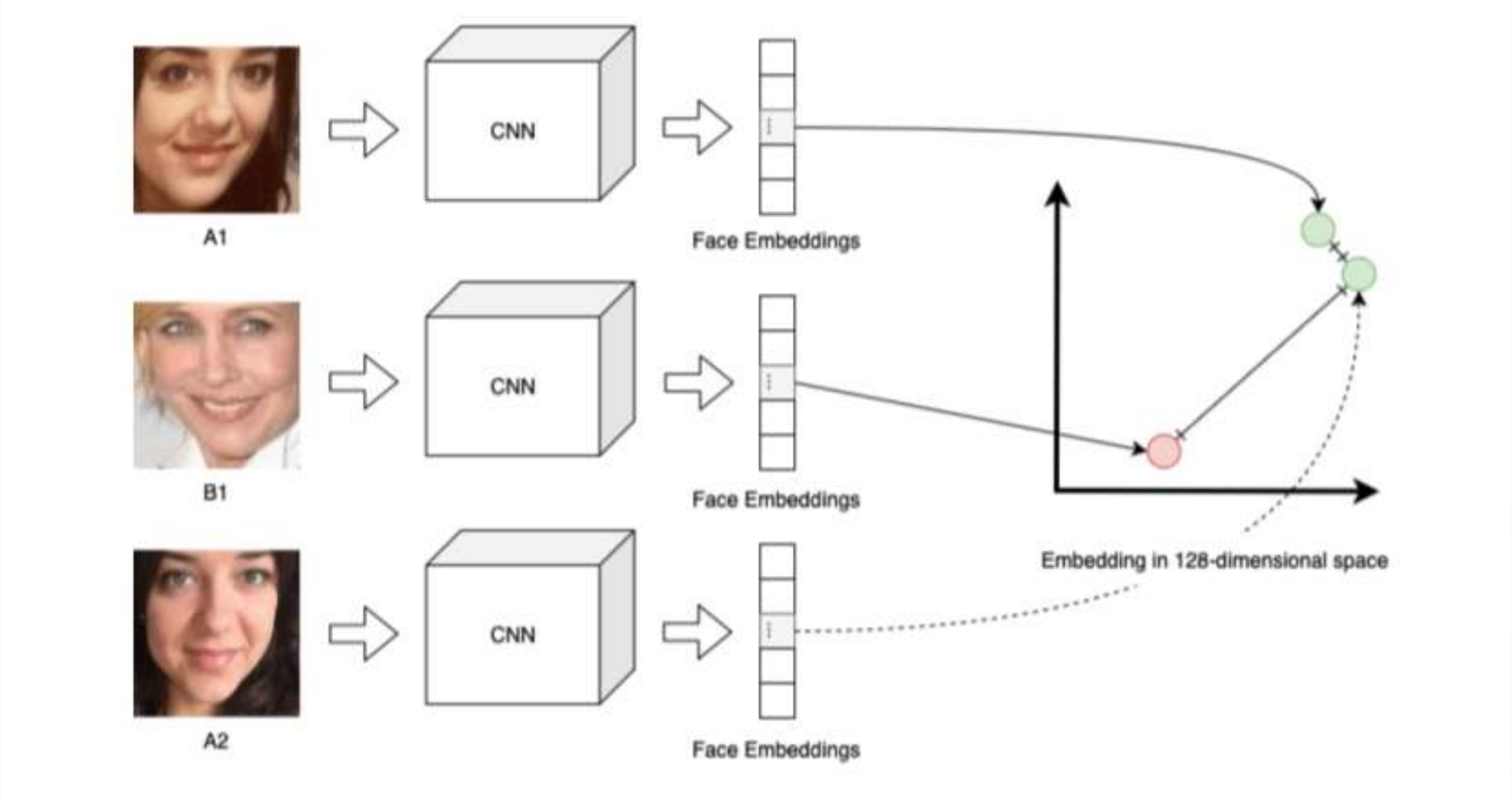
컴퓨터가 처리할 수 있도록 정보를 벡터로 변환하는 것

고차원의 정보를 필요한 정보를 보존하면서 저차원으로 변환하여 벡터로 표현하는 것

$$\overbrace{[0.87,\ -\ 0.03,\ 0.121,\ 0.365,\ \ldots\ ,\ 0.007,\ -0.217]}^{\text{N차원}}$$

