Recursive Cross-Domain Facial Composite and Generation from Limited Facial Parts
Yang Song, Zhifei Zhang and Hairong Qi

Abstract
• A facial composite is a graphical representation of eyewitness memory of a face.
• Existing work either synthesize faces by stitching patches from multiple domains which deteriorates the consistency and photo-reality or cannot handle large missing area cases.
• We aim to generate face/sketch with limited patches from multiple domain in a recursive generation fashion.

Approach
Training Stage: learn face2sketch mapping $f$ and sketch2face mapping $F$ in a bidirectional fashion.

$$x^f_0 = f(x_2), \quad x^s_0 = F(x_2) = F(f(x_2)),$$

$$x^s_1 = f(x_0), \quad x^f_1 = F(x_0) = F(f(x_0)).$$

Objective Function:
$$L_{adv} + \lambda L_{rec},$$

$$L_{adv} = \mathbb{E}_{x\sim D}[\log D(x)] - \mathbb{E}_{x\sim Q}[\log D(x_2)],$$

$$L_{rec} = \sum_{i=0}^{R} ||x_i - x_i^f|| + ||x_i - x_i^s||.$$  \hspace{1cm} \text{(1)}$$

Testing Stage: given a patch $P_j$, the mapping $f$ and $F$ trained on whole face/sketch will guide the patch converge to a whole sketch/face. In order to keep the identity, the given patch area is kept as constant at each iteration.

$$x_i^f \leftarrow x_i^f \circ (1 - M) + M x_i^f,$$

$$x_i^s \leftarrow f(x_i^f),$$

$$x_i^s \leftarrow x_i^s - \alpha D(x_i^s, x_i^f),$$

$$x_i^{s+1} \leftarrow F(x_i^s).$$

Results---Single Patch Completion
Comparison with different potential methods:

Results---Multiple Patches Composition
The training dataset is collected from CUHK, CUFSP, FERET and IIIT-D.

The examples shown here demonstrate with different patches from different identity or different domain will generate very consistency and photo realistic face/sketch images.

It is hard to preserve the identity when the missing area is more than 70%. More results can be found in the paper.