

Identity-Preserving Aging and De-Aging of Faces in the StyleGAN Latent Space



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Introduction

- **Context:** Face-age synthesis is relevant to **forensics** and **cross-age face recognition**, yet most GAN/Diffusion methods have heavy data and computing requirements.
- **Motivation:** Current methods **lack** age synthesis **control** and **not always ensure identity** (ID) is preserved after age editing, while also being **expensive** and **complex** to train.
- **Goal:** To **efficiently** and **effectively** synthesize **aged and de-aged** faces by finding an “age direction” in the StyleGAN space, **improving identity preservation** via feature selection, and providing **specific steps** to age in years.

Key contributions

- **Efficiency:** Light requirements on data and computing resources for face aging and de-aging.
- **Improve on ID Preservation:** feature selection by comparing PCA/LDA reconstructions.
- **Synthesizing to a specific age:** provide specific latent space offsets to age and de-age subjects.
- **Dataset and evaluation code:** Release of a fully synthetic dataset with 20k IDs \times 11 age variations and age synthesis evaluation toolset.

Method Overview

1. Moving along age direction. Extending [1], use a Linear SVR to fit StyleGAN2 latent vectors $w \rightarrow y$ true age label, find age direction $\hat{\lambda}$ through SVR coefficients (λ), and move latent vector using scalar s :

$$\text{Eq. 1 } w' = w + s \hat{\lambda}$$

2. Constrain change in latent components. Use element-wise mask Φ to constrain the movement of select components, computed by comparing reconstructions from PCA and LDA spaces using labeled datasets on ID and age:

$$\text{Eq. 2 } w' = w + (\Phi \odot s \hat{\lambda})$$

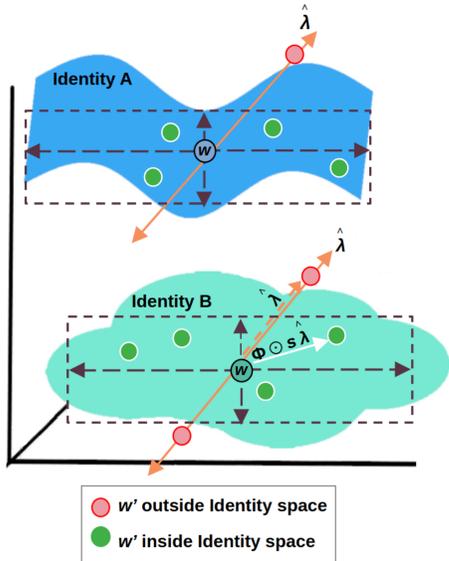


Figure: Aged latent w' inside ID region using Eq. 2.

3. Map scalar $s \mapsto y$ age. Compute compute scalar offset Δs for a specific age using polynomial fittings per age group.

Aging and de-aging to specific years

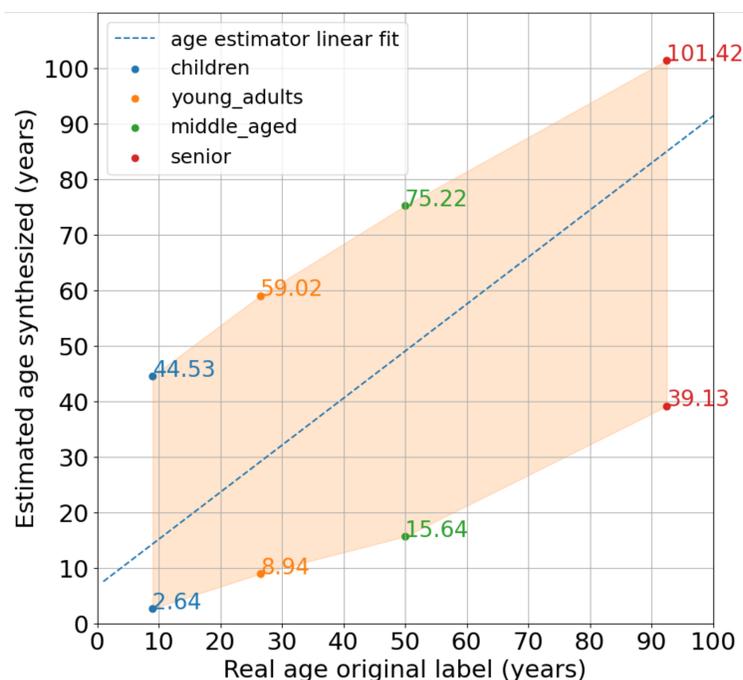


Figure: Maximum and minimum aging and de-aging limits (age group mean \pm 1 standard deviation) for our baseline approach per age group with at least 75% verified samples, using EdgeFace-S for Face Recognition.

| Input | 45 y/o | 55 y/o | 65 y/o | 75 y/o |
|----------|--------|--------|--------|--------|
| | Ours | | | |
| | | | | |
| FR score | -0.22 | -0.25 | -0.40 | -0.66 |
| | SAM | | | |
| | | | | |
| FR score | -0.24 | -0.23 | -0.23 | -1.06 |

Figure: Comparison of our method against SAM, targeting specific ages and using EdgeFace-S to compute its Face Recognition (FR) score.