References
서경경제스타DB

Feature Extraction



References
https://www.analyticsvidhya.com/blog/2022/04/face-recognition-system-using-python/#h-understand-the-working-of-face-recognition

Face Recognition 모델

Face Recognition

Fig. 1

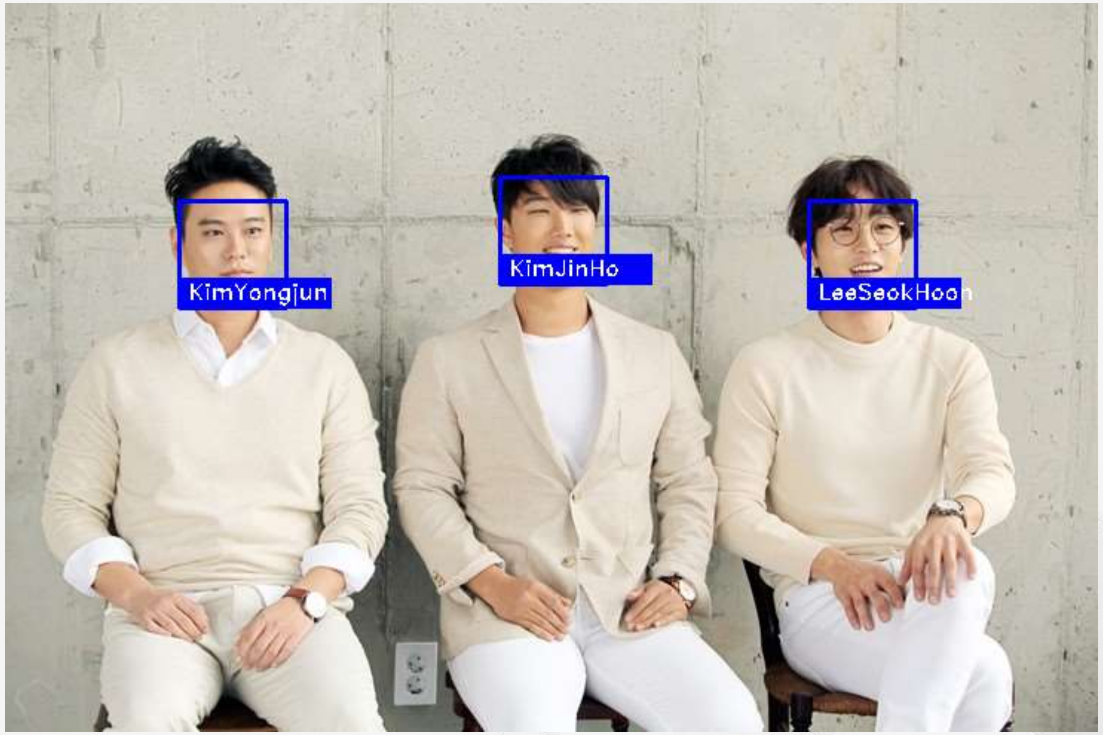
Fig. 2

Fig. 3

Fig. 4

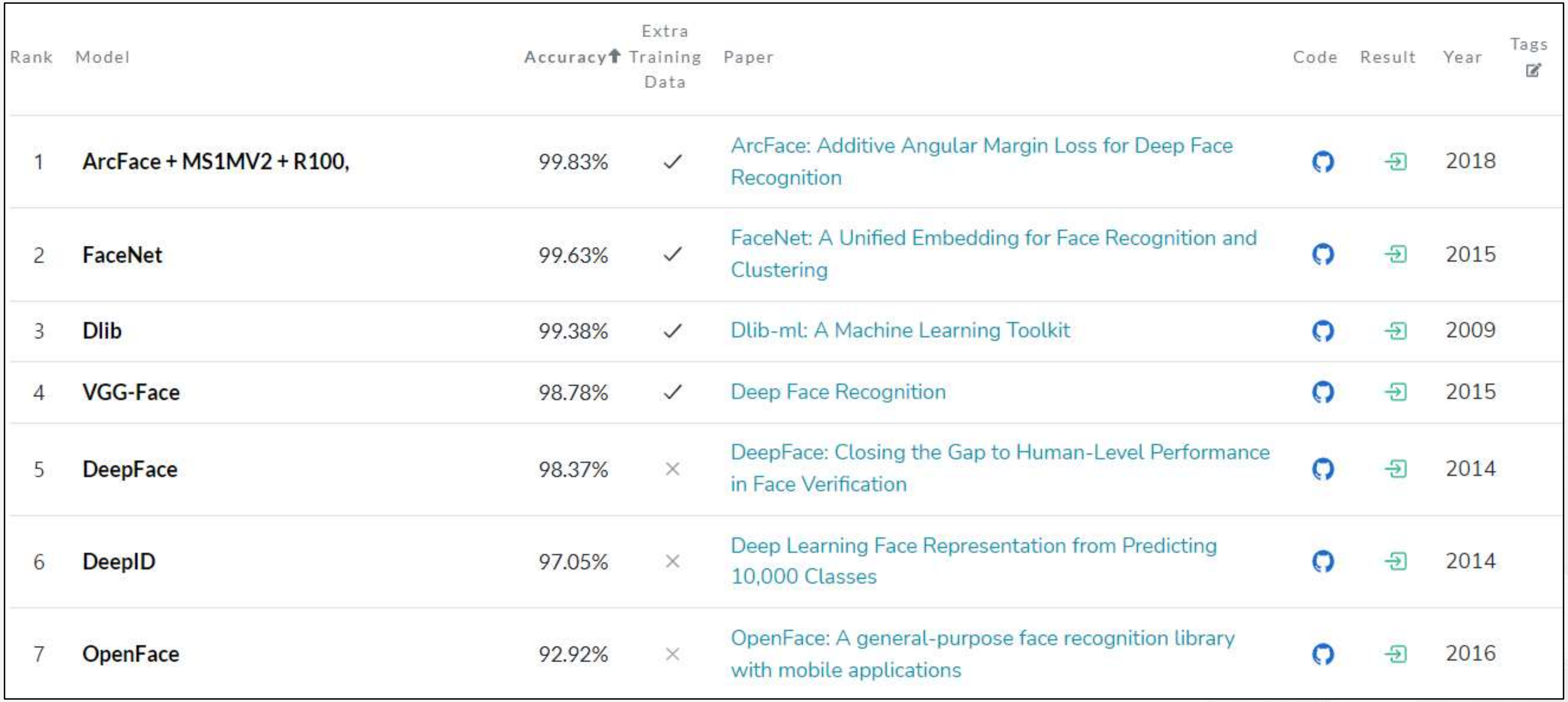
Fig. 5

인물 Database



References
(Fig. 1) 서경스타DB
(Fig. 2) YG엔터테인먼트
(Fig. 3) 김용준인스타그램캡처
(Fig. 4) 멜론프로필
(Fig. 5) https://m.sports.khan.co.kr/view.html?art_id=202207291714003&sec_id=540101

Face Recognition Model



Rank	Model	Accuracy ↑	Extra Training Data	Paper	Code	Result	Year	Tags ✎
1	ArcFace + MS1MV2 + R100,	99.83%	✓	ArcFace: Additive Angular Margin Loss for Deep Face Recognition	●	⇥	2018	
2	FaceNet	99.63%	✓	FaceNet: A Unified Embedding for Face Recognition and Clustering	●	⇥	2015	
3	Dlib	99.38%	✓	Dlib-ml: A Machine Learning Toolkit	●	⇥	2009	
4	VGG-Face	98.78%	✓	Deep Face Recognition	●	⇥	2015	
5	DeepFace	98.37%	×	DeepFace: Closing the Gap to Human-Level Performance in Face Verification	●	⇥	2014	
6	DeepID	97.05%	×	Deep Learning Face Representation from Predicting 10,000 Classes	●	⇥	2014	
7	OpenFace	92.92%	×	OpenFace: A general-purpose face recognition library with mobile applications	●	⇥	2016	

References
https://paperswithcode.com/sota/face-verification-on-labeled-faces-in-the

