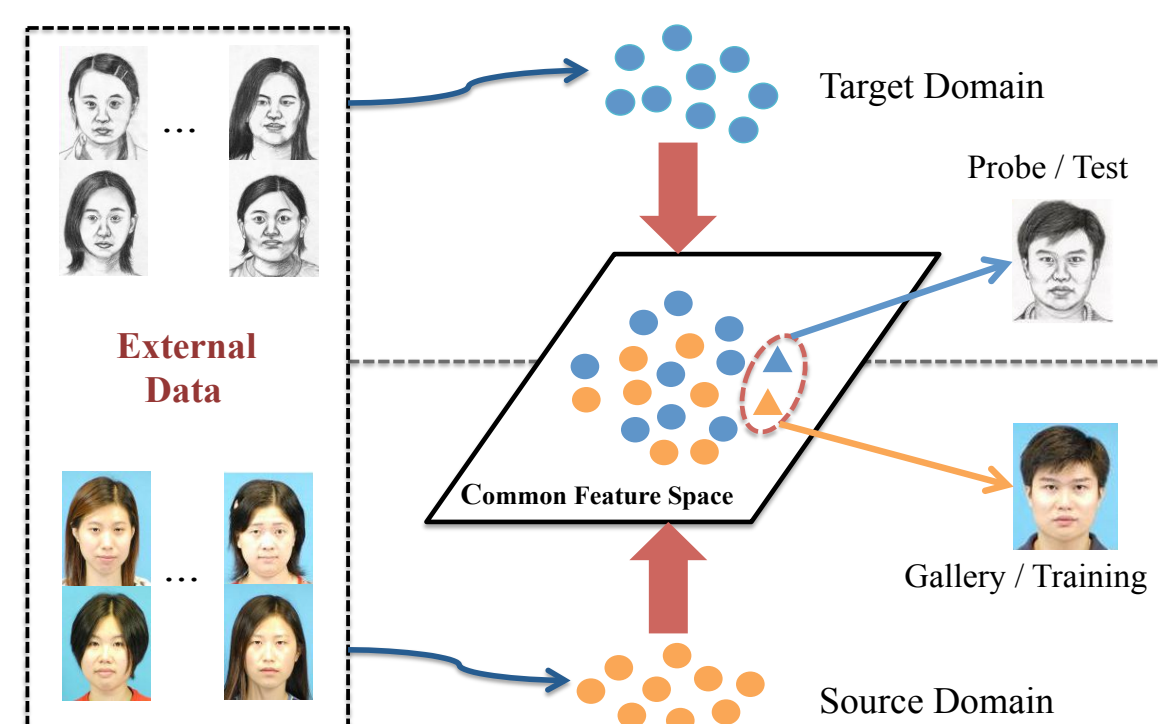
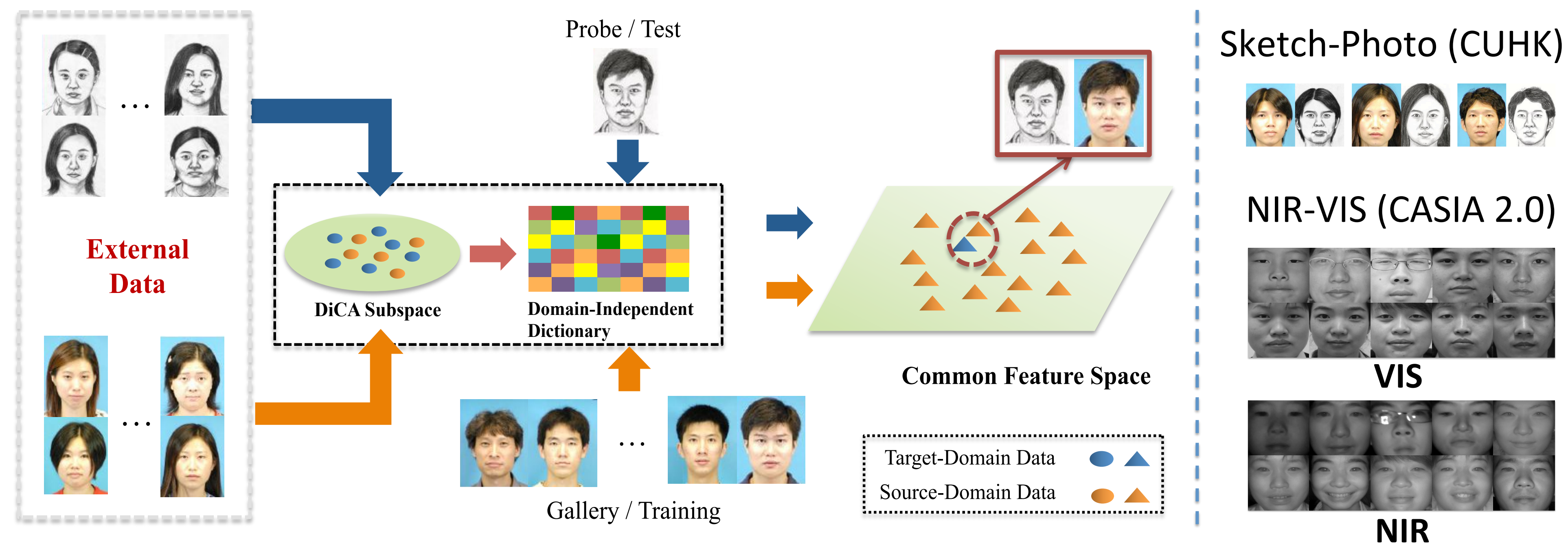


