2020.07 하계방학 Part.2

Deep Face Recognition: Survey

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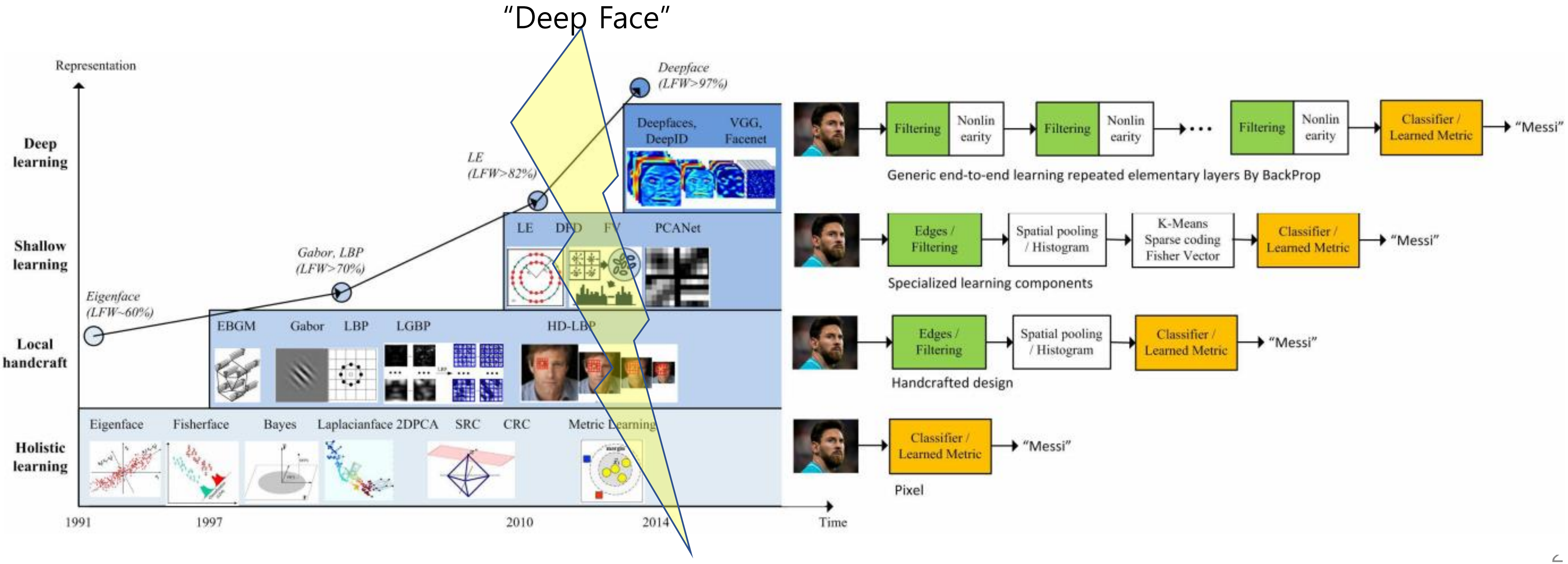
20151739 공대현

- **Face Recognition(FR)의 발전**

  -2014년을 기점으로 DL 사용 -> 비약적인 정확도 상승



Main Point of Face Recognition

- Face Processing
- Loss Function

Prior Knowledge

- Gallery : Subjects enrolled in the system (Training Data)
- Probe : New Subjects (Test Data)

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Prior Knowledge

- Face Verification

- 두 사람(Gallery-Probe)이 같은 사람인지 비교

$$r(x_1, x_2) = log\frac{P\left(x_1, x_2|H_I\right)}{P\left(x_1, x_2|H_E\right)}$$

- Face Identification

- 여러 사람 중 가장 비슷한 사람 찾아냄(Gallery에서 Probe와 가장 비슷한 사람 찾아냄)

- Both use Feature Similarity (Metric)

