Image Restoration

POSTECH CG LAB
Wonjong Jang

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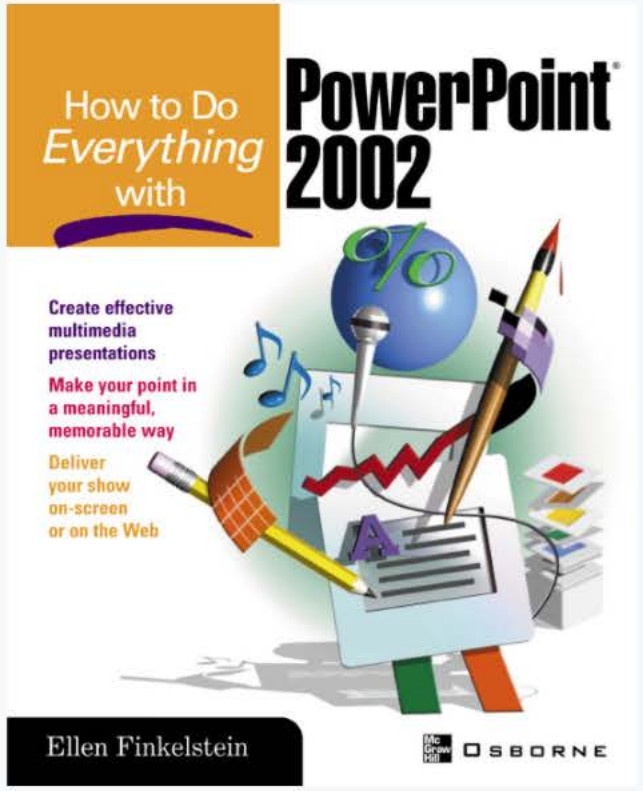
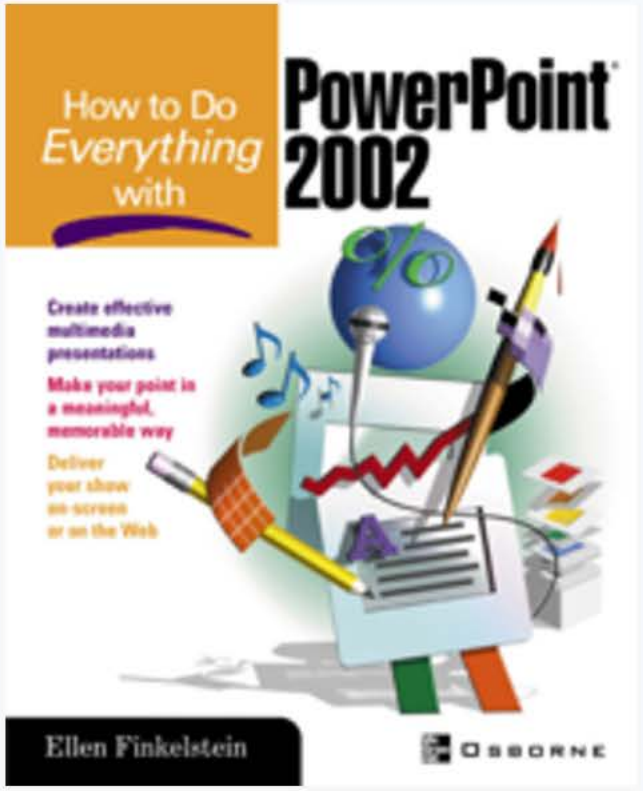
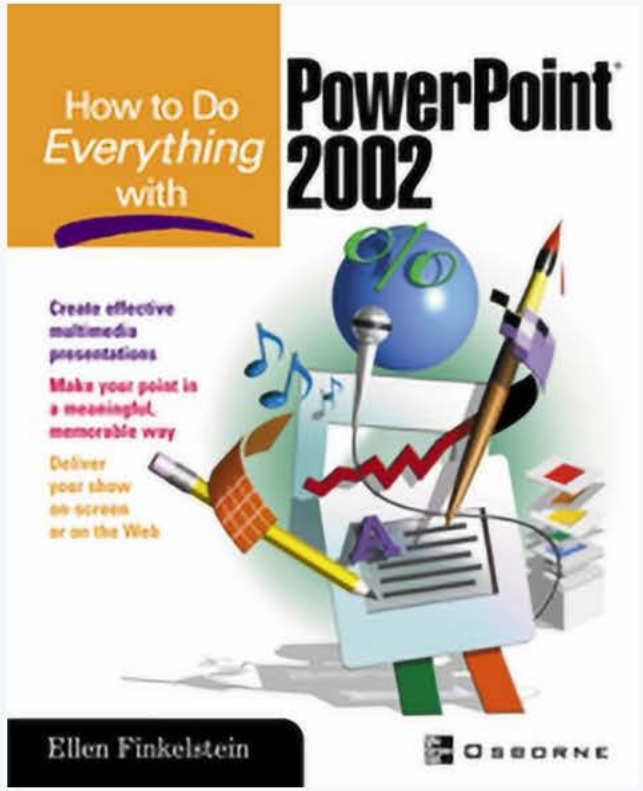
Image super-resolution using CNNs