Fully synthetic aged dataset

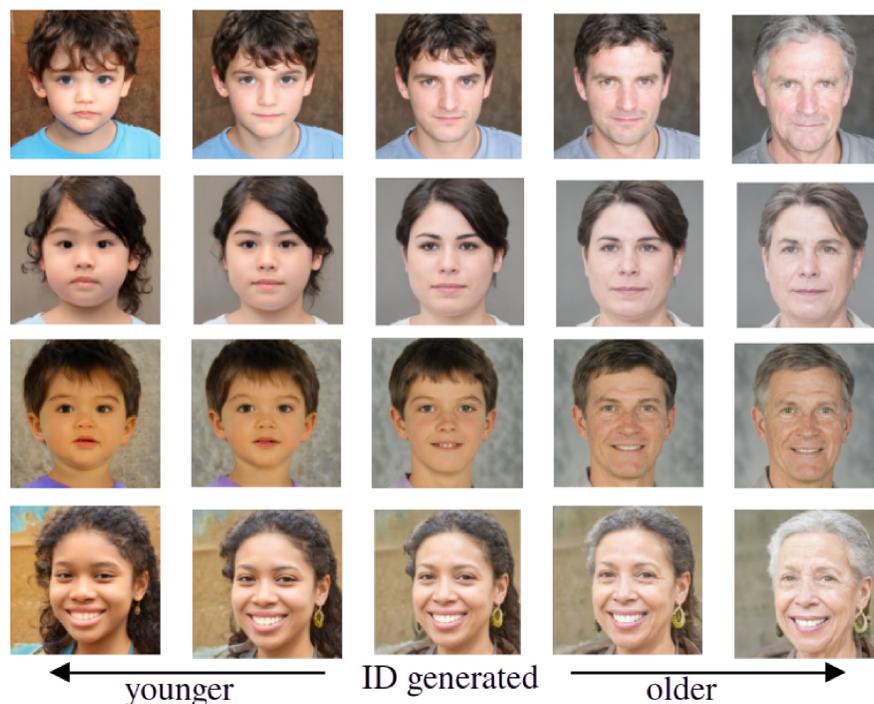


Figure: Samples from fully synthetic dataset generated. IDs generated using Langevin sampling [2] and linear approach for aging and de-aging the synthetic identities.

Experimental Setup

- **Datasets:** Train and test partitions of UTKFace (age), train partition of Color FERET (identity).
- **Age estimation and face recognition:** MobileNetV2 age estimator; EdgeFace-S face recognition backbone calibrated on IJBC.

ID preservation and age

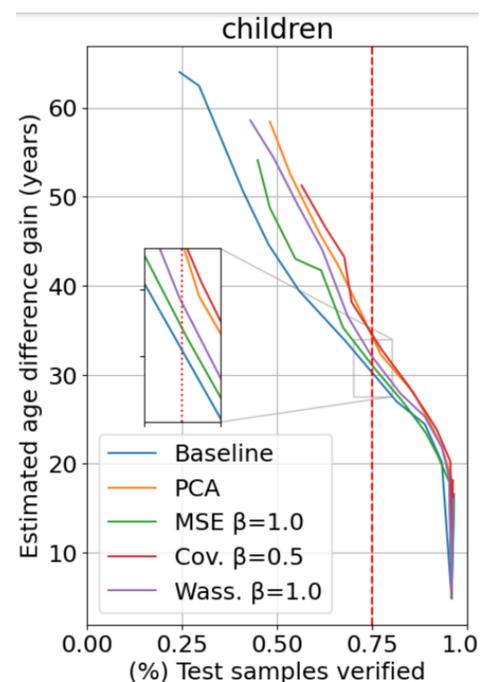


Figure: Age gain per number of samples verified for the children age group. LDA reconstruction metrics for MSE, Covariance, and Wasserstein distance.

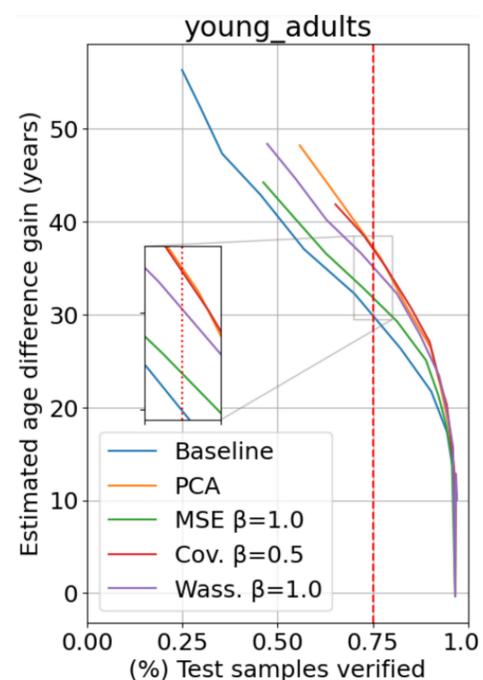


Figure: Age gain for young adults per number of samples verified. MSE, Covariance, and Wasserstein distance used for LDA reconstructions.

Selected references

- [1] Colbois, L. et al. On the use of automatically generated synthetic image datasets for benchmarking face recognition. In 2021 IEEE International Joint Conference on Biometrics (IJCB), IEEE Press, 2021.
- [2] Geissbühler, D. et al. Face datasets generation via latent space exploration from brownian identity diffusion. In Proceedings of the 42nd International Conference on Machine Learning (ICML) (to appear). PMLR, 2025