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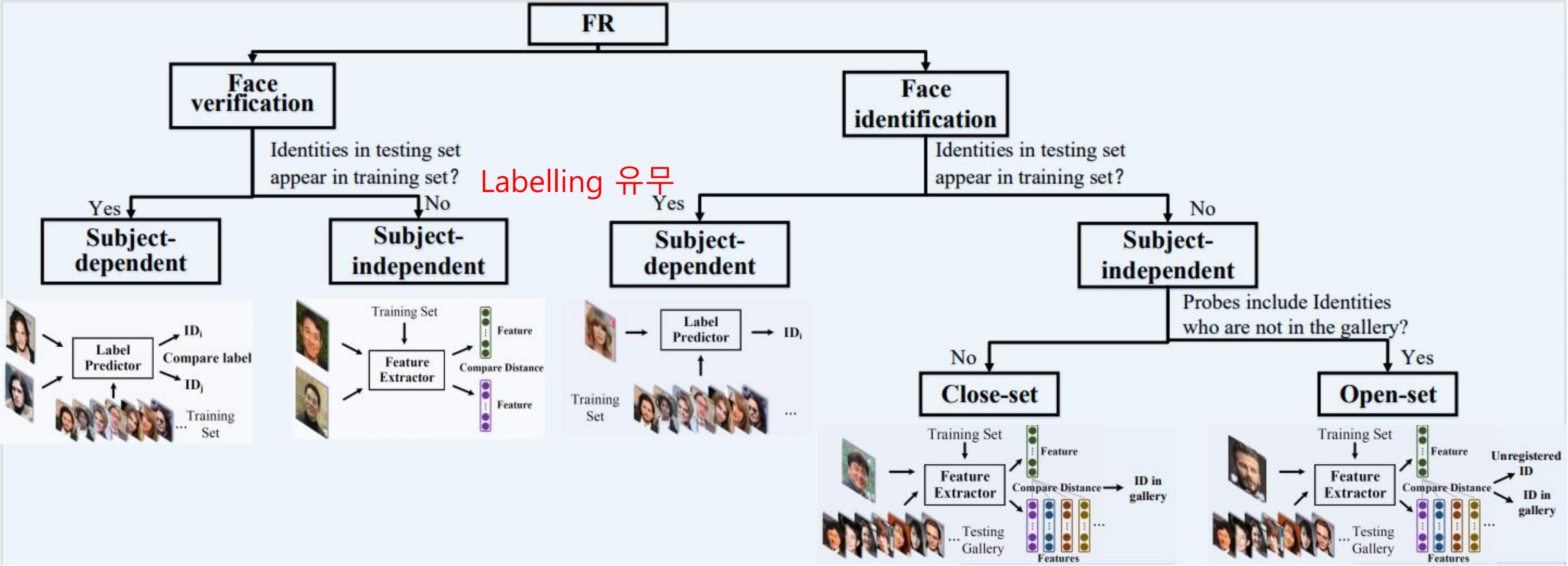
• Prior Knowledge



Labelling 유무

Test image가 Training set에 있나 없나 [273]

• Prior Knowledge

Dataset

TABLE VI
THE COMMONLY USED FR DATASETS FOR TRAINING

Datasets	Publish Time	#photos	#subjects	# of photos per subject [1]	Key Features
MS-Celeb-1M (Challenge 1)[69]	2016	10M 3.8M(clean)	100,000 85K(clean)	100	breadth; central part of long tail; celebrity; knowledge base
MS-Celeb-1M (Challenge 2)[69]	2016	1.5M(base set) 1K(novel set)	20K(base set) 1K(novel set)	1/-/100	low-shot learning; tailed data; celebrity
MS-Celeb-1M (Challenge 3) [2]	2018	4M(MSv1c) 2.8M(Asian-Celeb)	80K(MSv1c) 100K(Asian-Celeb)	-	breadth;central part of long tail; celebrity
MegaFace [105], [145]	2016	4.7M	672,057	3/7/2469	breadth; the whole long tail;commonalty
VGGFace2 [22]	2017	3.31M	9,131	87/362.6/843	depth; head part of long tail; cross pose, age and ethnicity; celebrity
CASIA WebFace [243]	2014	494,414	10,575	2/46.8/804	celebrity
UMDFaces-Videos [10]	2017	22,075	3,107	–	video
VGGFace [149]	2015	2.6M	2,622	1,000	depth; celebrity; annotation with bounding boxes and coarse pose
CelebFaces+ [187]	2014	202,599	10,177	19.9	private
Google [176]	2015	>500M	>10M	50	private
Facebook [195]	2014	4.4M	4K	800/1100/1200	private

