CemiFace: Center-based Semi-hard Synthetic Face Generation for Face Recognition

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1.Background:

➢ Challenge for FR:

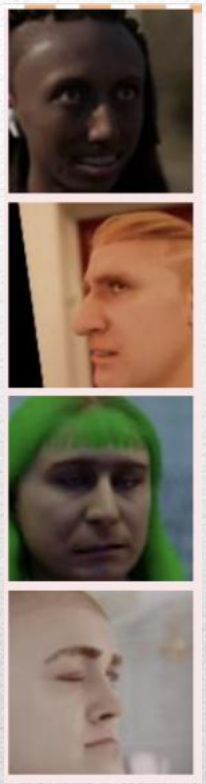
- Privacy & License issue : Should obtain user consent [1]
- Dataset such as MS1M is recalled by the creators

➢ Training challenge:

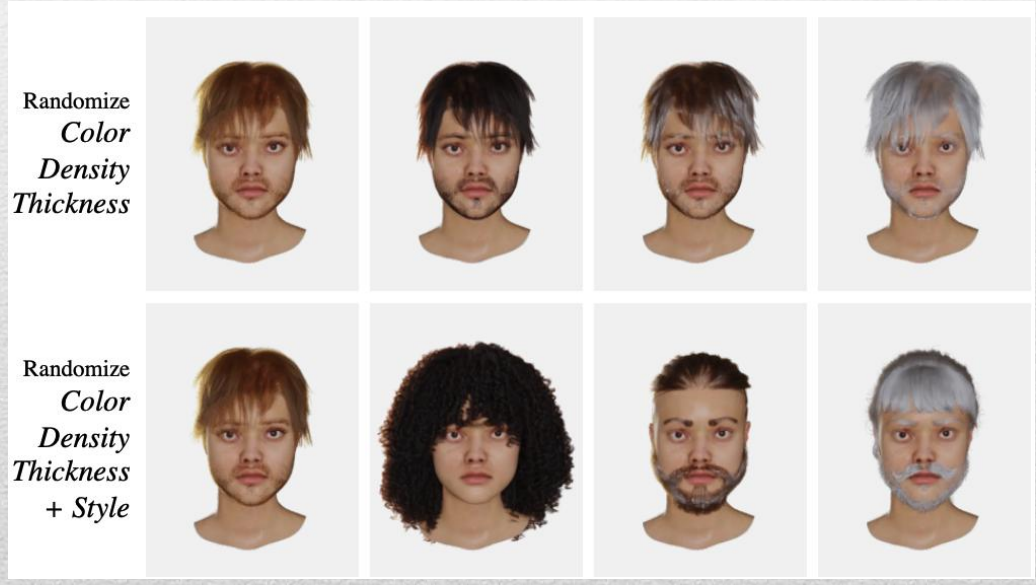
- Performance degradation: Lack discriminative samples

- [1] Protection Regulation. Regulation (eu) 2016/679 of the european parliament and of the council. Regulation (eu), 679:2016, 2016.

1.Background:



- **Previous work--Fixed Pattern(DigiFace):**
  - Figure: from their paper
  - Lack age/make-up variation, etc



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1.Background:

- **Previous work**
  - Invalid Style Transfering (DCFace)