SRCNN

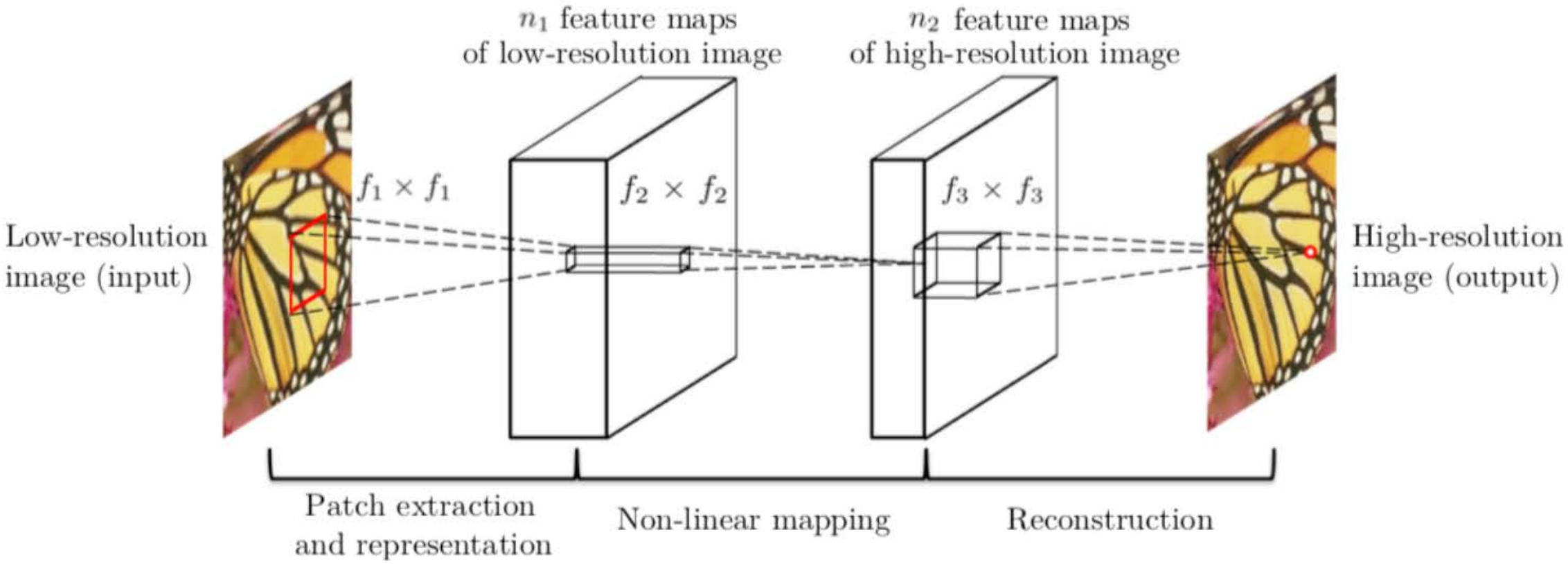
Objective

- Super-resolution
  - Conversion low-resolution image to high-resolution image with less information loss.
  - Should be better than bicubic interpolation

