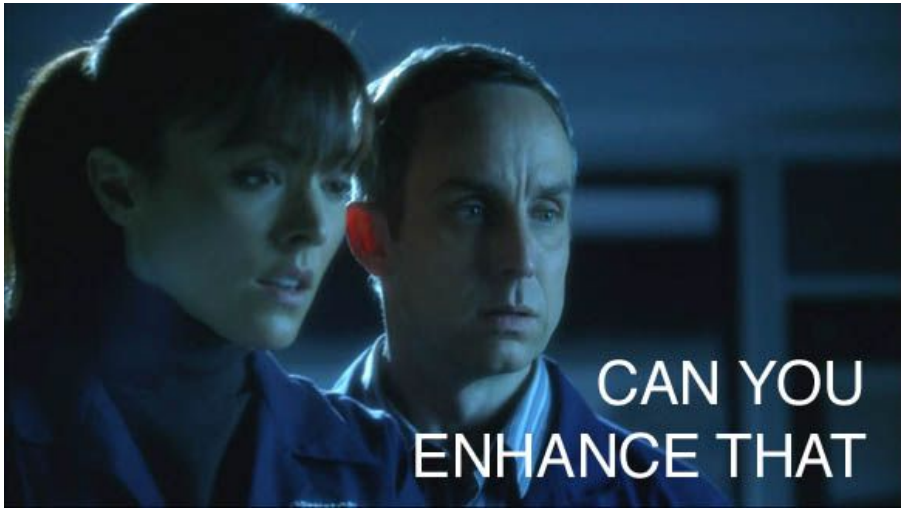
First Thesis Presentation Research Results

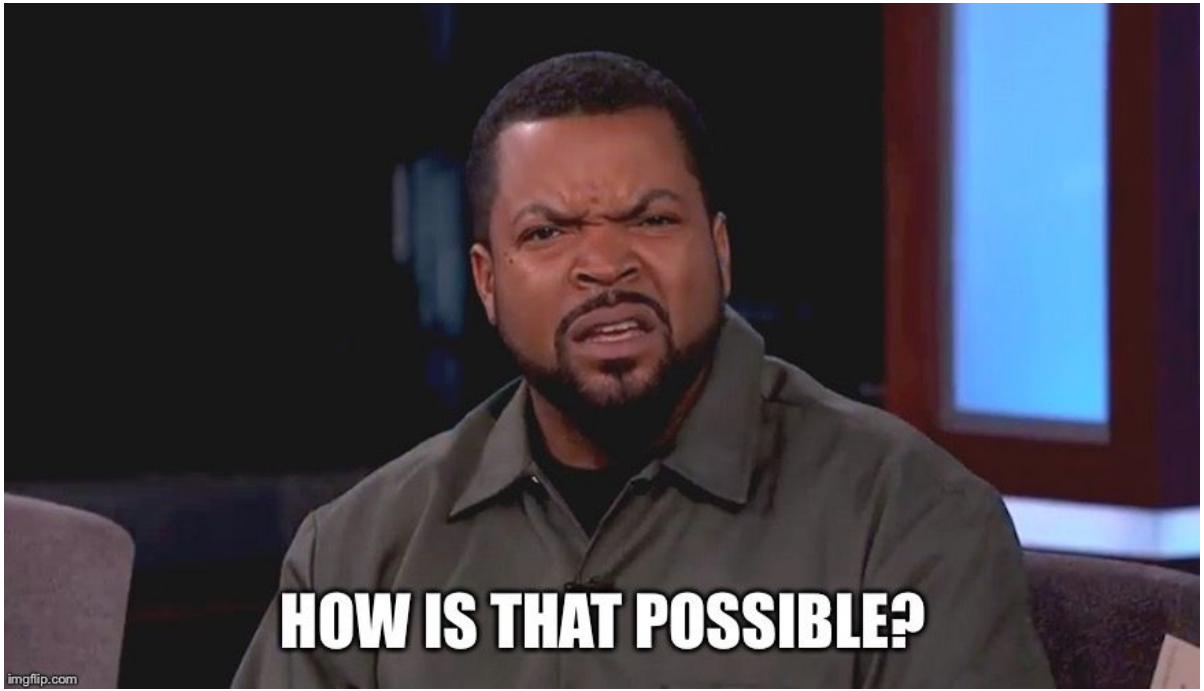
Single-Image Super Resolution

Iheb Chhibi

Why This Topic?

