Age Gap Reducer-GAN for Recognizing Age-Separated Faces

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Motivation

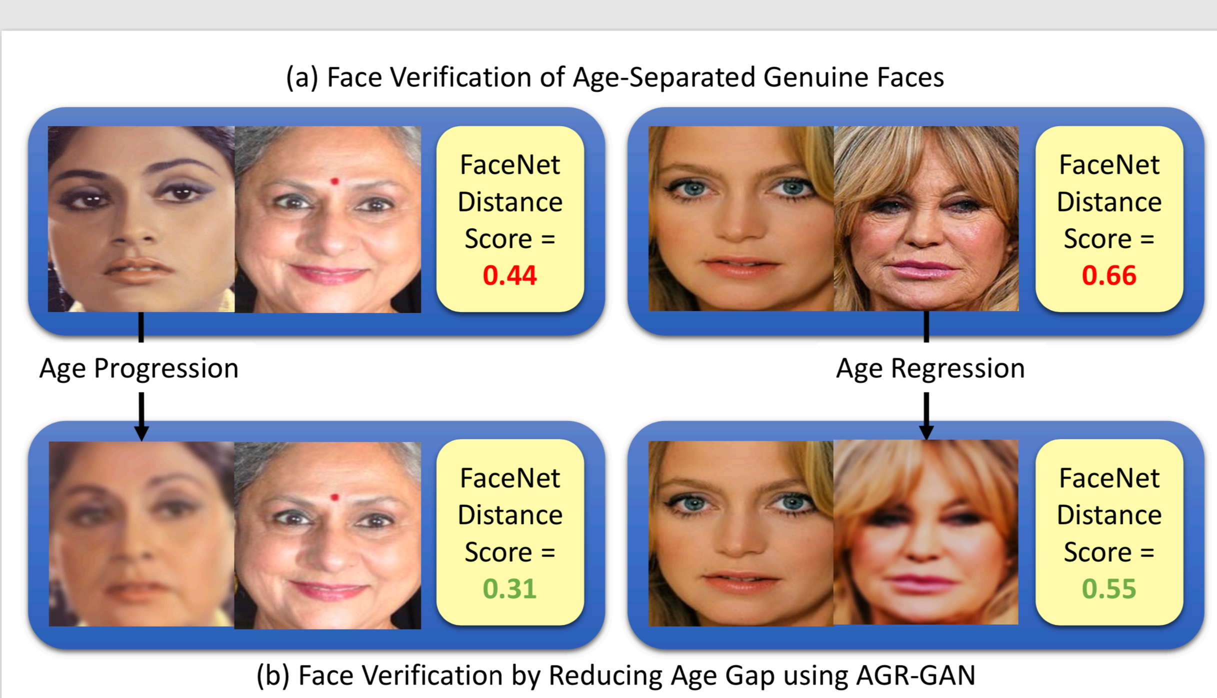
- Building age-invariant face recognition algorithms beneficial in applications such as locating missing persons, homeland security, and passport services
- Generative adversarial networks (GANs) are being utilized to generate synthetic images using convolutional neural nets (CNNs). Different GAN based approaches have been proposed for facial age simulation [1, 2]

Issues with existing GAN based research on facial aging:

- Majority focus only on generating images for different age groups.
- Only some of these techniques can produce both age-progressed as well as age-regressed faces and very few of them cater to both young as well as old age groups.
- Most do not demonstrate their efficacy in enhancing the face recognition accuracy of age-separated probe and gallery face images.

Research Contributions

- Introducing AGR-GAN: Uses a multi-task discriminator that is able to progress/regress the age of an input face to a target age group
- Incorporating an identity preserving feature which ensures that the generated (regressed/progressed) face image has the same identity representation as the input face image
- Performing joint learning of the age group estimator module with the image generation. This novel architecture eliminates the need for paired age-labeled data in the training phase
- Demonstrating the efficacy on three publicly available facial aging databases for age-separated face recognition



The proposed AGR-GAN is utilized with face recognition models such as FaceNet [3] to decrease the distance score of age-separated faces

Proposed Age Gap Reducer (AGR)-GAN

Components of AGR-GAN:

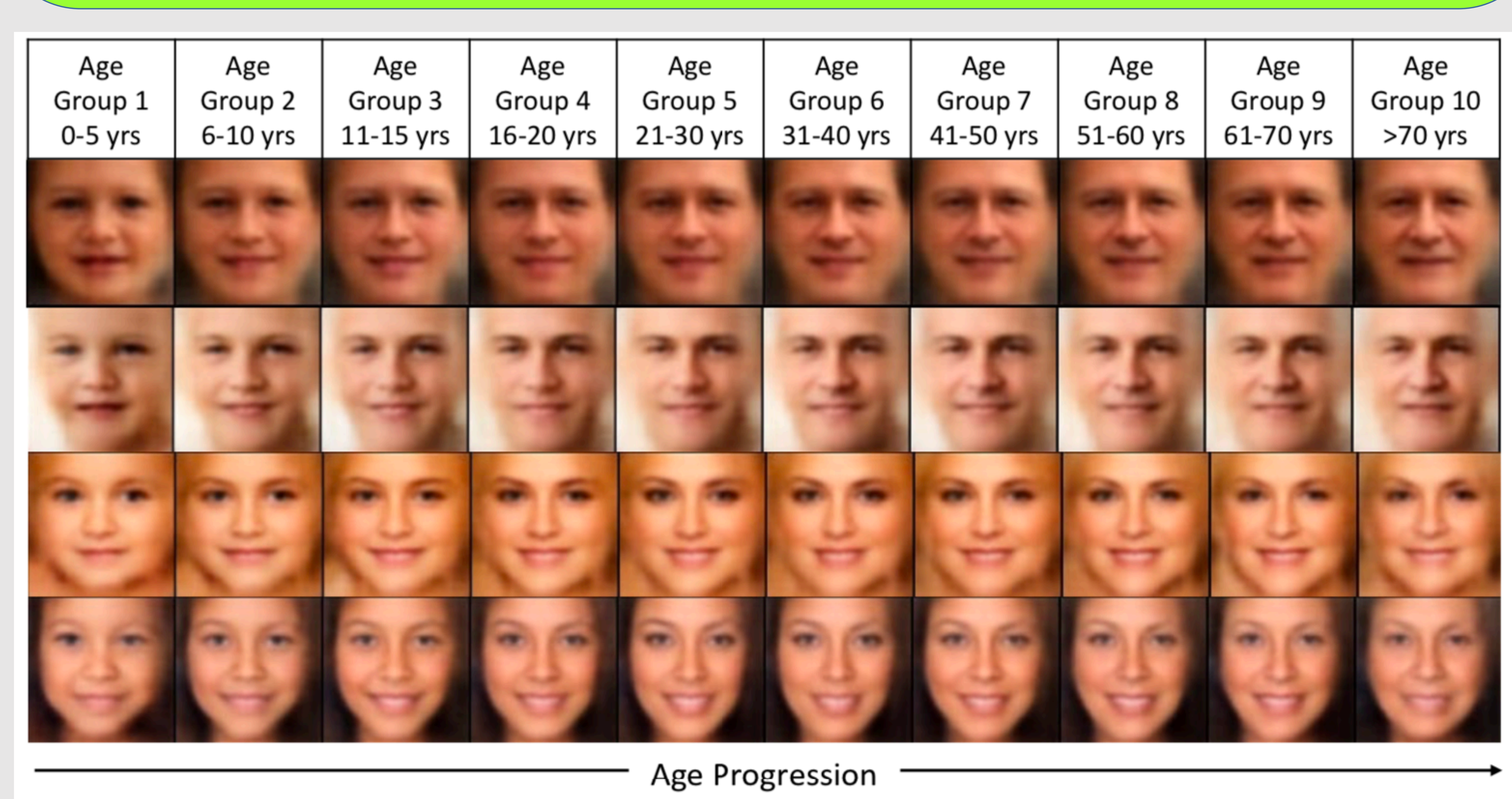
Representor R:
- To learn low-dimensional representations enc of input faces which are invariant to age progression/regression
- Consists of 5 blocks of conv layers with stride = 2 and 5 × 5 conv kernels followed by an exponential linear unit (ELU) layer
- fc-layer is applied to compute the low-dim encoding enc

Generator G:
- To utilize enc to synthesize a face image x′ with the same gender g, and target age group a
- Consists of a fc-layer followed by six blocks of transposed conv layers with stride = 2 and padding = 2.