Original	BICUBIC x3	SRCNN x3 (28.58 dB)
		

Model Architecture

- Very simple structure
  - 9x9 conv layer -> ReLU -> 5x5 conv layer -> ReLU -> 5x5 conv layer -> output



Loss function

- Simple MSE

$$l_{MSE}^{SR} = \frac{1}{r^2WH}\sum_{x=1}^{rW}\sum_{y=1}^{rH}(I_{x,y}^{HR} - G_{\theta_G}(I^{LR})_{x,y})^2$$

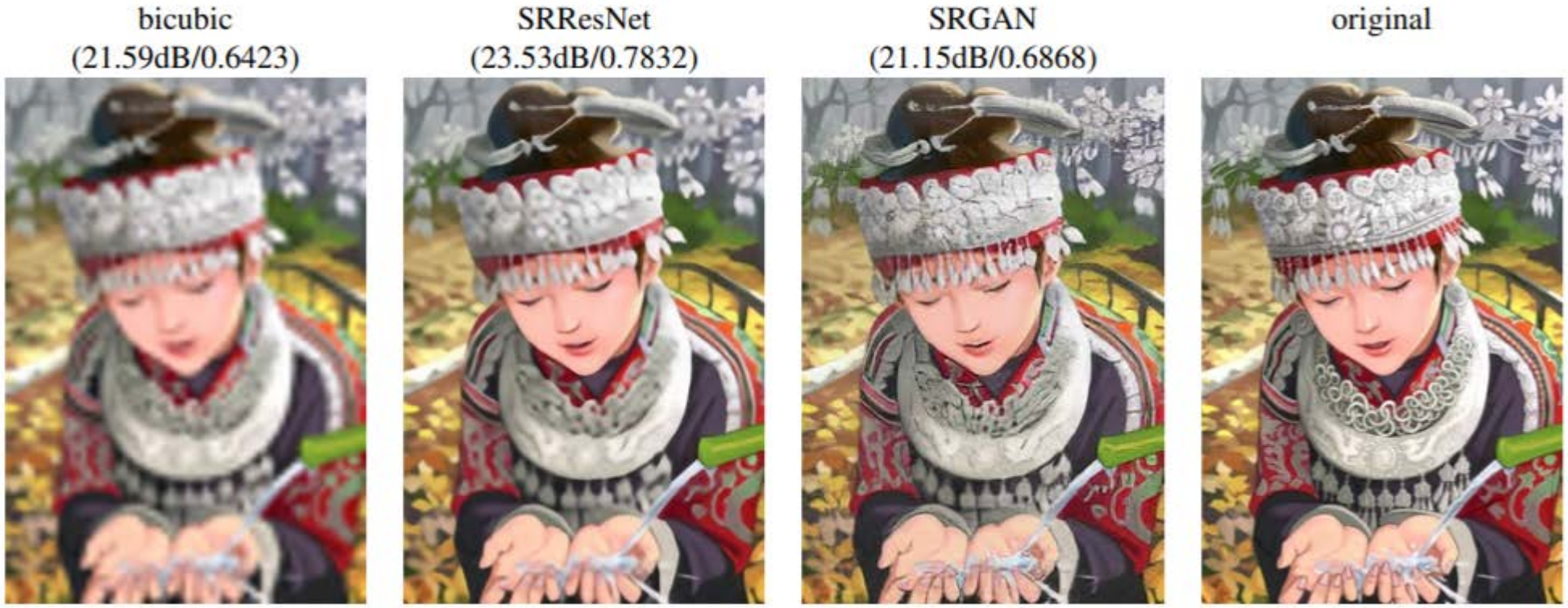
- Perceptual loss (Assignment)
  - Using VGG16 or VGG19, define perceptual loss and use it with the MSE loss.
  - Check the visual quality

