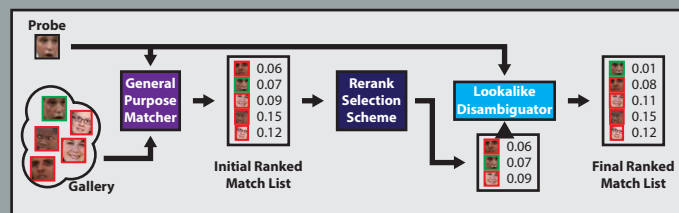


Introduction

- Identification compares a probe biometric sample against a set of labeled biometric samples (a gallery)
- This search yields a ranked match list (RML)
- RML contains an ordering of samples most similar to the probe sample
 - Most-similar sample at rank 1
- RML may not have correct match at rank 1
 - For example, correct match may occur at rank 5
 - Matcher was confused by similar-looking faces at ranks 1 to 4
- "Lookalike" faces may be a special case in face recognition
- "Lookalike" faces may not be well-handled by a general-purpose matcher

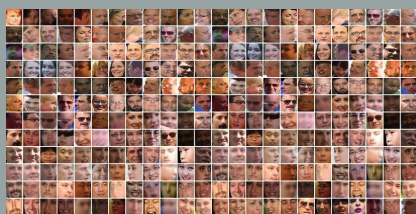
Proposed Solution



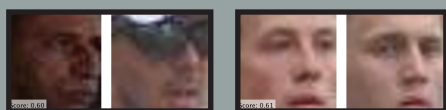
- We propose the use of two matchers:
 - General-Purpose Matcher (GPM) – trained like a normal face recognition system
 - Lookalike Disambiguator (LD) – trained specifically to distinguish between lookalikes
- GPM obtains an initial RML and LD reranks a certain subset of the list to obtain the final RML

TinyFace Dataset¹

- Consists of small face images
 - average size 20x16 pixels
- 2,569 subjects; 3,728 probe images; 4,443 gallery images



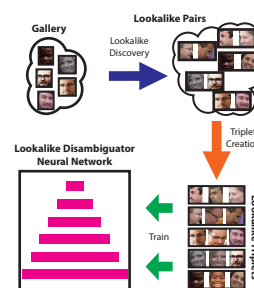
Examples of lookalike face images as judged by the ArcFace matcher.² A lookalike pair is an imposter pair with a low distance score.



Lookalike Disambiguator (LD)

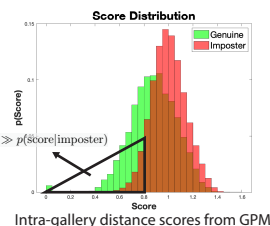
- Finetunes GPM using lookalike triplets from gallery
- Lookalike triplet consists of **anchor**, **positive**, and **negative** samples
 - Anchor & positive** sample of same subject
 - Anchor & negative** samples of different subjects, but judged by GPM to be similar
- Loss function:

$$L = \sum_{(I_a, I_p, I_n)} \|f(I_a) - f(I_p)\|_2 - \|f(I_a) - f(I_n)\|_2 + \alpha_{\text{margin}}$$

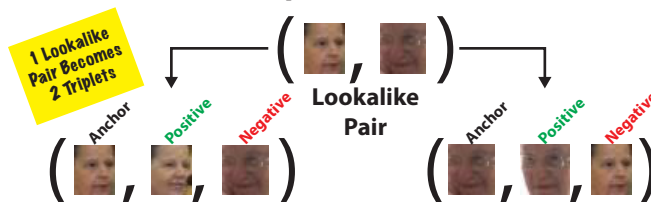


Lookalike Pair Discovery

- Compare gallery to itself using GPM
- Look for imposter pairs with small distance score (≤ 0.8)
- Results in ~679K lookalike pairs
 - 6.9% of all imposter pairs



Lookalike Pair To Triplets



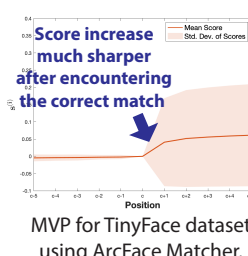
Re-rank Selection Schemes

2 schemes considered:

- FIXED**: re-rank top K ranks on initial ranked match list
- ADAPTIVE**: use scores to determine how many of the top ranks on initial ranked match list to re-rank

Match Vicinity Plot (MVP)

- Find the match-vicinity scores for a given probe image p in a ranked match list
 - Distance score for p at rank i : $d_p^{(i)}$
- Normalize score with respect to the score at position of correct gallery match ($d_p^{(c)}$)
 - Correct match for p occurs at rank c
 - Normalized Score: $s_p^{(i)} = d_p^{(i)} - d_p^{(c)}$
- MVP shows how match scores change from rank to rank before and after encountering the correct gallery sample



Adaptive Re-Rank Selection

- Calculate rolling sum of consecutive distance scores in ranked match list, S_k
 - Number of consecutive distance score defined by parameter k
- Re-rank the top k matches
 - For the smallest value of k such that $S_k > \tau$

Results

- Filter Tinyface dataset to 2,081 probes images and 2,461 galleries images of 1,145 subjects
 - We manually remove faces with a profile view during filtering
- ArcFace² matcher used as GPM, LD trained as described in middle column

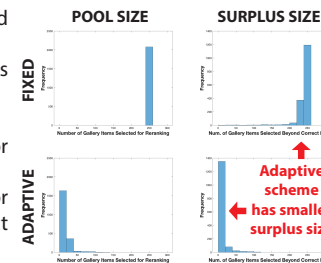
Parameter Selection

- Estimate q and τ from gallery dataset (filtered)
- Rolling sum calculated for those gallery samples that have at least 1 other gallery sample of the same subject
 - 1,897 such images
- τ is the average value of the rolling sum taken at position of correct match (S_c)

q	τ	Surplus Size		Hit Rate
		Total	Per Search	
1	0.7695	270,276	142.5	55.77%
2	1.378	294,003	155.0	61.68%
3	1.958	295,173	155.6	62.20%
4	2.511	296,353	156.2	62.63%
5	3.049	297,541	156.8	63.05%
6	3.574	298,737	157.5	63.52%
7	4.090	299,942	158.1	63.78%
8	4.597	301,152	158.8	63.94%
9	5.094	302,365	159.4	64.21%
10	5.584	303,583	160.0	64.63%

Scheme Comparison

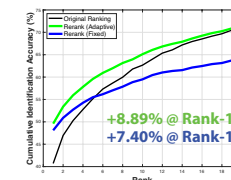
- For adaptive scheme, $q=10$ and $\tau=5.584$
- For fixed scheme, top 10% of matches are re-ranked (246)
 - 1,897 such images
- Pool Size**: # samples selected for re-ranking
- Surplus Size**: # samples selected for re-rank with rank higher than correct match
- Hit Rate**: Fraction of probes where scheme selects subset which includes correct match



Scheme	Pool Size (Min/Mean/Median/Max)	Hit Rate
Fixed	246/246/246/246	80.1%
Adaptive	5/20.66/18/121	71.3%

Identification Performance

- Given a probe: Use GPM to rank gallery samples
- Select gallery samples to re-rank using **fixed** and **adaptive** schemes
- Re-rank top gallery samples using LD
- Rank-1 identification accuracy improves from 40.7% to 49.6%



Summary

- Proposed an **adaptive gallery selection scheme** based on match scores generated using a face matcher
- Proposed the use of a **separate matcher** for re-ranking lookalike face images
- Observed an improvement in identification accuracy when using a **Lookalike Disambiguator** on the selected gallery samples

References

- Z. Cheng, X. Zhu, and S. Gong, "Low-resolution face recognition," in *Proceedings of the Asian Conference on Computer Vision (ACCV)*, 2018, pp. 605–621.
- J. Deng, J. Guo, X. Niannan, and S. Zafeiriou, "Arcface: Additive angular margin loss for deep face recognition," in *Proceedings of the Conference on Computer Vision and Pattern Recognition (CVPR)*, 2019.