[1] The min/average/max numbers of photos or frames per subject

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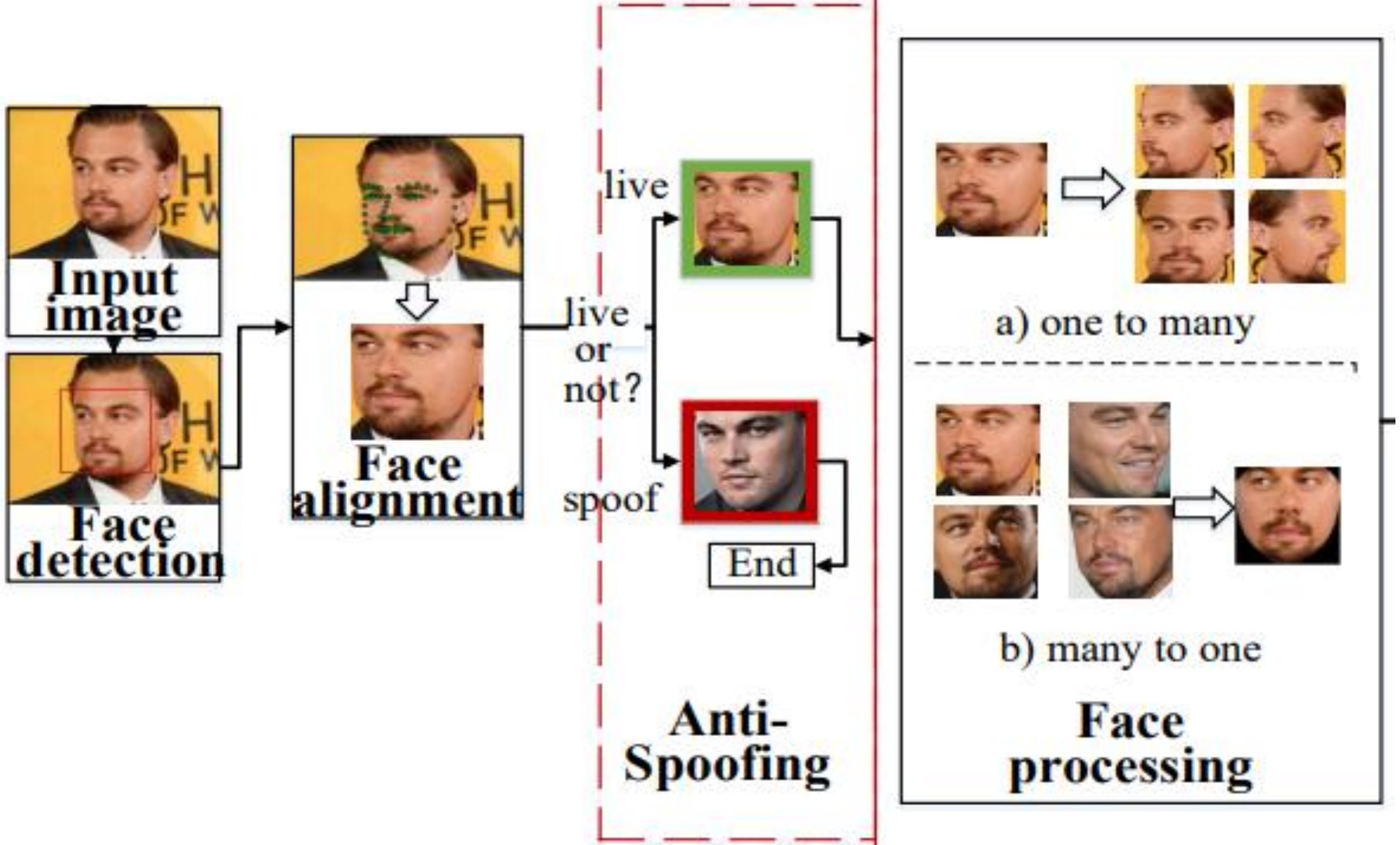
Face Processing

-Conditions(**Poeses**, illumination, expressions, occlusion …) affect Performance of FR -> need to be data-processed

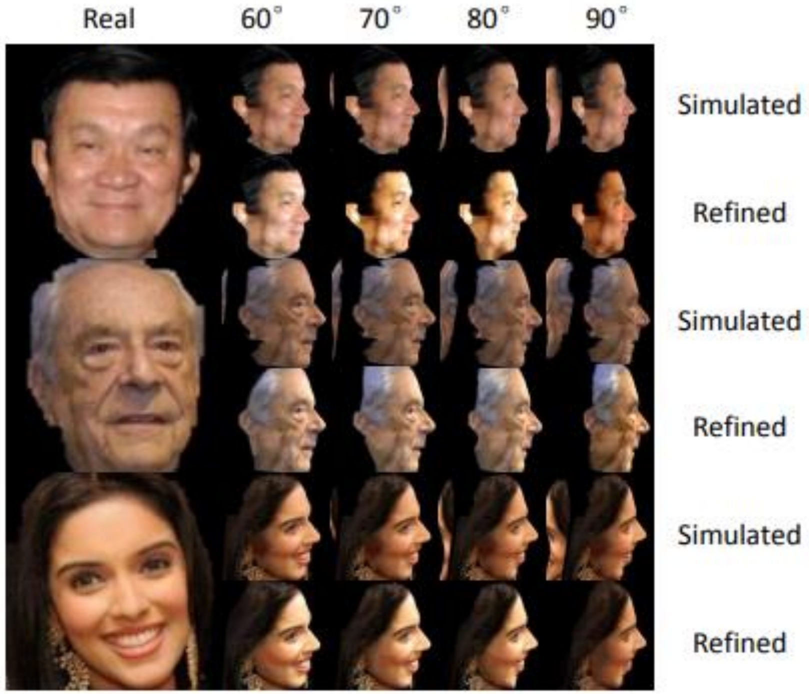
- "One-to-many augmentation": single image -> images of the pose variability (ex: 정면 -> 여러각도의 얼굴 생성)
- "Many-to-one normalization" : recovering the canonical view of face images from one or many images of a nonfrontal view (ex : 여러각도의 얼굴 -> 정면으로 normalize)

- # Face Processing

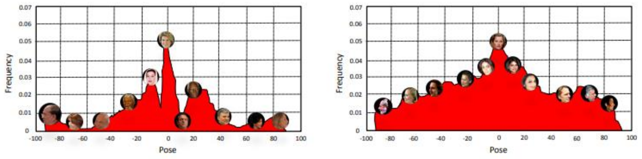


- # Face Processing

  - DA GAN (Dual Agent GAN)

