Conditional CycleGAN for Attribute Guided Face Image Generation

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> We are interested in realistic face image generation where facial attributes can be fully controlled in the automatic generation process.

> With the proposed attribute-guided approach to face image generation, where the input consists of a low resolution face image and a set of face attributes during inference, we demonstrate the efficacy of our approach on identity-preserving face image super-resolution.

Cycle GAN

$$L(G_{X \to Y}, G_{Y \to X}, D_X, D_Y) = L(G_{X \to Y}, D_Y) + L(G_{Y \to X}, D_X) + \lambda L_c(G_{X \to Y}, G_{Y \to X})$$
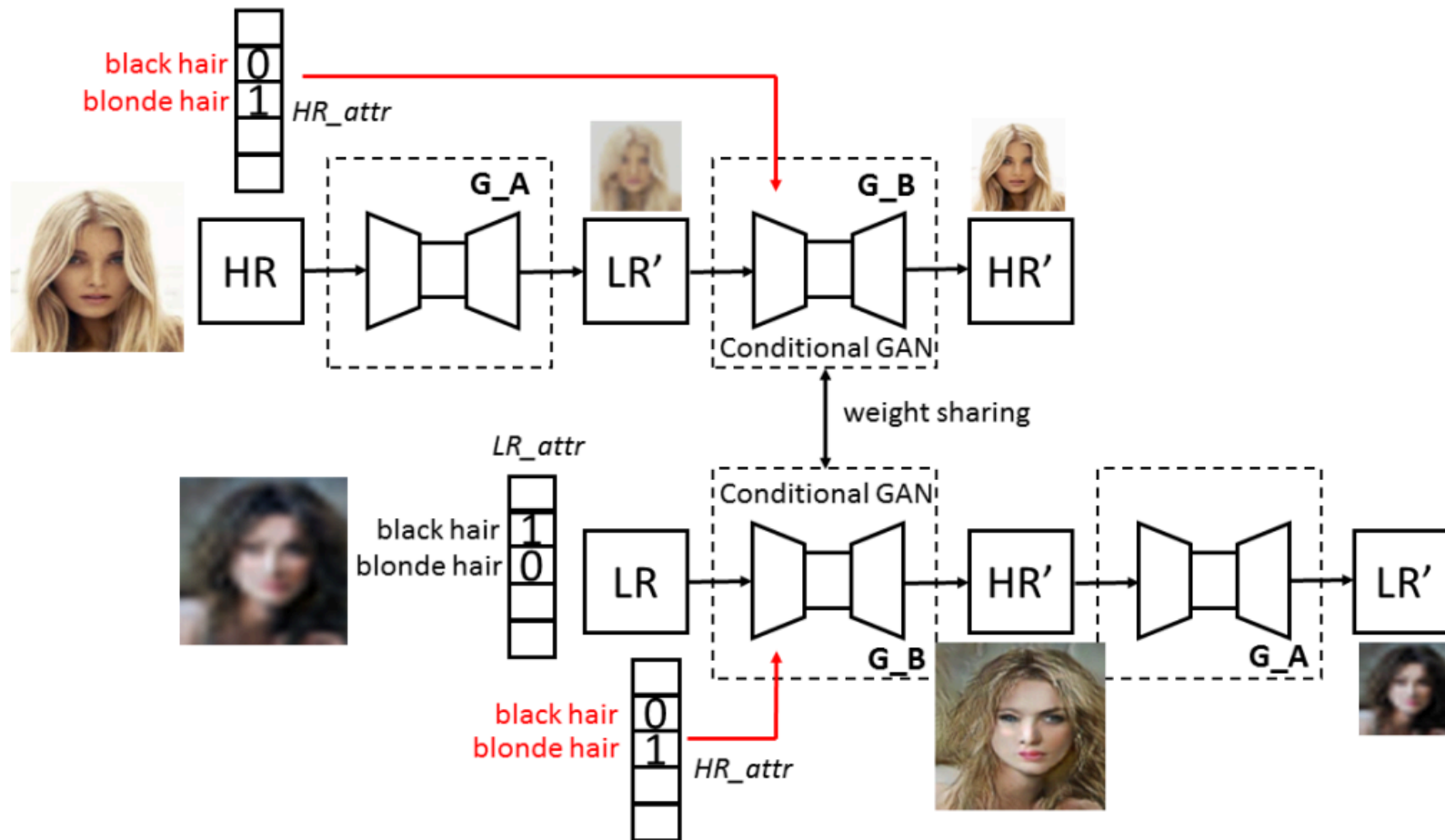
Attribute Guided Conditional CycleGAN

> To include conditional constrain into the cycleGAN network, the adversarial loss is modified to include the conditional feature vector as part of the input of the generator and discriminator as:

$$L(G_{(X,Z) \to Y}, D_Y) = \min_{\Theta_g} \max_{\Theta_d} E_{y,z}[\log D_Y(y, z)] + E_{x,z}[\log(1 - D_Y(G_{(X,Z) \to Y}(x, z), z))]$$