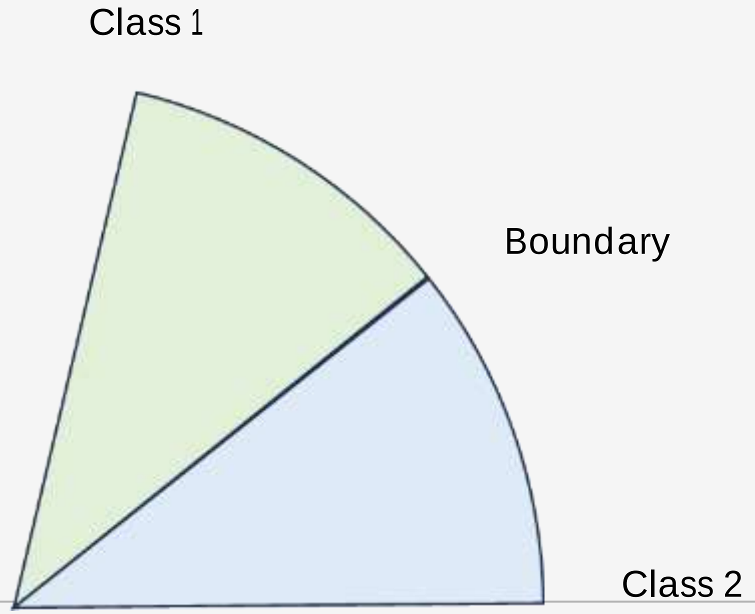
Loss Function

Softmax

Cross Entropy를 이용하여 Softmax 출력값과 정답 사이의 오차를 계산

대표적인 모델

- AlexNet
- ResNet
- DeepFace
- DeepID

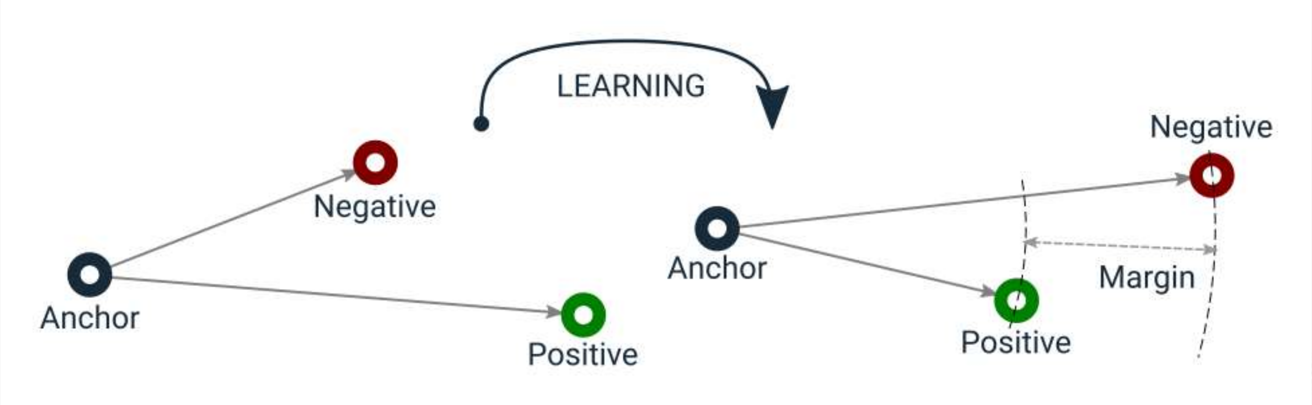


거리기반

특징 벡터 간의 거리를 활용하여, 동일한 클래스의 특징 벡터는 가깝게 동일하지 않은 클래스의 특징은 멀게 학습

대표적인 Loss Function

- Contrastive Loss Function
- Triplet Loss Function



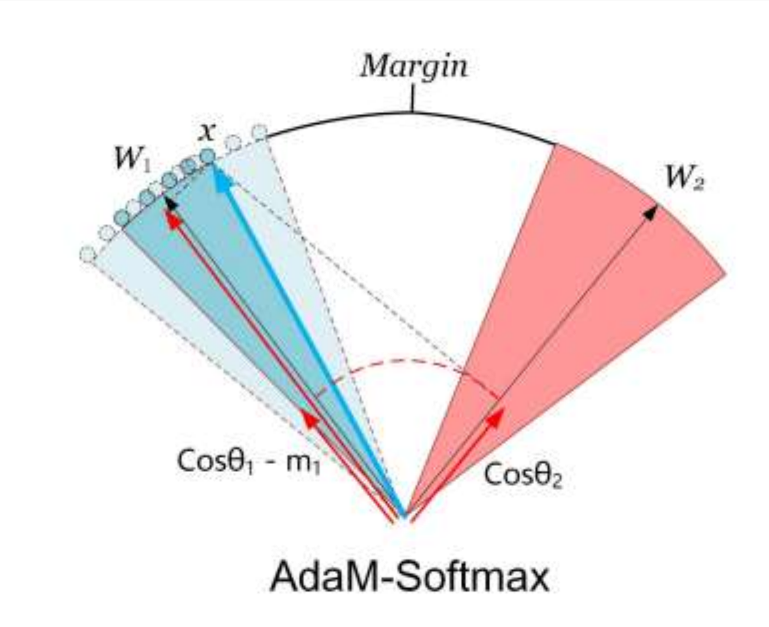
References
https://tech.kakaoenterprise.com/63