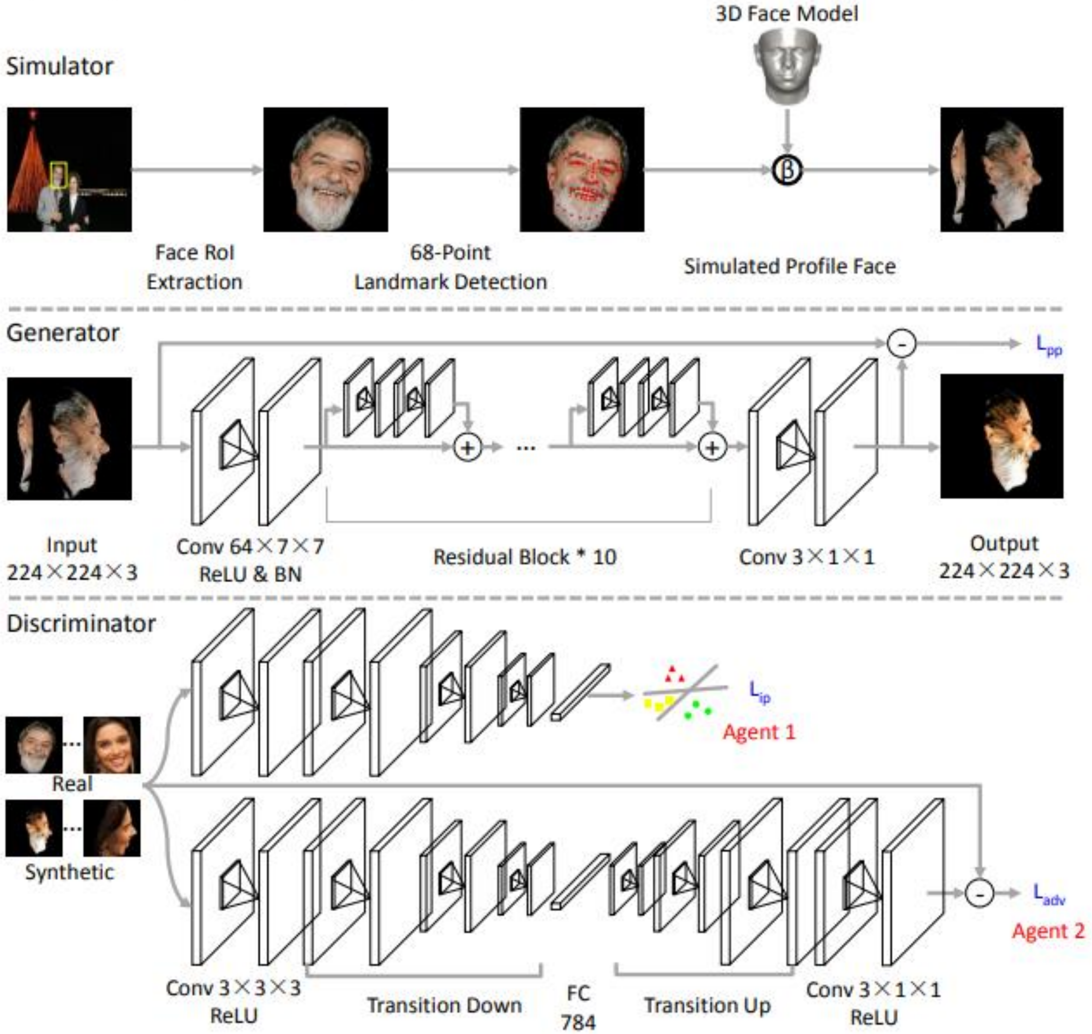


(a) Refined results of DA-GAN.



(a) Extremely unbalanced pose distribution. (b) Well balanced pose distribution with DA-GAN.

Figure 1: Comparison of pose distribution in the IJB-A (15) dataset w/o and w/ DA-GAN.



• Face Processing

- CG GAN (Dual Agent GAN)

use the first 200 subjects under 9 poses (−60∘ ~ +60∘) and 20 illuminations for training,
and use the remaining 137 subjects under 9 poses and 20 illuminations for testing