In our implementation, the conditional feature vector is first resized(using replicate) to match the image size of the input

image which is downsampled into a low resolution image, with the intensity value of each feature map equal to the value of each column of the feature vector. Hence, for 18-dimensional feature vector, we have 18 homogeneous feature maps after resizing. The resized feature vector is then concatenated with the *conv1* layer of the generator network to propagate the inference of feature vector to the generated images. In the discriminator network, the resized feature vector is also concatenated with the *conv1* layer.
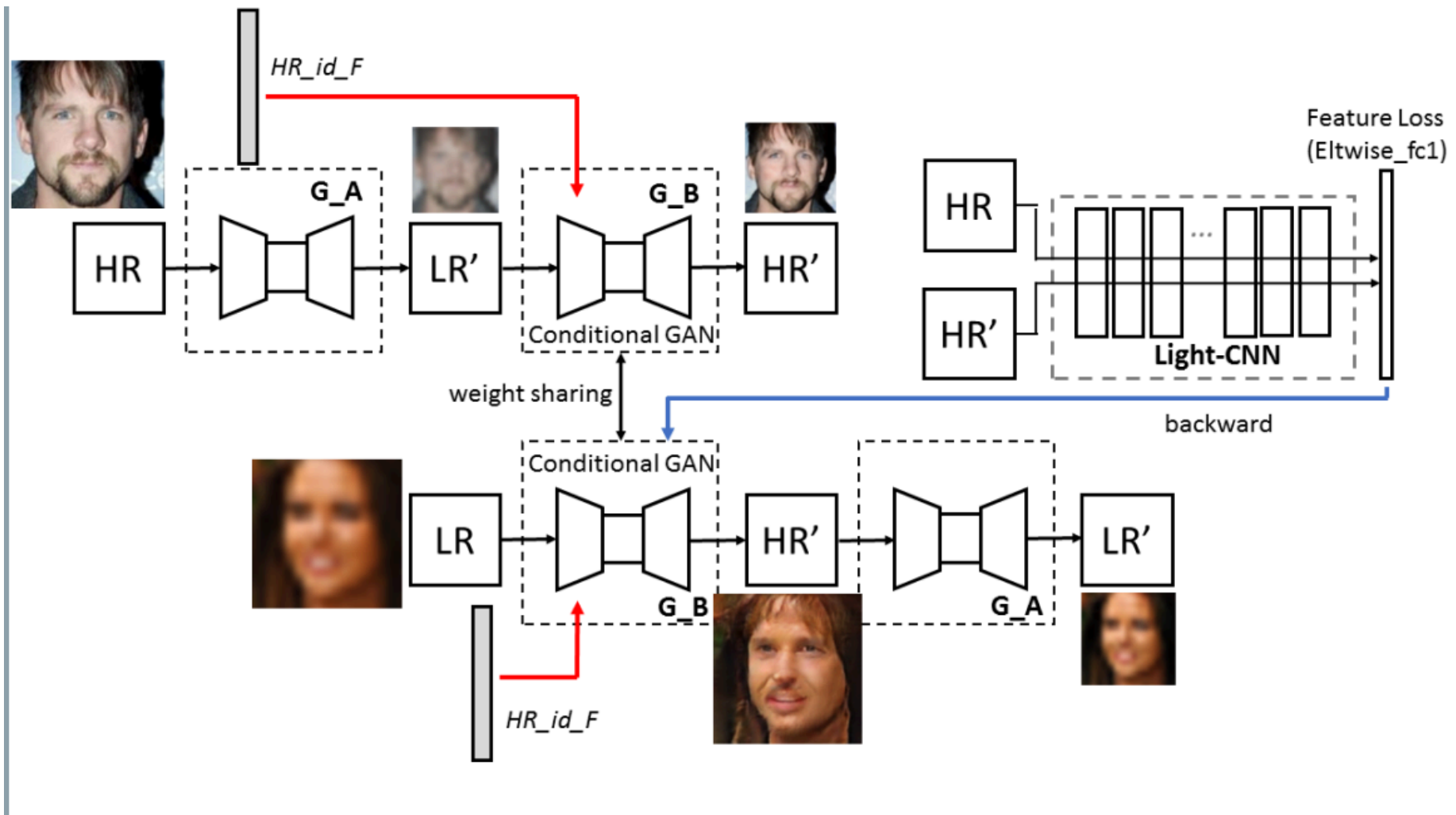
Conditional CycleGAN for attribute guided face super-resolution

We embed an additional attribute vector, and utilize conditional GAN to train a generator G_B to generate high resolution face

image given the low resolution face image and the attribute vector as inputs.

Conditional CycleGAN for identity preserving face super-resolution

We include additional face verification loss into the training process.