Angular margin

소프트맥스 기반의 손실함수에 Angular Margin을 적용

대표적인 손실함수

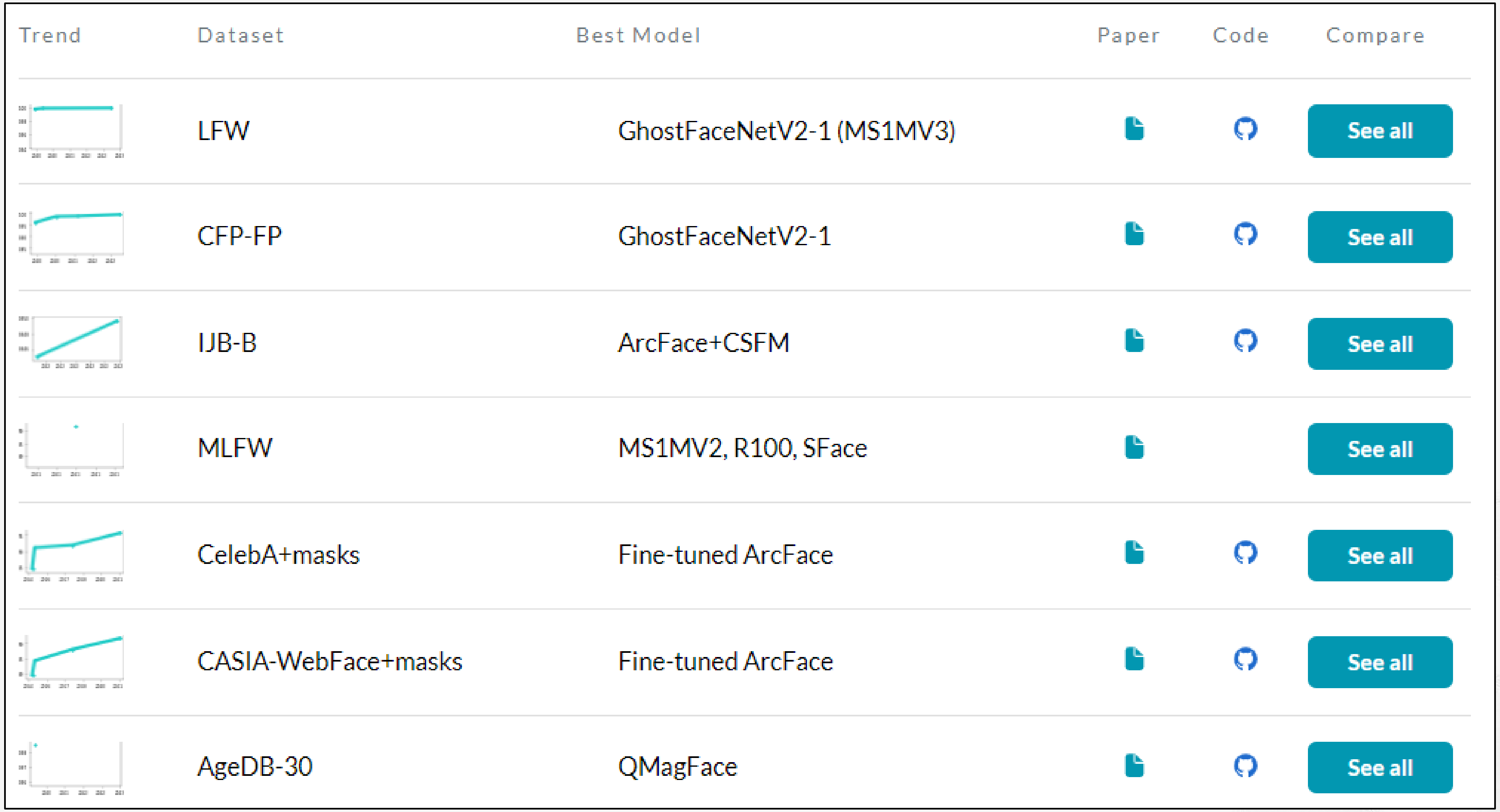
- CosFace
- ArcFace
- SphereFace



References
https://openaccess.thecvf.com/content_CVPR_2019/papers/Liu_AdaptiveFace_Adaptive_Margin_and_Sampling_for_Face_Recognition_CVPR_2019_paper.pdf

Face Recognition Dataset

Face Recognition Dataset



Trend	Dataset	Best Model	Paper	Code	Compare
	LFW	GhostFaceNetV2-1 (MS1MV3)	📄	●	See all
	CFP-FP	GhostFaceNetV2-1	📄	●	See all
	IJB-B	ArcFace+CSFM	📄	●	See all
	MLFW	MS1MV2, R100, SFace	📄		See all
	CelebA+masks	Fine-tuned ArcFace	📄	●	See all
	CASIA-WebFace+masks	Fine-tuned ArcFace	📄	●	See all
	AgeDB-30	QMagFace	📄	●	See all

References
https://paperswithcode.com/task/face-recognition

Dlib

Dlib

Dlib is a modern C++ toolkit containing machine learning algorithms and tools for creating complex software in C++ to solve real world problems.