Image super-resolution using GANs

SRGAN

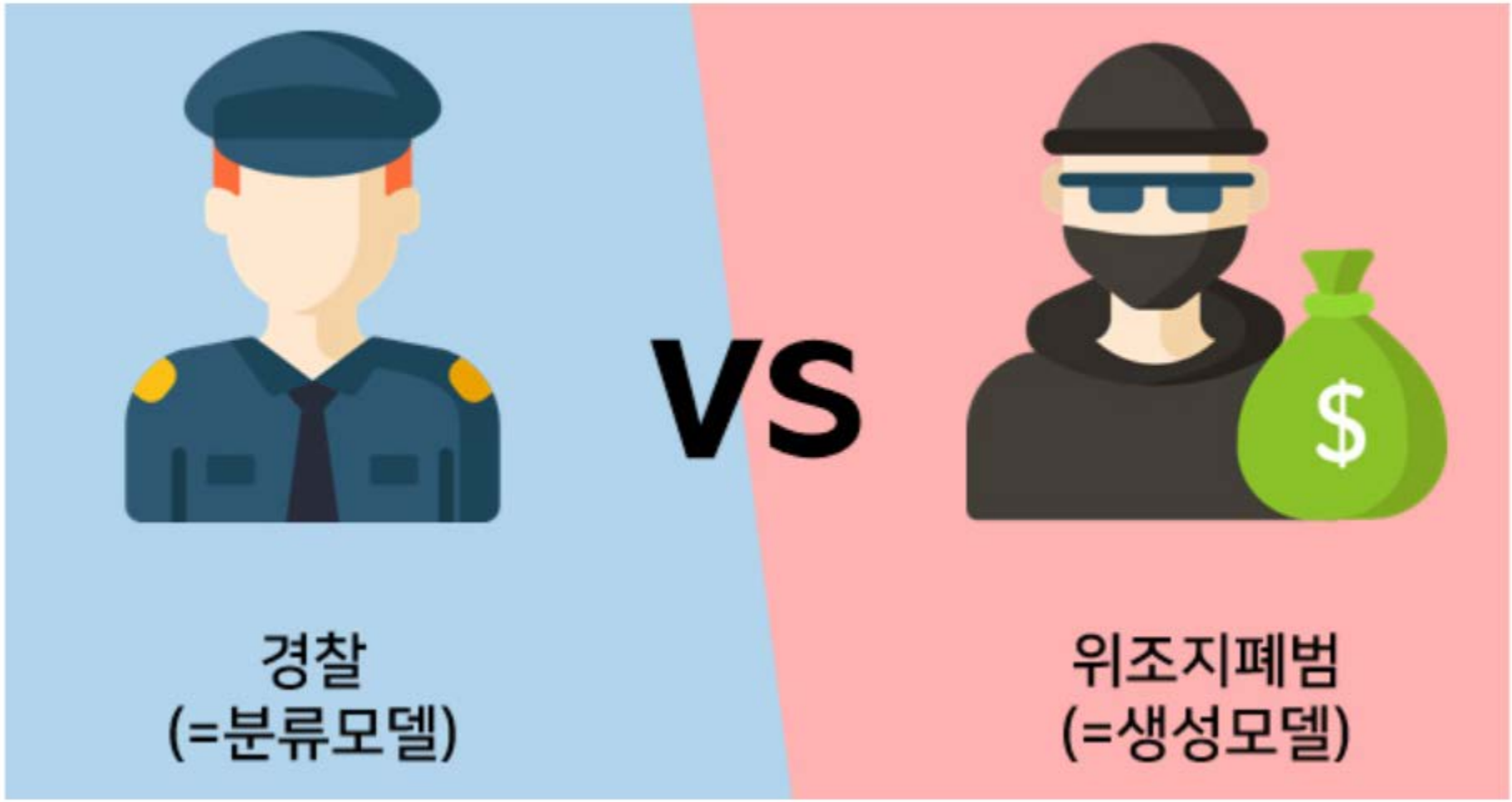
Objective

- Better super-resolution using GAN
  - Discriminator helps generator to generate photo-realistic images
  - However, GAN training is very unstable and hard to train