Table I
RECOGNITION RATES (%) COMPARING CROSS-GENERATING, FRONTAL REPRESENTATION AND REMOTE CODING

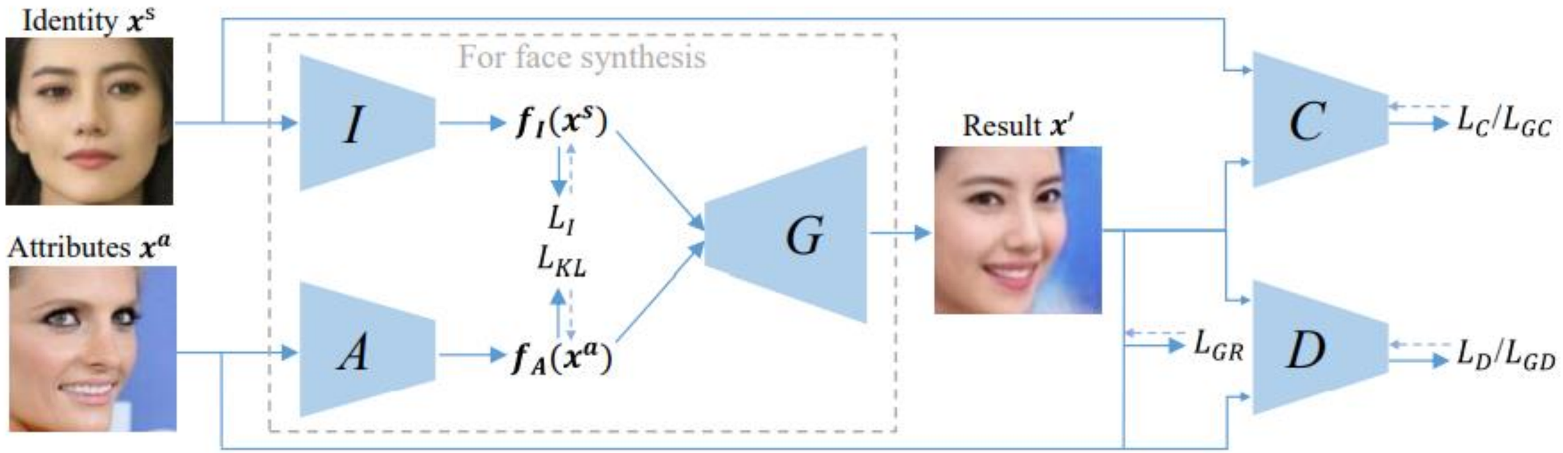
FIR Method	0°	15°	30°	45°	60°	Average
Cross-genrating	**99.7**	**99.1**	**97.2**	**93.9**	**85.3**	**94.5**
Frontal representation	99.1	97.9	93.8	91.2	82.4	92.1
Remote coding	98.7	96.2	93.0	89.8	80.5	90.9

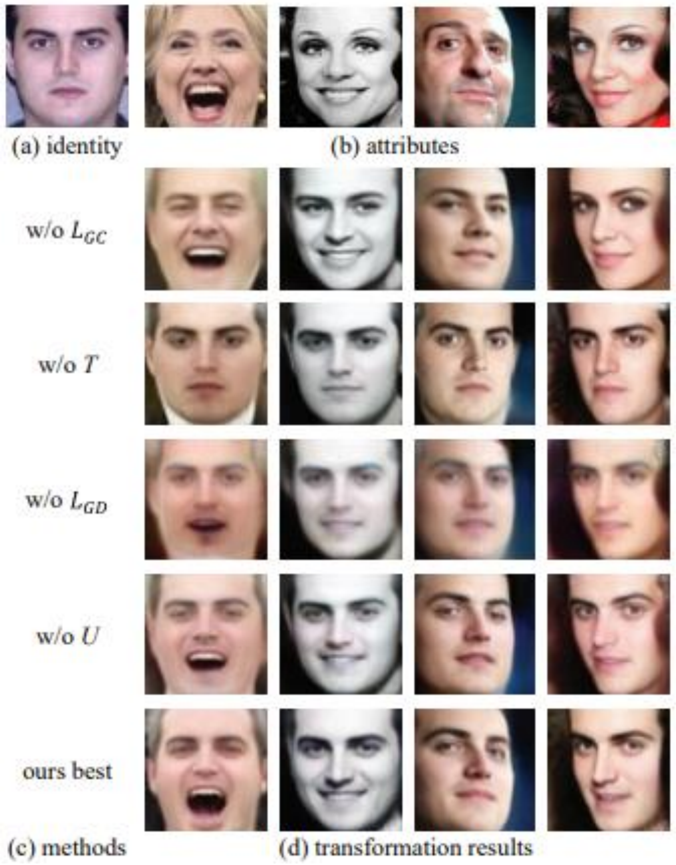
Table III
BENCHMARK COMPARISION OF RECOGNITION RATES (%) ON MULTI-PIE

Method	0°	15°	30°	45°	60°	Average
Zhu et al. [3]	94.3	90.7	80.7	64.1	45.9	72.9
Yim et al. [7]	99.5	95.0	88.5	79.9	61.9	83.3
Tran et al. [2]	97.0	94.0	90.1	86.2	83.2	89.2
CG-GAN	**99.7**	**99.1**	**97.2**	**93.9**	**85.3**	**94.5**