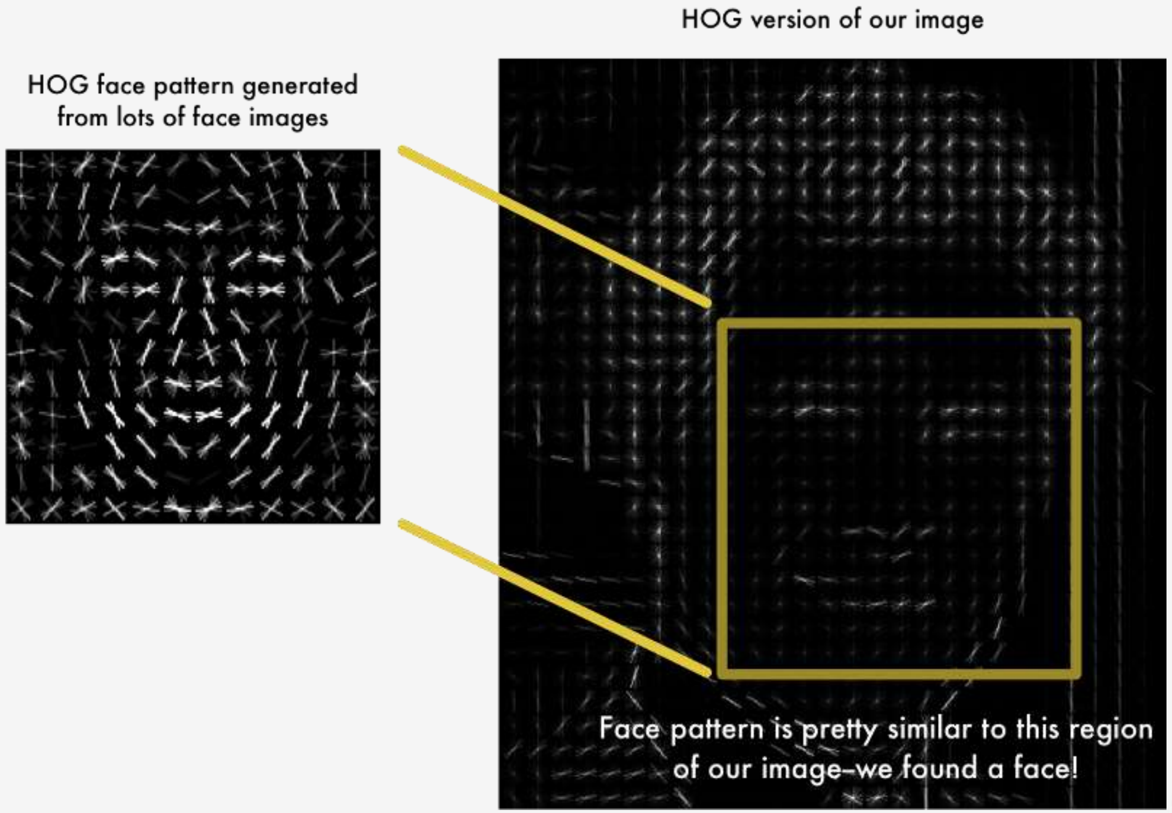
공식 사이트 : http://dlib.net/

공식 Github : https://github.com/davisking/dlib

References
http://blog.dlib.net/

Dlib Face Detector

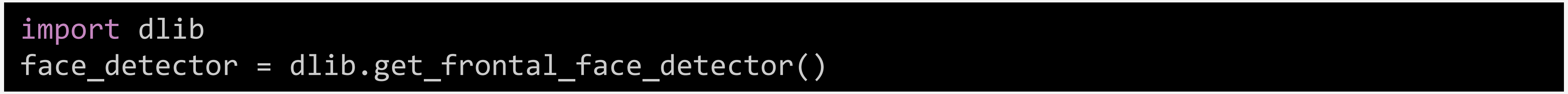
HOG (Histogram of Oriented Gradients) feature를 이용하여 SVM (Support Vector Machine)의 Sliding Window로 검출


HOG version of our image
HOG face pattern generated from lots of face images
Face pattern is pretty similar to this region of our image–we found a face!

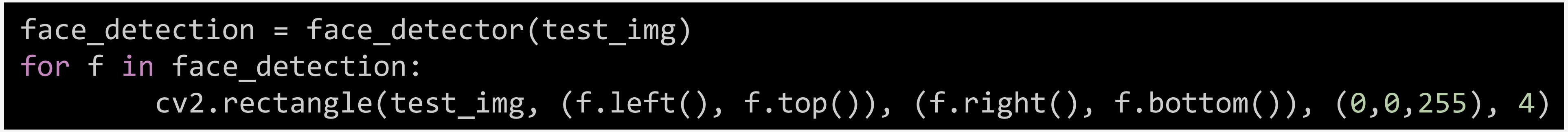
References
https://medium.com/@jongdae.lim/%EA%B8%B0%EA%B3%84-%ED%95%99%EC%8A%B5-machine-learning-%EC%9D%80-%EC%A6%90%EA%B2%81%EB%8B%A4-part-4-63ed781eee3c

Dlib Face Detector

HOG (Histogram of Oriented Gradients) feature를 이용하여 SVM (Support Vector Machine)의 Sliding Window로 검출



```
import dlib
face_detector = dlib.get_frontal_face_detector()
```