Motivation

- Heterogeneous face recognition (e.g., sketch-to-photo or NIR-to-VIS face recognition)
- Utilize **external data** (i.e., subjects **not** of interest) across modalities for domain adaptation
- **No** cross-domain pairwise correspondences needed



Overview of Our Approach



Domain-independent Components Analysis

- **Goals**
 - ✓ Find a subspace to associate images across different domains
 - ✓ Learn the transformation: \mathbf{W}_{DiCA}

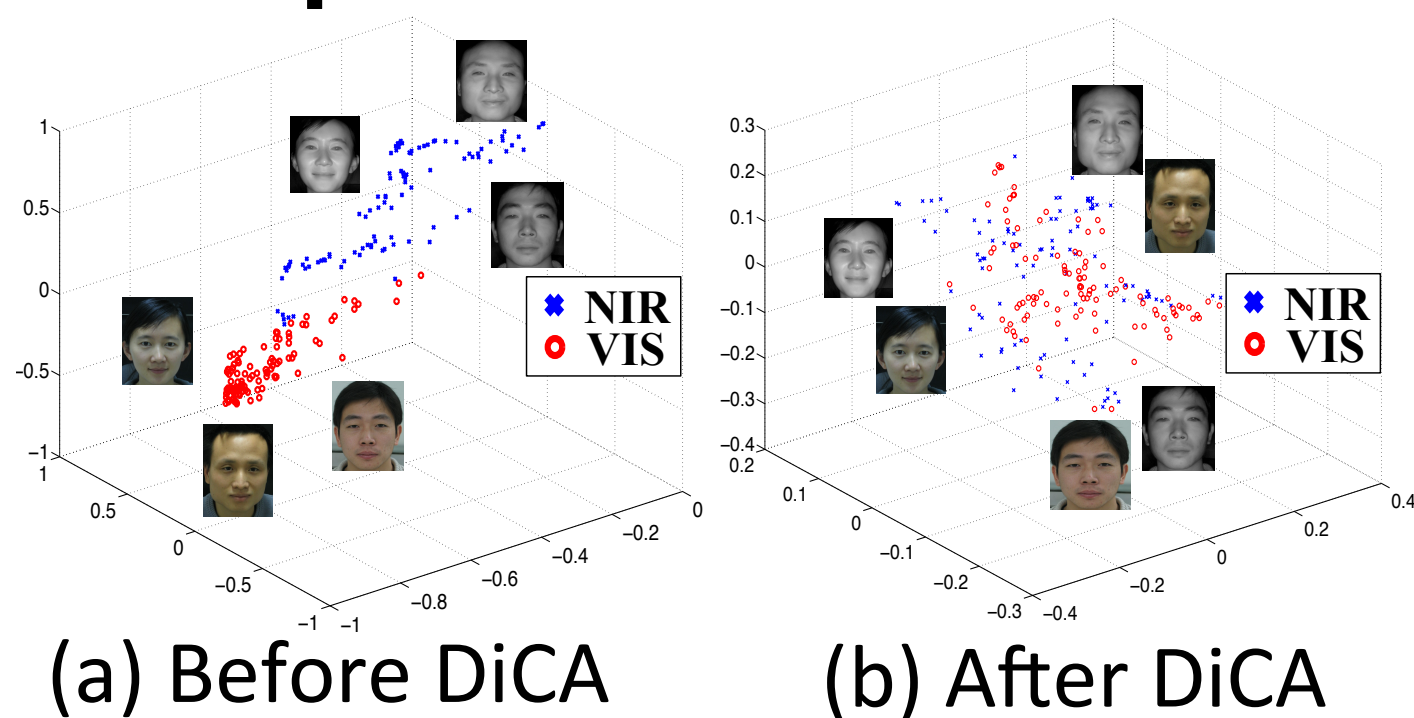
Observations/Ideas

- ✓ Domain difference dominates the data variance (see Fig. (a))
- ✓ Observe the MMD (Maximum Mean Discrepancy) distance:

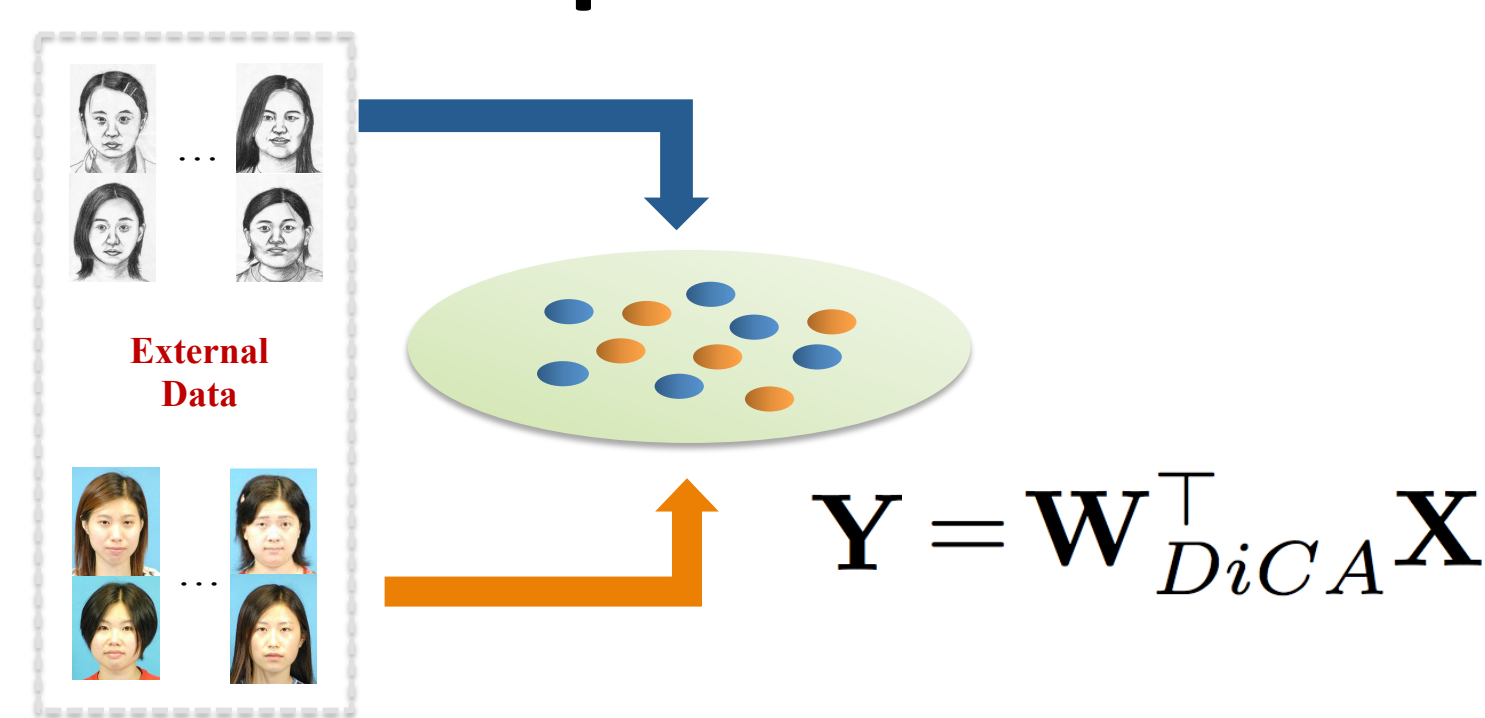
$$d(\mathbf{w}_i) = \left\| \frac{1}{n_s} \sum_{x_j \in D_s} \mathbf{w}_i^\top \mathbf{x}_j - \frac{1}{n_t} \sum_{x_k \in D_t} \mathbf{w}_i^\top \mathbf{x}_k \right\|$$

- ✓ Calculate \mathbf{W}_{DiCA} by performing PCA & disregarding PCs with large $d(\mathbf{w})$

Example



DiCA subspace



Domain Adaptive Dictionary Learning

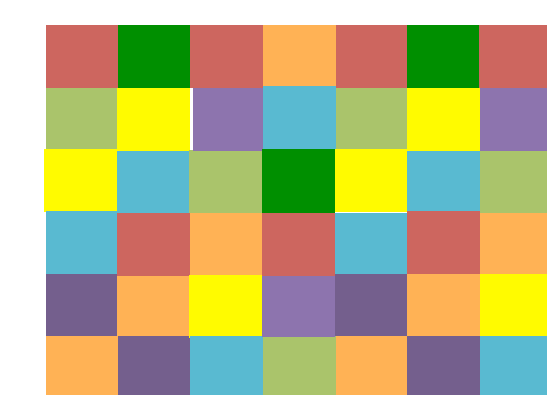
Motivation

- ✓ DiCA subspace is constructed from external data.
- ✓ When recognizing the subjects of interest, need a better feature representation in the DiCA subspace.