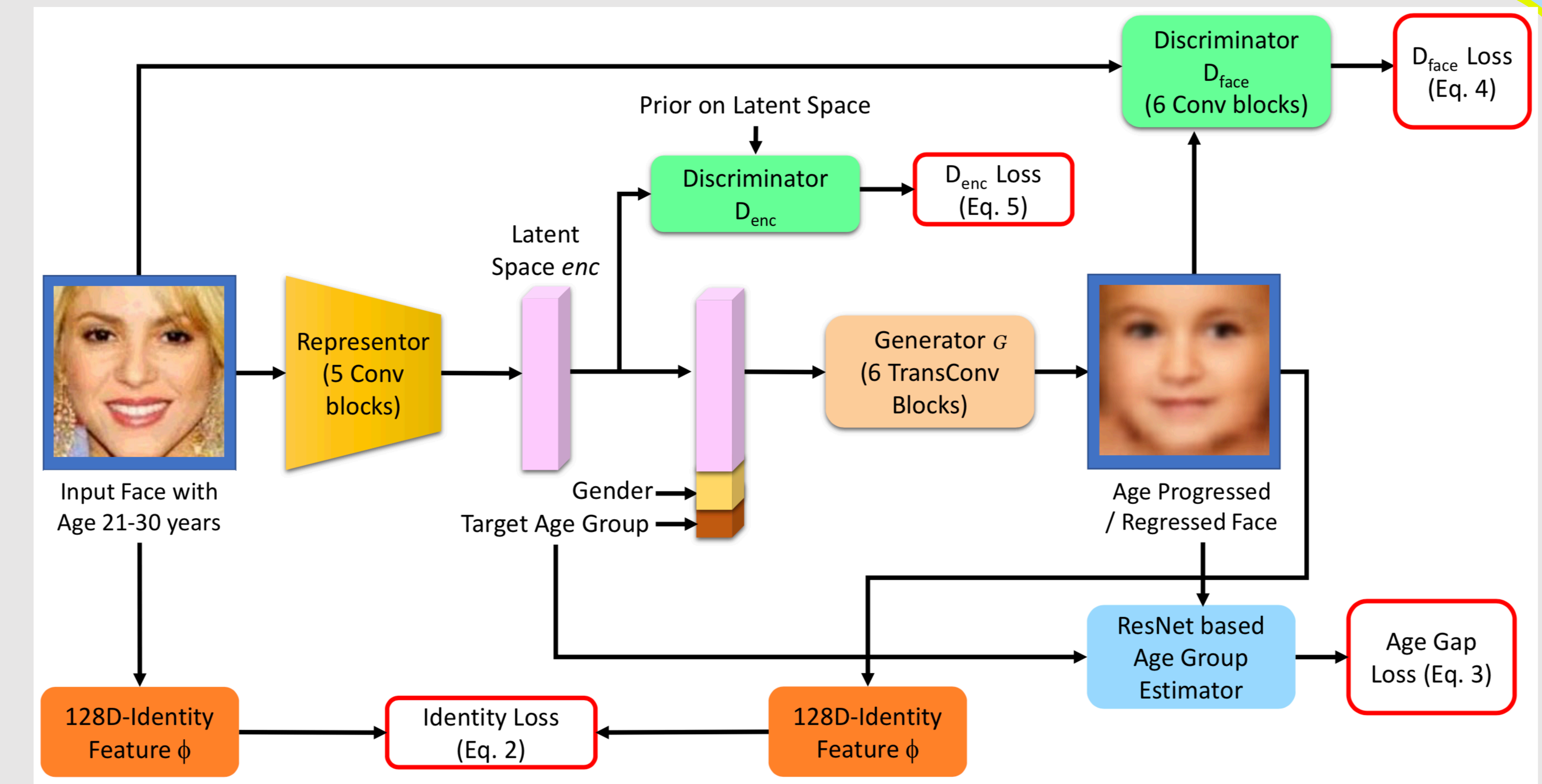
Discriminator D_{enc}:
- To ensure that the distribution of enc approaches the prior distribution
- Respresentor is forced to generate enc so that it can fool D_{enc}.
- Ensures that enc smoothly populates the low-dim latent space to remove unrealistic faces

Discriminator D_{face}:
- To distinguish generated images by G from real images
- Consists of six blocks of conv layers with kernel size = 5, stride = 2, and padding = 2.

Age Group Estimator:
- To reduce the age gap between the input face (x) and the generated face image (x')
- Utilizes ResNet-18 model [30] as its backbone to predict the age group of the input image.
- Loss function = the sum of cross-entropy loss between the correct and predicted age group + mean average group error.



Sample generated outputs by the proposed AGR-GAN across age groups



Proposed Age Gap Reducer (AGR)-GAN architecture

Database	Metric	Per-DB SOTA	Only FaceNet [3]	FaceNet + AGR-GAN
MORPH	Rank-1	93.60 [4]	94.03	94.15
CACD-VS	Accuracy @ FPR=0.1%	91.10 [4]	97.50	98.39
CALFW	Accuracy @ FPR=0.1%	86.50 [5]	57.50	87.15

Increase in FaceNet model-based face recognition performance by using faces generated from the AGR-GAN

Age Group (Age Range)	MORPH [3]	CACD-VS [4]	CALFW [5]
1 (0-5)	5.26	8.45	6.79
2 (6-10)	12.18	11.32	12.38
3 (11-15)	14.32	15.09	14.23
4 (15-20)	17.65	18.94	19.36
5 (21-30)	29.22	27.13	22.71
6 (31-40)	33.51	39.10	35.13
7 (41-50)	47.20	42.59	41.36
8 (51-60)	54.19	53.72	58.75
9 (61-70)	63.69	68.24	63.84
10 (>70)	69.85	74.32	78.38

The difference in the values of age groups 1, 2, and 10 may be attributed to lesser number of face images in the training set

Age estimation (years) of faces generated by the proposed AGR-GAN

References:

[1] Liu et al., "Attribute-aware face aging with wavelet- based generative adversarial networks," in IEEE CVPR, 2019, pp. 11 877–11 886.
[2] Yang et al., "Learning face age progression: A pyramid architecture of GANs," in IEEE CVPR, 2018, pp. 31–39.
[3] Schroff et al., "FaceNet: A unified embedding for face recognition and clustering," in IEEE CVPR, 2015, pp. 815–823.
[4] Li et al., "Distance metric optimization driven convolutional neural network for age invariant face recognition," Pattern Recognition, vol. 75, pp. 51–62, 2018.
[5] Zheng et al., "Cross-age LFW: A database for studying cross-age face recognition in unconstrained environments," CoRR, vol. abs/1708.08197, 2017.