- **Face Processing**

  Towards Open-Set Identity Preserving Face Synthesis





Face Processing

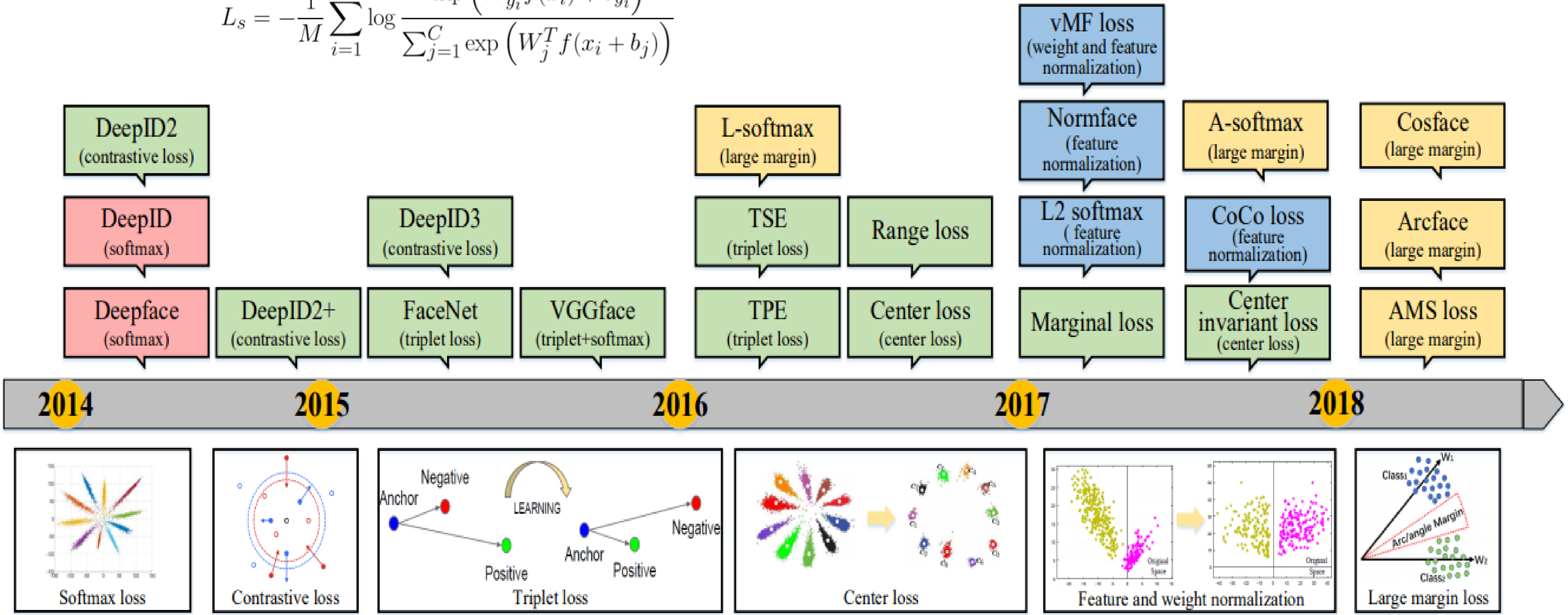
- Different Data Processing Approaches

TABLE I
DIFFERENT DATA PREPROCESSING APPROACHES

Data processing	Brief Description	Subsettings
one to many	generating many patches or images of the pose variability from a single image	3D model [139], [137], [165], [166], [53] [67], [197], [196]
		2D deep model [279], [267], [182]
		data augmentation [124], [276], [51] [222], [187], [188], [192], [202]
many to one	recovering the canonical view of face images from one or many images of nonfrontal view	SAE [101], [264], [240]
		CNN [278], [280], [89], [37], [246]
		GAN [91], [198], [41], [249]

- # Loss Function
  - **Softmax Loss : if intra-variation > inter-variation, not good**

$$L_s = -\frac{1}{M}\sum_{i=1}^{M}\log\frac{\exp\left(W_{y_i}^T f(x_i) + b_{y_i}\right)}{\sum_{j=1}^{C}\exp\left(W_j^T f(x_i + b_j)\right)}$$



Loss Function

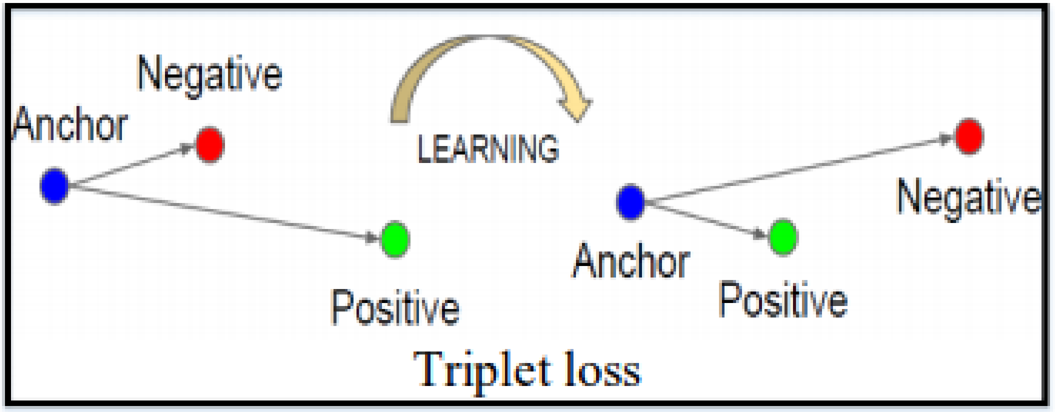
- **Euclidean-distance-based loss : metric learning method**

$$\mathcal{L} = y_{ij} max\left(0, \|f(x_i) - f(x_j)\|_2 - \epsilon^+\right) + (1 - y_{ij}) max\left(0, \epsilon^- - \|f(x_i) - f(x_j)\|_2\right)$$