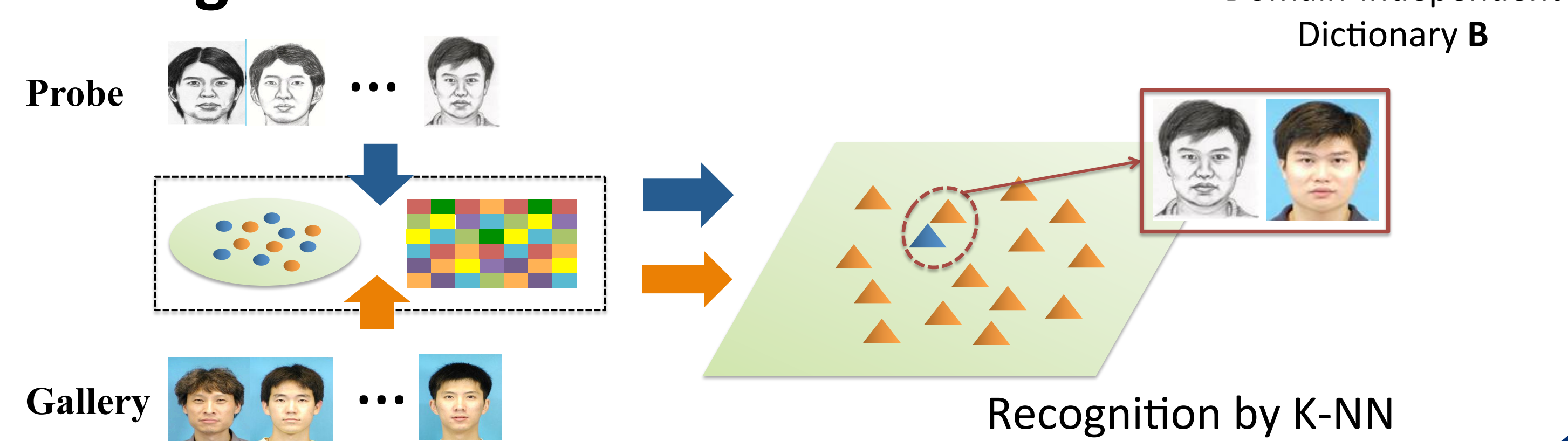
Goals

- ✓ Advance the technique of self-taught learning for observing a dictionary in the DiCA subspace

$$\min_{\mathbf{B}, \mathbf{A}_e} \|\mathbf{Y} - \mathbf{B}\mathbf{A}_e\|_F^2 + \lambda \|\mathbf{A}_e\|_1, \quad \text{s.t. } \|\mathbf{b}_i\|_2 \leq 1, \forall i,$$



Recognition



Experiments

Settings

- ✓ **Sketch-Photo:**
 - 200 images in external data (100 sketches & 100 photos)
 - 100 subjects/images in gallery
 - 100 subjects/images in probe
- ✓ **NIR-VIS:**
 - 3000 images in external data (1500 NIR & 1500 VIS)
 - 358 subjects/images in gallery
 - ~6200 images in probe

Recognition Performance

Methods	Recognition Rate (%)	Data Pairs
CCA	94.6	Y
BLM	94.2	Y
PLS	93.6	Y
Huang et al. [2]	97.2	Y
PCA + self-taught learning	97.4	N
Ours	99.4	N

Sketch-Photo (CUHK)

Methods	Recognition Rate (%)	Std (%)
PCA	7.16	0.52
HCA [1]	23.07	1.12
HCA + Sym [1]	23.70	1.89
PCA + self-taught learning	26.20	1.31
HCA + self-taught learning	29.63	1.89
Ours	32.58	1.47

NIR-VIS (CASIA 2.0)

Conclusions

- We presented a domain adaptive self-taught learning framework for heterogeneous face recognition.
- We proposed a DiCA algorithm, which is able to associate face image data across different domains.
- We do not require cross-domain data correspondence nor label information during domain adaptation (for external data).
- We advanced the strategy of self-taught learning for better representing cross-domain images and improving recognition.

Reference

- [1] S. Z. Li, D. Yi, Z. Lei, and S. Liao, "The CASIA NIR-VIS 2.0 Face Database", in IEEE CVPR Workshops, 2013
- [2] D.-A. Huang and Y.-C. F. Wang, "Coupled dictionary and feature space learning with applications to cross-domain image synthesis and recognition," in IEEE ICCV, 2013.