Searching for Alignment in Face Recognition

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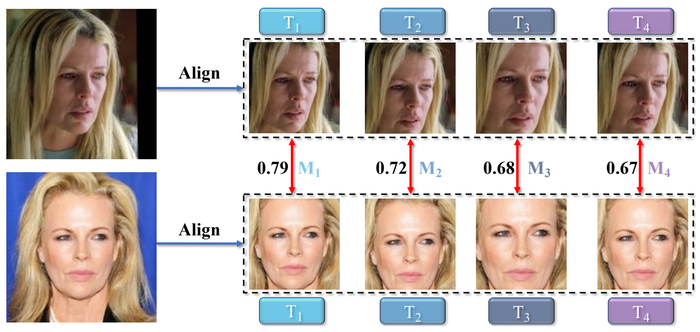
Introduction

Significant differences between matching scores are observed.

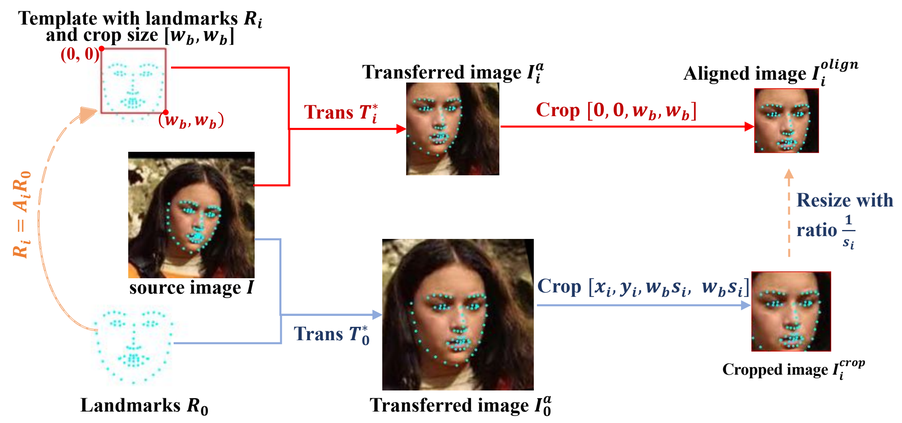


- **Goal: Search for the optimal template for face recognition.**

Face Alignment

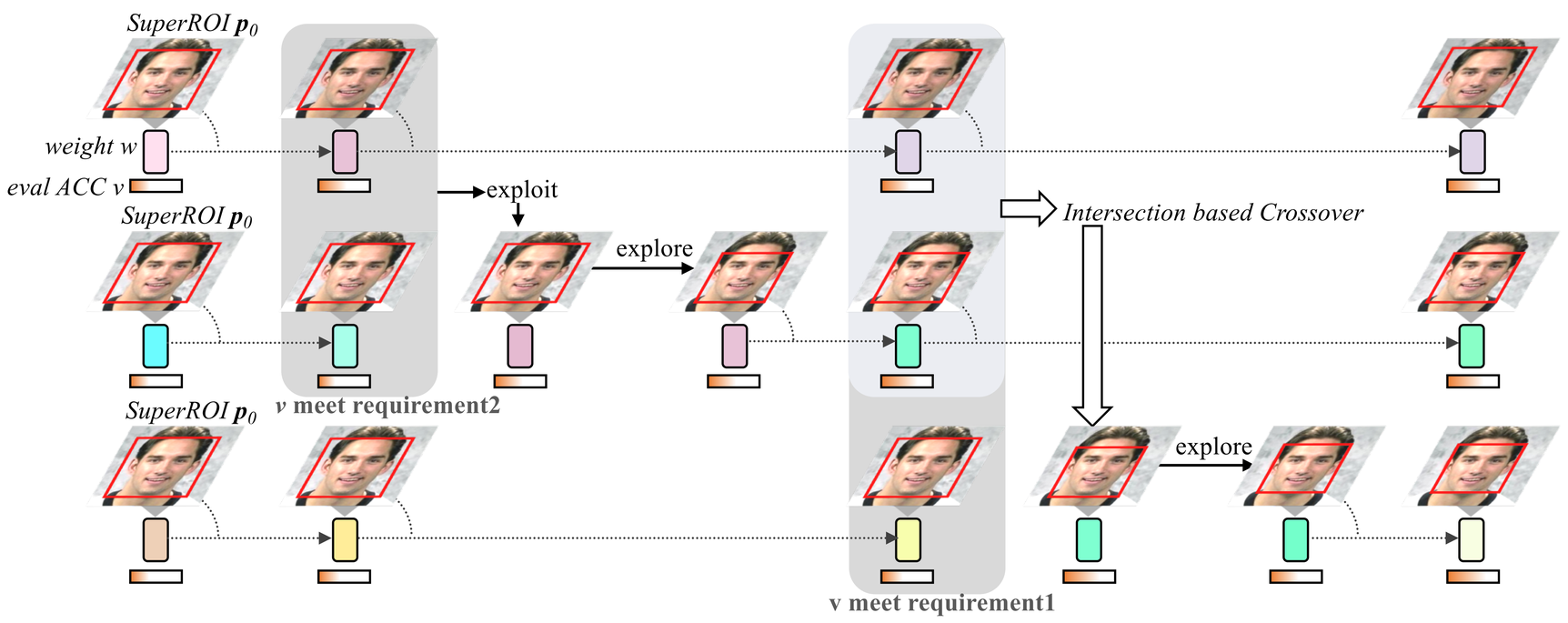
Re-formulate conventional alignment process (red path) with template i to blue path:

- Align face $\mathbf{I}$ with a base landmarks R_0 to $\mathbf{I}_0^a$.
- Crop the corresponding area based on transformation A_i.
- Resize the cropped image.

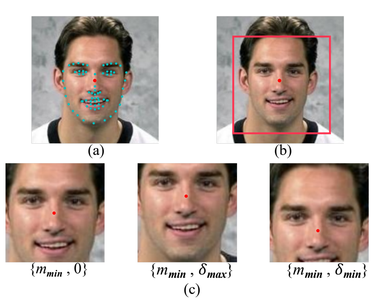


Let $m_i = w_b \cdot s_i$, $\delta_i = y_i / s_i$ and define alignment policy $\boldsymbol{p} = \{m, \delta\}$.
$\Longrightarrow$ **Goal now is to search for the optimal policy p*.**

Proposed Method



- **Search Space**



- **Search Strategy**

$$\boldsymbol{p}^* = \text{argmax}_{\boldsymbol{p} \in \mathcal{P}} \text{ACC}_{val}(f(w^* | \boldsymbol{p}))$$
$$s.t.\ w^* = \text{argmin}_w\ \mathcal{L}_{train}\ f(w | \boldsymbol{p})$$

Face Alignment Policy Search

Require: Current policy search space $\mathcal{P}$, *SuperROI* $\boldsymbol{p}_0 = \{m_{max}, 0\}$, population size of models N.

Initialize N models $f(w|\boldsymbol{p}_0)$
for each model $f(w|\boldsymbol{p}_0)$
  while not end of training
    $w \leftarrow \text{step}(w|\boldsymbol{p})$ ▷ train current model with policy $\boldsymbol{p}$
    $v \leftarrow ACC_{val}(f(w|\boldsymbol{p}))$ ▷ evaluation
    if ready(f, v) **then**
      check v's performance among all models
      if v meets *requirement1* **then**
        generate $w', \boldsymbol{p}'$ via *Intersection based Crossover*
        If $\boldsymbol{p}'$ doesn't exist currently **then**
          $w, \boldsymbol{p} \leftarrow w', \boldsymbol{p}'$
        else
          $w, \boldsymbol{p} \leftarrow explore(w', \boldsymbol{p}')$
      elif v meets *requirement2* **then**
        get $w', \boldsymbol{p}'$ through *exploit*
        $w, \boldsymbol{p} \leftarrow explore(w', \boldsymbol{p}')$
    update model populations with new $f(w|\boldsymbol{p})$
return $\boldsymbol{p}$ with highest v among training

Explore function

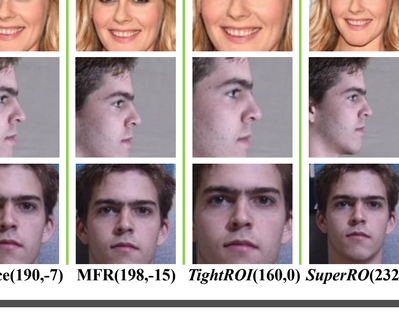
Require: current alignment policy $\boldsymbol{p} = \{m, \delta\}$, *SuperROI*, magnitude parameters $\boldsymbol{s} = \{s_m, s_\delta\}$

for *param* in $\boldsymbol{p}$
  if random(0, 1) <0.2 **then**
    sample *param* uniformly from search space
  else
    level = [0,1,2,3] with probability [0,1, 0.3, 0.3, 0.3]
    if random(0,1) <0.5 **then**
      $param = param - level \times \boldsymbol{s}_{param}$
    else
      $param = param + level \times \boldsymbol{s}_{param}$
    Clip *param* to stay within *SuperROI*

Other Terminologies

- **SuperROI**. An initialized Region of Interest (ROI) containing all internal features (eyes, nose and mouth) and external features (jaw-line, ears, part of the hair).
- **Intersection based Crossover.**