If $x_i = x_j$, y_{ij} = 1 → verification
If $x_i \neq x_j$, y_{ij} = -1 → identification

FaceNet : Triplet Loss $\|f(x_i^a) - f(x_i^p)\|_2^2 + \alpha \ < \ - \|f(x_i^a) - f(x_i^n)\|_2^2$

Minimizes the distance between an anchor and a positive sample of the same identity and maximizes the distance between the anchor and a negative sample of a different identity



단점: Training instability due to the selection of effective training samples

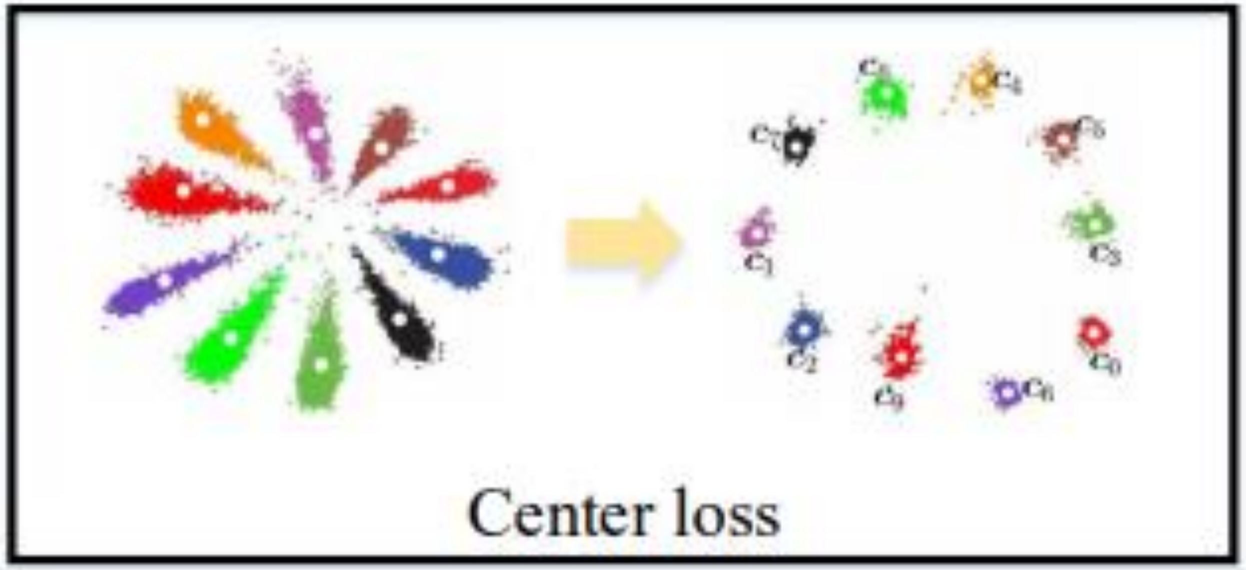
Loss Function

- **Euclidean-distance-based loss : metric learning method**

$$\mathcal{L}_C = \frac{1}{2}\sum_{i=1}^{m}\|x_i - c_{y_i}\|_2^2$$

단점 : Massive GPU memory consumption on the classification layer

Centor loss:



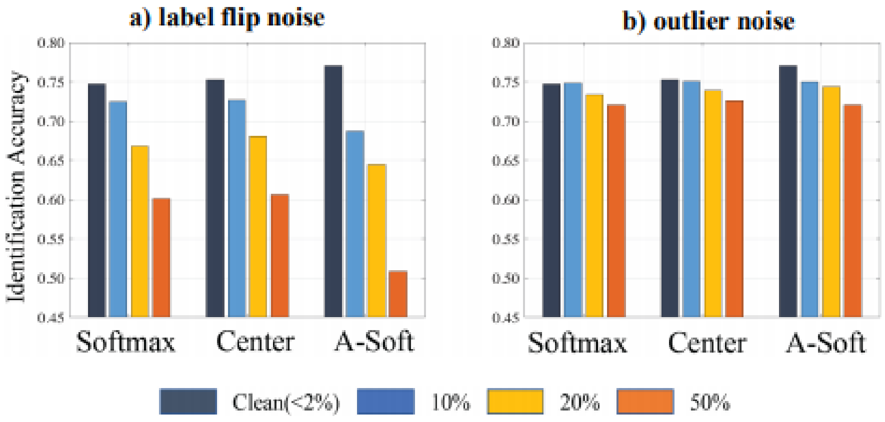
• Loss Function

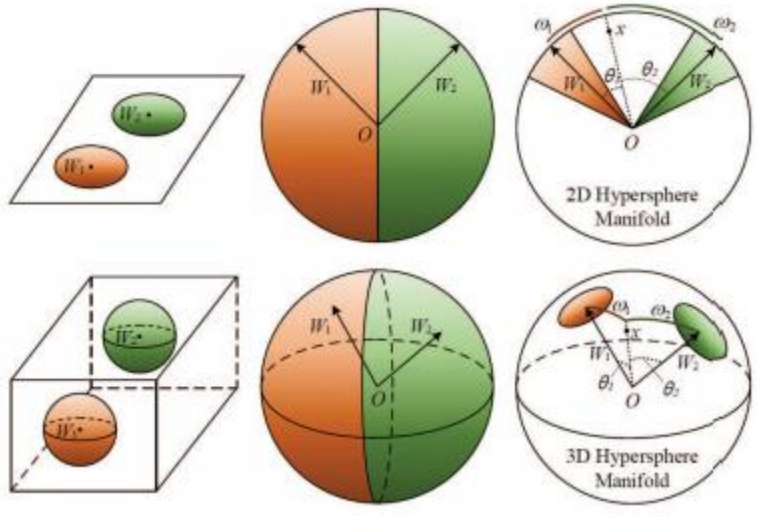
-Angular/cosine-margin-based Loss

Hypersphere Manifold with an angular margin

$$\mathcal{L}_i = -log\left(\frac{e^{\|W_{yi}\|\|x_i\|\varphi(\theta_{yi})}}{e^{\|W_{yi}\|\|x_i\|\varphi(\theta_{yi})}+\sum_{j\neq y_i} e^{\|W_{yi}\|\|x_i\|cos(\theta_j)}}\right)$$

단점: clean dataset이 아니면 성능이
Centor loss나 Softmax보다 안좋다





A-Softmax

Loss Function

-Angular/cosine-margin-based Loss

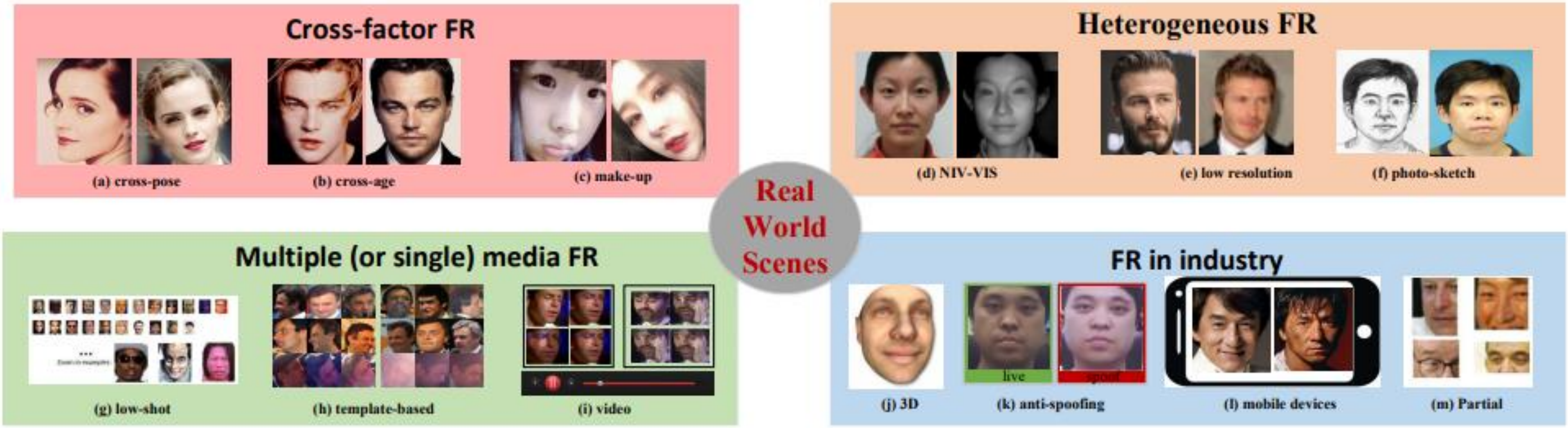
TABLE V
DECISION BOUNDARIES FOR CLASS 1 UNDER BINARY CLASSIFICATION CASE, WHERE $\hat{x}$ IS THE NORMALIZED FEATURE. [42]

Loss Functions	Decision Boundaries
Softmax	$(W_1 - W_2)\, x + b_1 - b_2 = 0$
L-Softmax [126]	$\|x\| \left(\|W_1\| \, cos(m\theta_1) - \|W_2\| \, cos(\theta_2)\right) > 0$
A-Softmax [125]	$\|x\| \left(cosm\theta_1 - cos\theta_2\right) = 0$
CosineFace [205]	$\hat{x}\left(cos\theta_1 - m - cos\theta_2\right) = 0$
ArcFace [42]	$\hat{x}\left(cos\left(\theta_1 + m\right) - cos\theta_2\right) = 0$

	Megaface challenge1			
	FaceScrub		FGNet	
Method	Rank1 @10^6	TPR @10^{-6}FPR	Rank1 @10^6	TPR @10^{-6}FPR
Arcface [42]	0.9836	0.9848	-	-
Cosface [205]	0.9833	0.9841	-	-
A-softmax [125]	0.9743	0.9766	-	-
Marginal loss [43]	0.8028	0.9264	0.6643	0.4370

Challenges

- Data noise
- Data bias (Age, Race, Pose…)
-



Reference

file:///C:/Users/kdh46/iCloudDrive/papers/Face_Recognition_Survey_kong.pdf#page=24&zoom=100,65,790