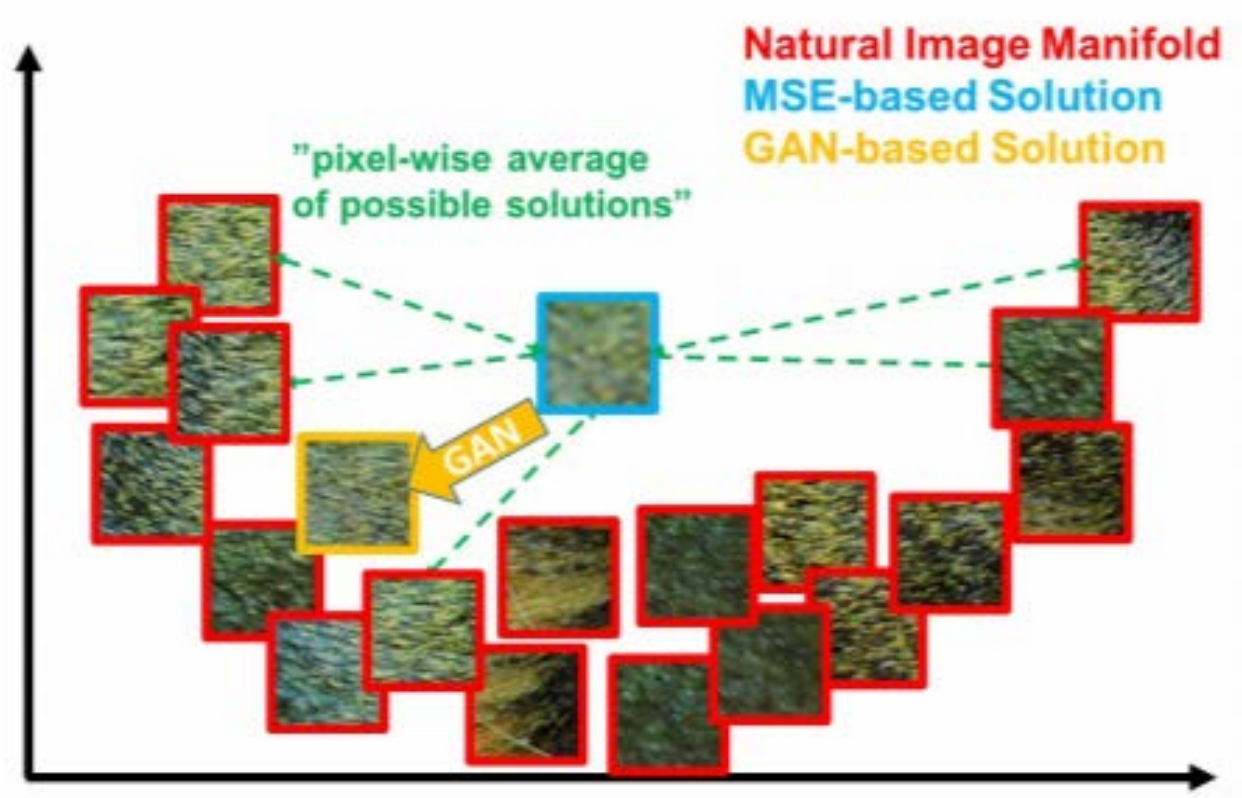
What is GAN?