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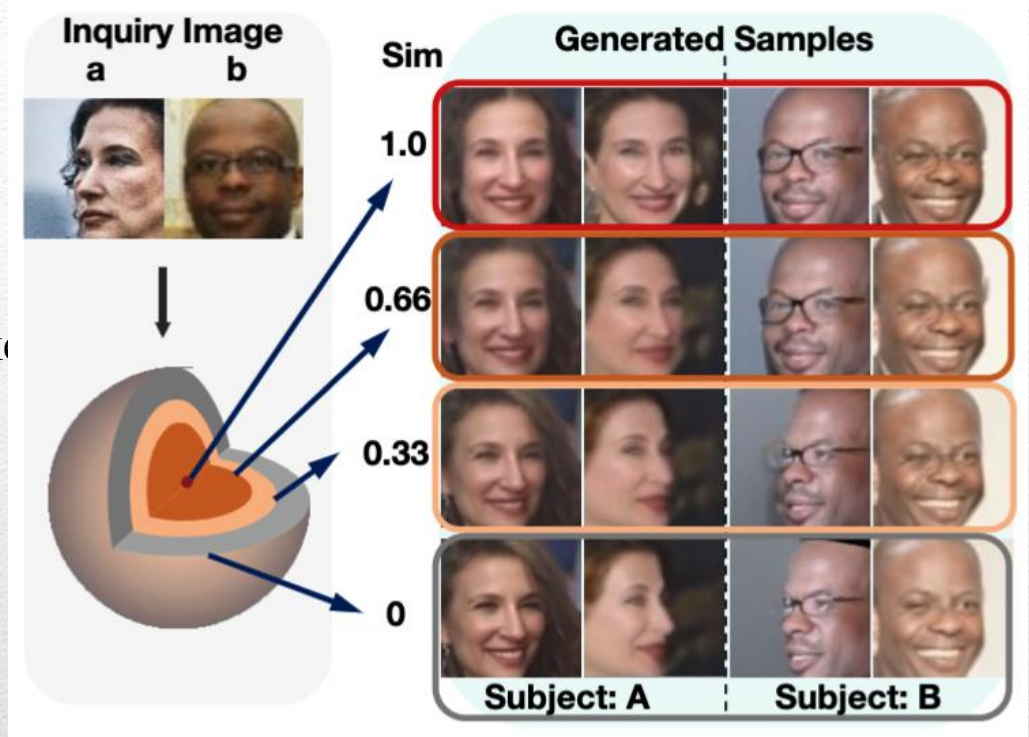
1.Background:



- **Thinking:**
  - What kinds of images mak
    - ✓ Age
    - ✓ Pose
    - ✓ Other factors.....?
  - We consider a unified way
    - **similarity to the identity center**

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1.Contribution:

- **Finding:**
  - FR model performance is **affected by different levels of similarity**
- **Diffusion-based model**
  - similarity condition: **m**
  - Loss for distangling similarity : L_{SimMat}
- **Use unlabelled data for training--Data Efficient**
- **SOTA**

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3.How semi-hard samples works

- **Tony experiment:**
  - split CASIA-WebFace into 5 similairty groups

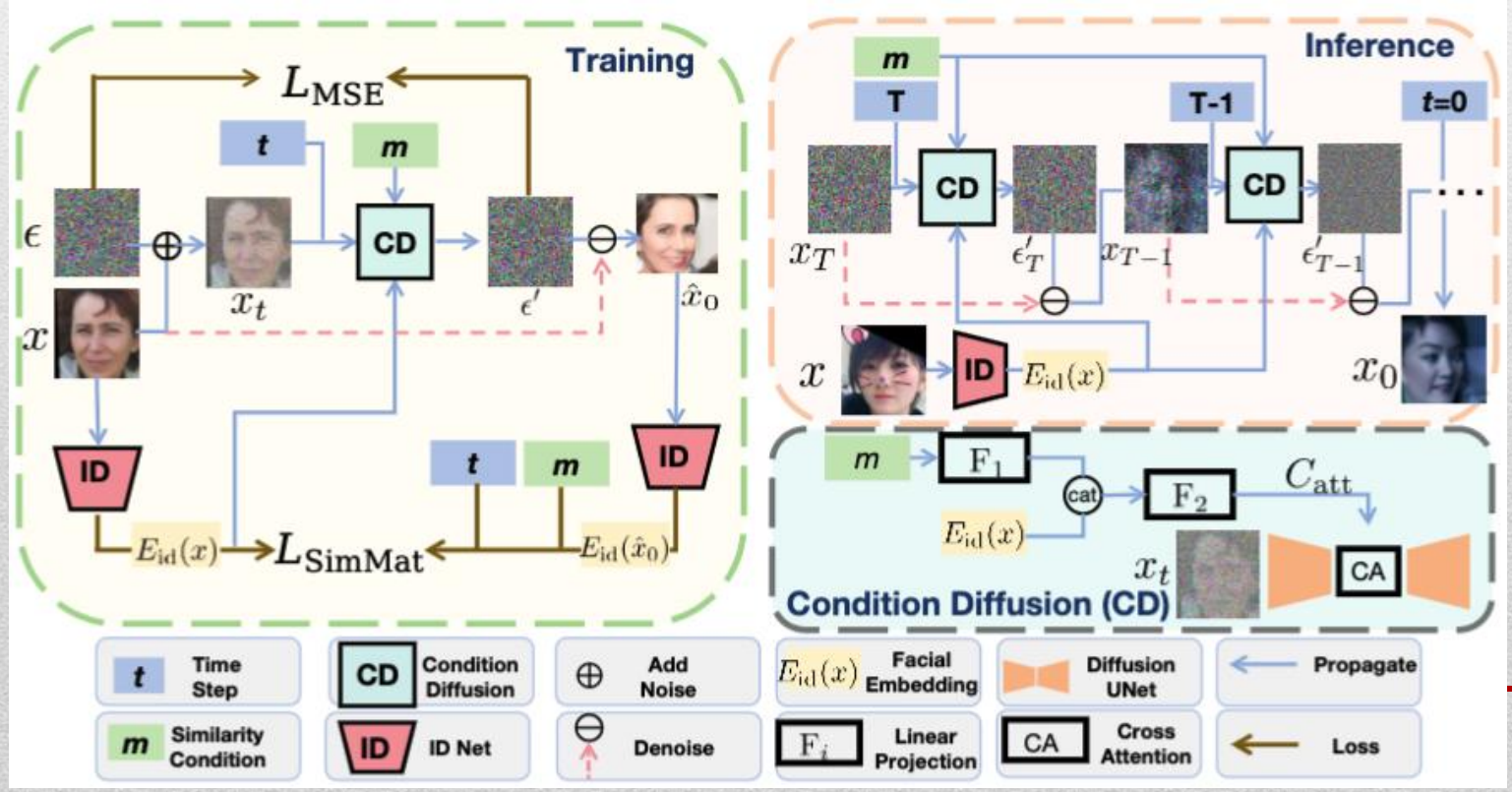
Avg Sim	average largest sim	average lowest sim	AVG
0.85	0.887	0.831	89.48
0.81	0.831	0.794	91.01
0.76	0.794	0.747	91.78
0.70	0.747	0.676	91.55
0.53	0.767	0.277	82.36

