# Generative Aging of Photographs for Kinship Verification


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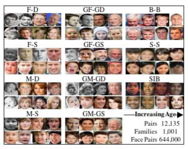
## Motivation

- Kinship verification has applications to paternity testing, human trafficking, and genetics.
- Inputs are a pair of face images, output is whether they are blood relatives
- Current methods using photographs have seemed to stagnate at around 70% accuracy
- Through pre-processing inputs with a generative aging algorithm we were able to increase performance in a model-agnostic way

## Data and Features

- Data came from Families in the Wild (FIW)[4]
- 50,000 color image pairs of 11 different classes of family relationships (Father-Daughter, Grandmother-Grandson, etc.)



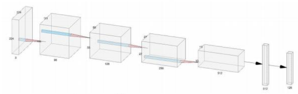

| Training | Dev | Test |
|---|---|---|
| 153 families | 5 families | 5 families |
| 46,735 triplets | 3,276 pairs | 1,558 pairs |

- For CNN training the outputted "features" were encodings of the images.
- The generative networks were learning features that corresponded to the facial manifold so they could properly age the faces.

## Modeling

CNN[1]

1. Triplet Loss: $L(A, P, N) = max\left(||A - P||_2^2 - ||A - N||_2^2 + \alpha, 0\right)$ where $\alpha$ was empirically chosen to be 0.4
2. $D = ||encoding_1 - encoding_2||_2^2$, where $D > \epsilon$ means the two inputs are relatives, $\epsilon$ chosen from dev set

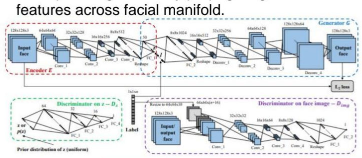


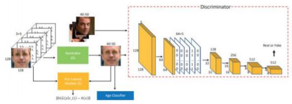
IPCGAN[3]

Uses an age estimator and an identity-preserved condition to decrease unnecessary smoothing in age-progressed faces.

CAAE[2]

Attempts to age faces by propagating certain features across facial manifold.





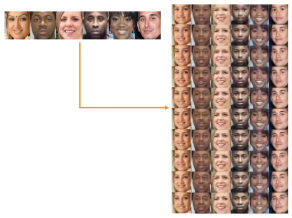
Normalized FIW data → Aging through Generative Network → Select photos from desired age → Encode photos using CNN → Evaluate Kinship

## Discussion

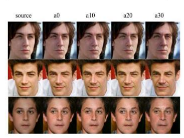
- As hypothesized, the best option for accuracy was to age the images to a younger age.
- The best CAAE age was category 2 not category 1 likely because category 1 had too many false positives (encodings were too similar overall)
- Aging forward using IPCGAN yielded the highest precision, likely because the preserved features made encodings inherently more different
- Overall saw up to a 3% boost in accuracy. This is raised to a 5% boost in accuracy by adjusting hyper-params.

## Results

CAAE- 20 epochs



IPCGAN- Pretrained




| GAN | Age category | Accuracy | Precision | Recall |
|---|---|---|---|---|
| NA - no pre-processing | - | 57.7 | 60.1 | 48.9 |
| CAAE | Category 1 | 56.7 | 56.5 | **63.7** |
| | Category 2 | **60.4** | 60.7 | 62.1 |
| | Category 3 | 58.8 | 59.6 | 58 |
| | Category 4 | 60.2 | 61.6 | 57.1 |
| | Category 5 | 59 | 60.9 | 53.2 |
| | Category 6 | 58.8 | 60.6 | 53.6 |
| | Category 7 | 58.7 | 61.6 | 49.1 |
| | Category 8 | 56.3 | 58.6 | 46.9 |
| | Category 9 | 56.5 | 58.8 | 47.3 |
| | Category 10 | 55.3 | 57.7 | 44.1 |
| IPC | Category 1 | 57.1 | 59.3 | 48.9 |
| | Category 2 | 57.1 | 59.8 | 46.9 |
| | Category 3 | 57.1 | 60.9 | 43 |
| | Category 4 | 56.7 | 60.7 | 41.4 |
| | Category 5 | 57.6 | **63.1** | 39.4 |

Table 5: Results with GAN's preprocessing

## References


[1] Weiyang Liu, Yandong Wen, Zhiding Yu, Ming Li, Bhiksha Raj, and Le Song. Sphereface: Deep hypersphere embedding for face recognition. In The IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2017.

[2] Zhifei Zhang, Yang Song, and Hairong Qi. Age progression/regression by conditional adversarial autoencoder. In IEEE Conference on Computer Vision and Pattern Recognition. University of Tennessee, Knoxville, 2017.

[3] Zongwei Wang, Xu Tang, Weixin Luo, and Shenghua Gao. Face aging with identity-preserved conditional generative adversarial networks. In IEEE Conference on Computer Vision and Pattern Recognition, 2017.

[4] Joseph P Robinson, Ming Shao, Yue Wu, and Yun Fu. Families in the wild(fiw): Large-scale kinship image database and benchmarks. In IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 40, No.11. IEEE, November 2018.


## Future Work

- See if can apply to SphereFace for state-of-the-art performance
- Use an age/gender estimator to generate more interesting aging policies (such as aging to the average age, or the age of the younger photo, etc.)