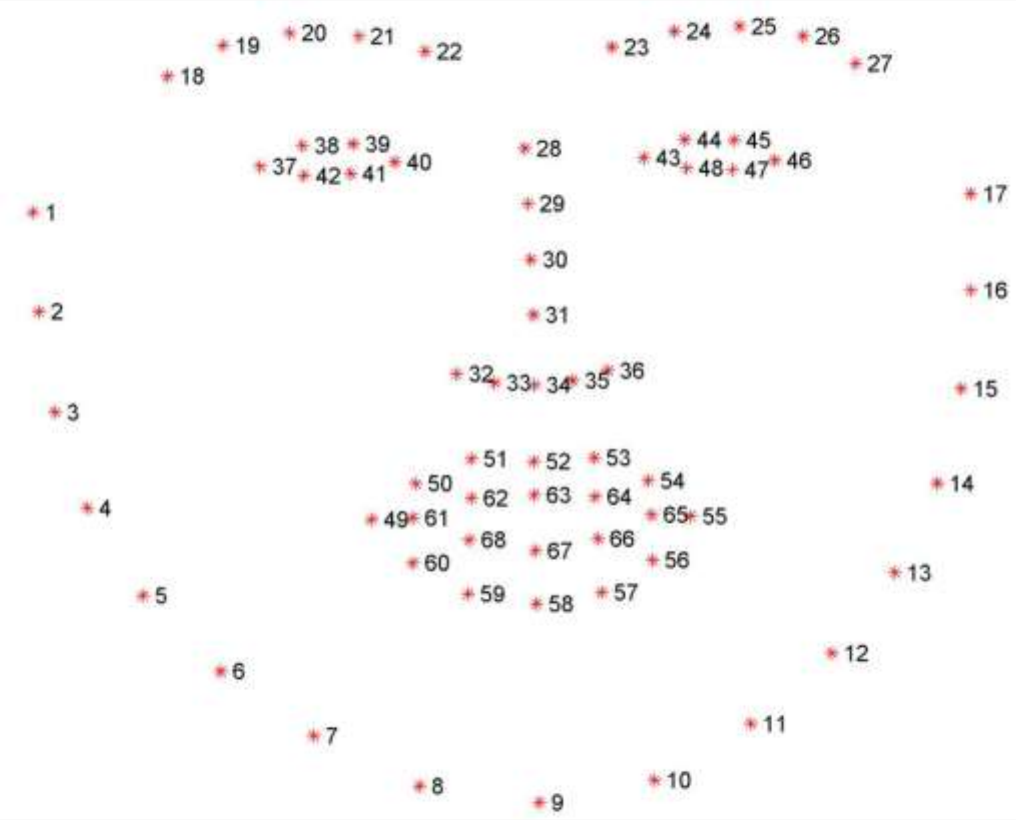


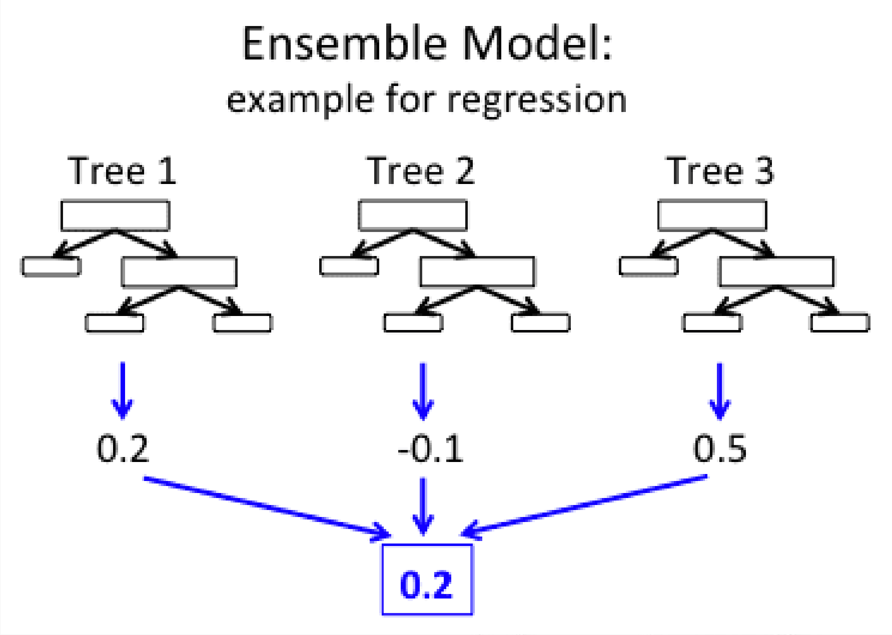
```
face_detection = face_detector(test_img)
for f in face_detection:
        cv2.rectangle(test_img, (f.left(), f.top()), (f.right(), f.bottom()), (0,0,255), 4)
```

left() top() right() bottom() height() width()

Dlib landmark predictor

Regression Tree의 Ensemble 모델로 iBUG-300W데이터셋을 학습한 모델





References
(Left) https://prlabhotelshoe.tistory.com/4
(Right) https://pyimagesearch.com/2019/12/16/training-a-custom-dlib-shape-predictor/

Dlib landmark predictor

Regression Tree의 Ensemble 모델로 iBUG-300W데이터셋을 학습한 모델

dlib.shape_predictor() is a tool that takes in an image region containing some object and outputs a set of point locations that define the pose of the object.

http://dlib.net/files/shape_predictor_68_face_landmarks.dat.bz2

```
import dlib
predictor_file = './model_data/shape_predictor_68_face_landmarks.dat'
face_detector = dlib.get_frontal_face_detector()
shape_predictor = dlib.shape_predictor(predictor_file)
```

```
face_detection = face_detector(test_img)
for f in face_detection:
    shape = shape_predictor(test_img, f)
```

References
http://dlib.net/imaging.html#shape_predictor

Thank You.