4. Hard Sample Mining--> Hard Sample Generation

➢ Method: Conditional Diffusion models

- similarity condition: m
- similarity matching loss:

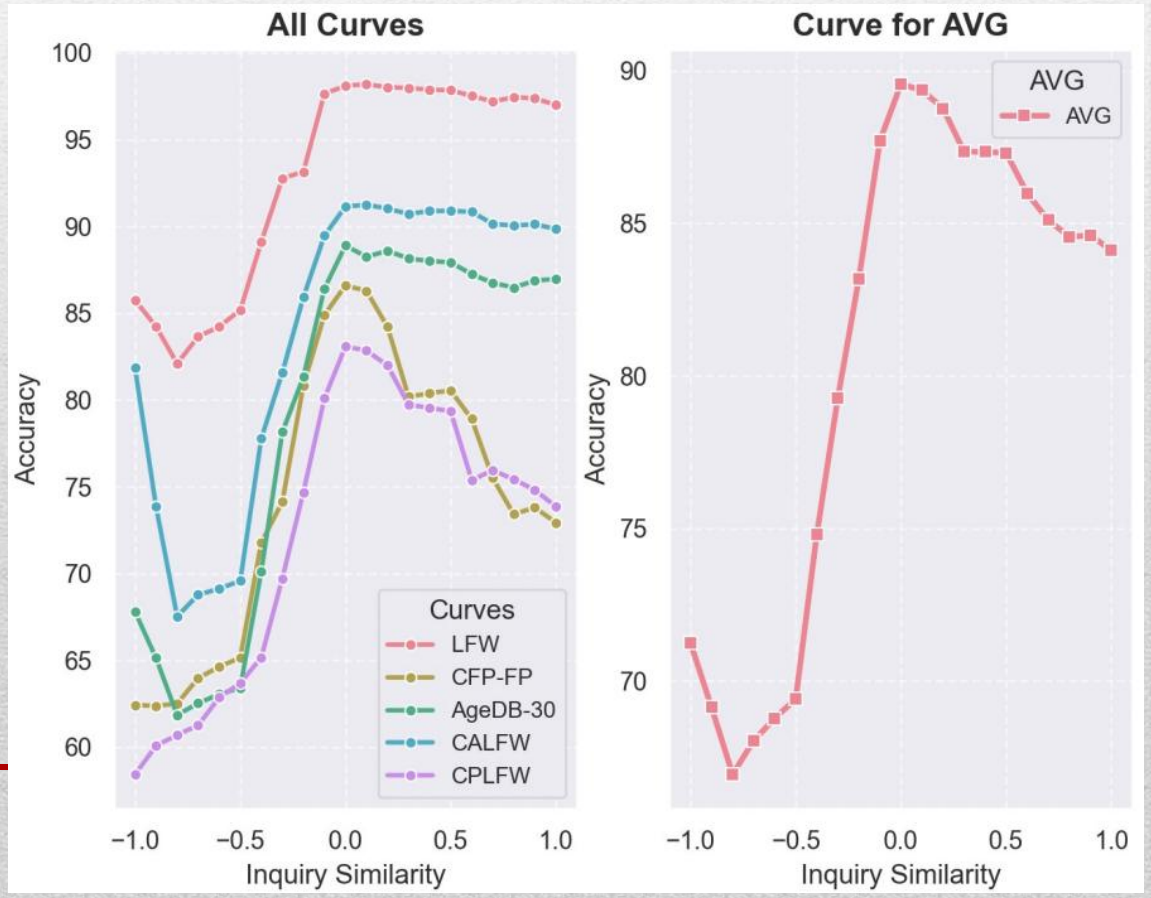
$$L_{\mathbf{sim}} = ||\mathbf{m} - \mathrm{sim}(E_{\mathbf{id}}(\mathbf{x}), E_{\mathbf{id}}(\hat{\mathbf{x}}_0)||_2$$