- Learn how to generate photo-realistic images by adversarial training



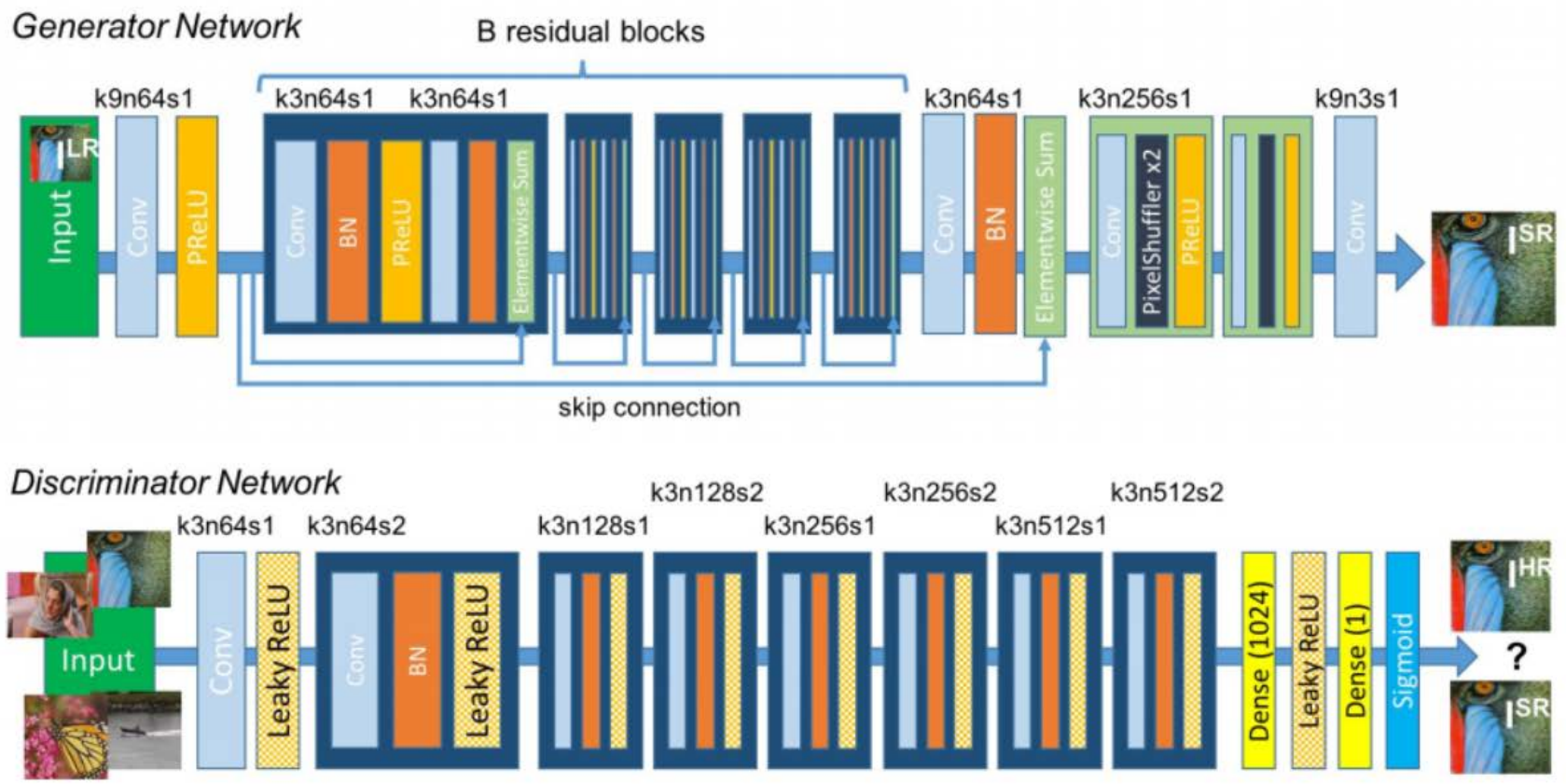
Why GAN?

- Help our model to fit into the training dataset



Model Architecture

- More complex architecture
  - PatchGAN
  - Residual block
  - Pixel shuffler layer



Loss function

- Data loss (simple MSE)

$$l_{MSE}^{SR} = \frac{1}{r^2WH}\sum_{x=1}^{rW}\sum_{y=1}^{rH}(I_{x,y}^{HR} - G_{\theta_G}(I^{LR})_{x,y})^2$$

- VGG loss (perceptual loss)

$$l_{VGG/i.j}^{SR} = \frac{1}{W_{i,j}H_{i,j}}\sum_{x=1}^{W_{i,j}}\sum_{y=1}^{H_{i,j}}(\phi_{i,j}(I^{HR})_{x,y} - \phi_{i,j}(G_{\theta_G}(I^{LR}))_{x,y})^2$$

- GAN loss
  - Discriminator

$$\max_{\theta_D} \mathbb{E}_{I^{HR}\sim p_{\text{train}}(I^{HR})}[\log D_{\theta_D}(I^{HR})] + \mathbb{E}_{I^{LR}\sim p_G(I^{LR})}[\log(1 - D_{\theta_D}(G_{\theta_G}(I^{LR}))]$$

  - Generator

$$l_{Gen}^{SR} = \sum_{n=1}^{N} -\log D_{\theta_D}(G_{\theta_G}(I^{LR}))$$