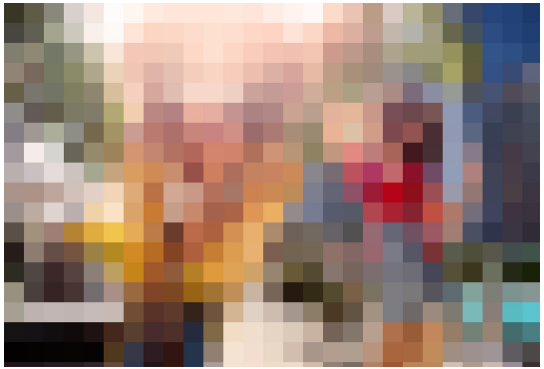


Why This Topic?



What Is SISR?

What Causes LR Images?

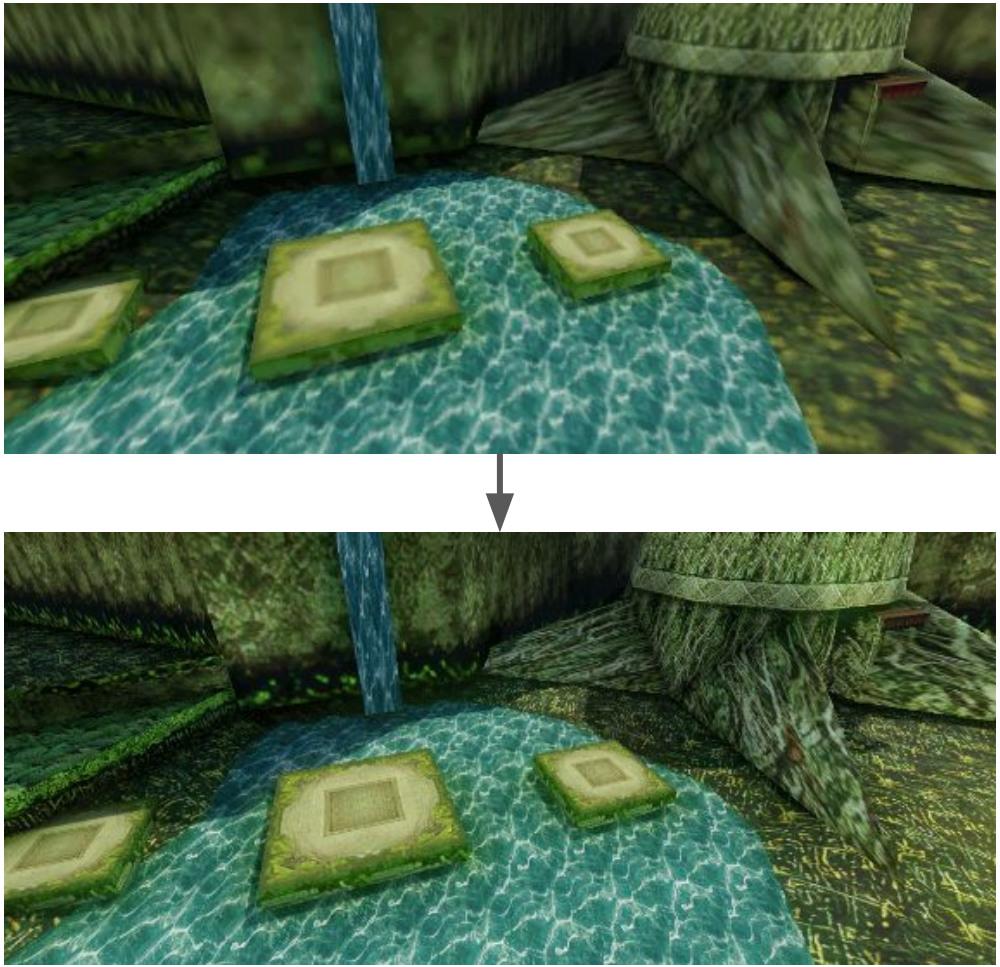


Hardware Limitations

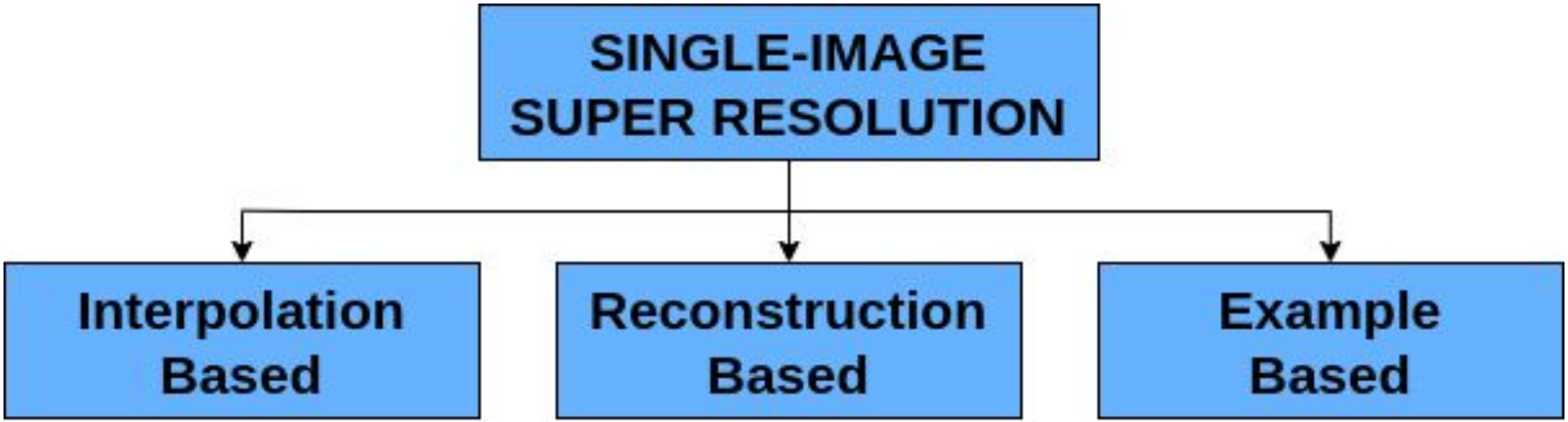
Noises

High Velocity