4. Hard Sample Mining--> Hard Sample Generation

➢ Appropriate Similarity

- Training m:
  - range from [-1,1] with interval 0.02
- Generation m:
  - mid-level similarity



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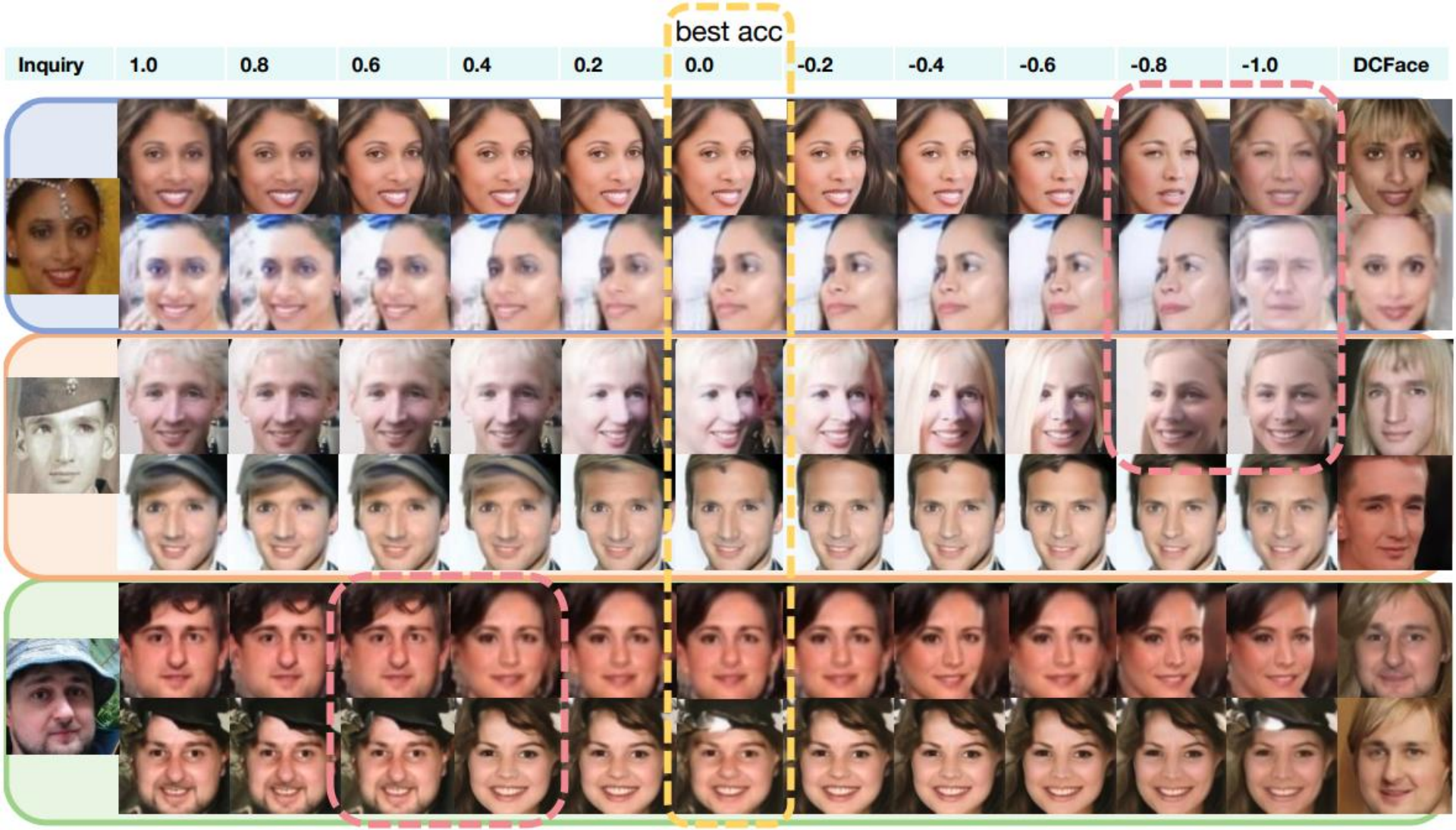
5. SOTA Comparison