$\boldsymbol{p}' \leftarrow \text{argmax}_{\boldsymbol{p} \in \mathcal{P}} \textbf{iou}(A(\boldsymbol{p}), A_{1,2})$
$i^* = \text{argmax}_{i \in \{1,2\}}\ \textbf{iou}(A(\boldsymbol{p}'), A_i)$
$w' \leftarrow w_{i^*}$



FAPS Benchmark

Benchmark	CASIA	MS-Celeb-1M-v1c
Searching Set	CASIA	*Reduced MS-Celeb-1M-v1c*
Training Set	CASIA	MS-Celeb-1M-v1c
Validation Set	CCW	CCW
Test Set	LFW AgeDB-30 CPLFW CALFW MultiPIE	LFW AgeDB-30 CPLFW CALFW MultiPIE IJB-A

Visulization

Expriments

- **Verification performance at different alignment policies.**

Training Set	Method	LFW	AgeDB-30	CALFW	CPLFW
CASIA	ReST	99.03	-	-	-
	ArcFace (190,-7)	99.43	94.42	90.92	85.15
	MFR (198,-15)	99.43	94.47	91.15	84.75
	TigthROI (160,0)	99.17	94.23	91.15	85.07
	SuperROI (232,0)	99.43	94.47	90.48	83.97
	baseline (184,4)	99.45	95.03	91.07	**85.88**
	FAPS$_C$ (192,4)	**99.48**	**95.25**	**92.07**	85.43
MS1M	GridFace	99.70	-	-	-
	ArcFace (190,-7)	99.72	98.02	95.23	87.98
	MFR (198,-15)	99.77	97.78	95.47	87.28
	TigthROI (160,0)	99.73	97.95	95.47	88.13
	SuperROI (232,0)	99.77	**98.25**	95.47	88.05
	FAPS$_C$ (192,4)	99.78	98.10	**95.78**	88.12
	FAPS$_M$ (200,4)	**99.82**	98.08	95.65	**88.95**

- **Rank-1 recognition rates for different poses on MultiPIE.**

Training Set	Method	±90°	±75°	±60°
CASIA	ArcFace (190,-7)	89.5	97.0	99.3
	MFR (198,-15)	91.2	97.7	**99.7**
	TigthROI (160,0)	90.8	97.6	**99.7**
	SuperROI (232,0)	90.7	97.1	99.3
	baseline (184,4)	90.4	97.5	99.6
	FAPS$_C$ (192,4)	**91.7**	**98.3**	**99.7**
MS1M	GridFace	75.4	94.7	99.2
	ArcFace (190,-7)	70.4	98.8	**100.0**
	MFR (198,-15)	71.9	98.9	**100.0**
	TigthROI (160,0)	68.7	98.4	**100.0**
	SuperROI (232,0)	70.7	98.0	99.9
	FAPS$_C$ (192,4)	74.6	**99.0**	**100.0**
	FAPS$_M$ (200,4)	**76.6**	98.8	**100.0**

- **Results on IJB-A with searched policies FAPS$_C$ and FAPS$_M$.**

Method ↓ / Metric →	Verification @FAR = 0.01	Verification @FAR = 0.001	Identification @Rank-1	Identification @Rank-5
GridFace	92.1 ± 0.8	83.9 ± 1.4	92.9 ± 1.0	96.2 ± 0.5
ArcFace (190,-7)	94.5 ± 0.6	87.1 ± 1.4	93.1 ± 0.8	95.5 ± 0.4
MFR (198,-15)	94.7 ± 0.6	88.6 ± 1.0	93.7 ± 0.7	96.0 ± 0.6
TigthROI (160,0)	93.6 ± 0.8	82.1 ± 2.8	92.4 ± 0.7	95.0 ± 0.6
SuperROI (232,0)	95.1 ± 0.7	87.4 ± 1.9	93.7 ± 0.8	95.8 ± 0.5
FAPS$_C$ (192,4)	94.8 ± 0.6	89.7 ± 1.4	93.8 ± 0.8	95.9 ± 0.5
FAPS$_M$ (200,4)	**95.1 ± 0.6**	**91.2 ± 0.6**	**94.1 ± 0.7**	**96.4 ± 0.4**

- **Verification of searched policies' generalization**

Alignment Policy	LFW	AgeDB-30	CALFW	CPLFW
ArcFace (190,-7)	99.10	93.18	89.05	78.43
MFR (198,-15)	99.12	93.30	89.45	79.22
TigthROI (160,0)	99.02	93.73	88.78	79.30
SuperROI (232,0)	99.18	93.38	88.80	79.22
FAPS$_C$ (192,4)	**99.20**	**94.02**	**89.47**	**80.28**