- † are the results reproduced by our settings
- Reduce the error by half

Method	Data Volume	LFW	CFP-FP	AgeDB	CALFW	CPLFW	AVG	GtR
CASIA-WebFace (AdaFace)	0.49M	99.42	96.56	94.08	93.32	89.73	94.62	-
CASIA-WebFace (CosFace)†		99.3	94.87	94.35	93.15	89.65	94.26	0
SynFace	0.5M	91.93	75.03	61.63	74.73	70.43	74.75	19.51
DigiFace		95.4	87.40	76.97	78.62	78.87	83.45	10.81
IDiff-Face		98.00	85.47	86.43	90.65	80.45	88.20	6.06
DCFace		98.55	85.33	89.70	91.60	82.62	89.56	4.70
DCFace†		98.33	87.7	90.01	91.61	83.26	90.18	4.08
CemiFace, ours		**99.03**	**91.06**	**91.33**	**92.42**	**87.65**	**92.30**	**1.96**
DCFace	1.0M	98.83	88.40	90.45	92.38	84.22	90.86	3.40
DCFace†		98.88	89.71	91.25	92.15	85.2	91.44	2.82
CemiFace, ours		**99.18**	**92.75**	**91.97**	**93.01**	**88.42**	**93.07**	**1.19**
DigiFace	1.2M	96.17	89.81	81.10	82.55	82.23	86.37	7.89
DCFace		98.58	88.61	90.97	92.82	85.07	91.21	3.05
DCFace†		99.05	89.8	91.73	92.7	86.05	91.87	2.39
CemiFace, ours		**99.22**	**92.84**	**92.13**	**93.03**	**88.86**	**93.22**	**1.04**


best acc
Inquiry
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
DCFace

4. Hard Sample Mining--> Hard Sample Generation

➢ Important characteristic

- sensitive to inquiry data

Inquiry source	sim	LFW	CFP-FP	AgeDB	CALFW	CPLFW	AVG
Random Center	1.0	Not converge					
Identity Center	1.0	96.80	71.81	86.13	89.52	71.72	83.20
	0.7	97.22	75.03	86.90	89.93	74.47	84.71
	0.5	97.50	78.96	87.12	90.38	77.62	86.32
	0.2	98.17	86.29	89.07	91.40	83.03	89.59
	0.1	**98.25**	87.30	**89.98**	91.35	83.23	90.02
	0.0	98.23	**87.49**	89.53	**91.47**	**83.73**	**90.09**
1-shot DigiFace	0.0	98.28	90.04	89.68	91.23	84.12	90.67
1-shot WebFace	0.0	99.03	91.06	91.33	92.42	87.65	**92.30**
DCFace	-	98.33	87.7	90.01	91.61	83.26	90.18

- pretrained FR model affect the final quality

Method	Pretrained FR	SFR loss	AVG
CASIA-WebFace	-	AdaFace	94.62
CASIA-WebFace	-	CosFace	94.26
CemiFace	AdaFace	CosFace	92.30
CemiFace	CosFace	CosFace	**92.60**

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➢ Issue:

- Model still needs a pretrained FR to provide embedding evaluation
- Still cannot reach real-world dataset results