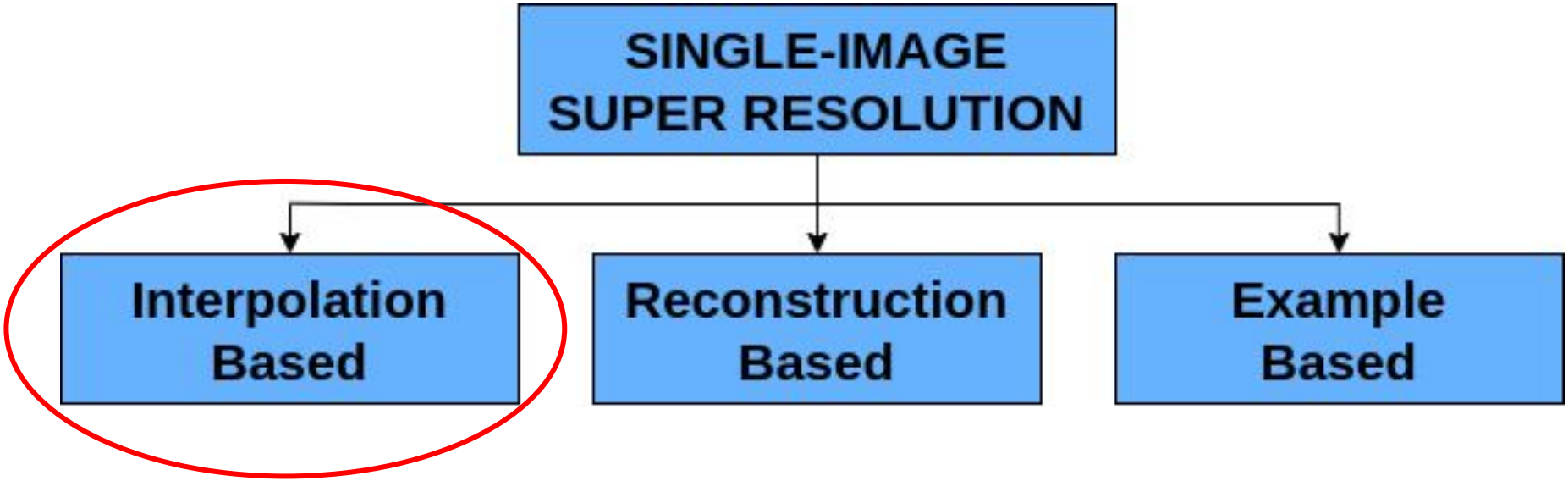
Other Use Cases?



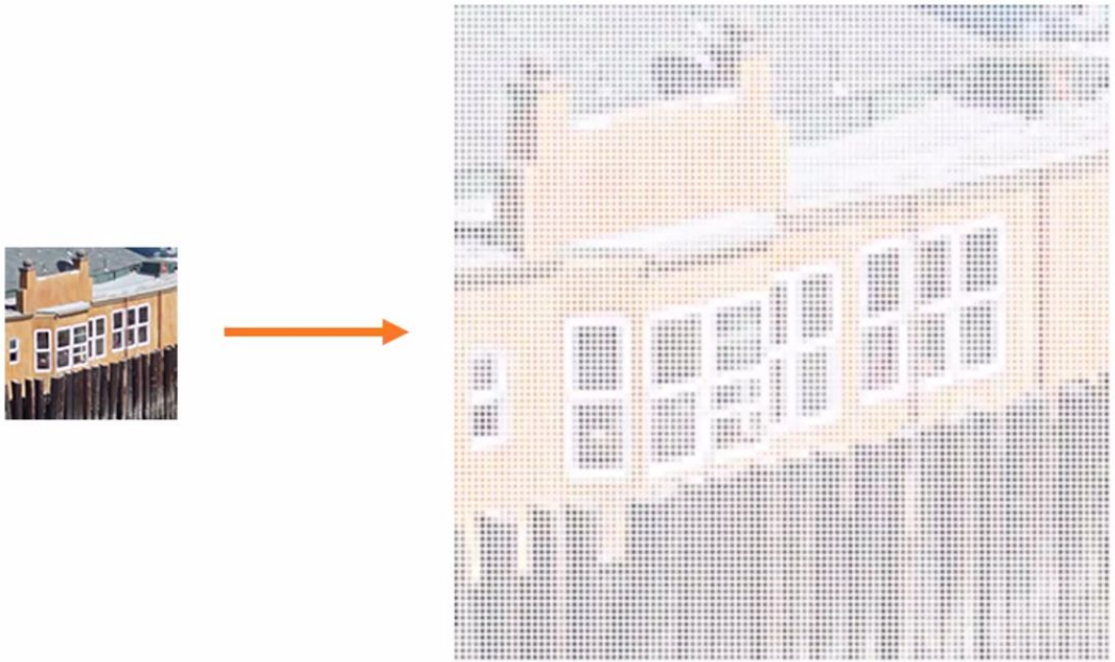
SISR Categories



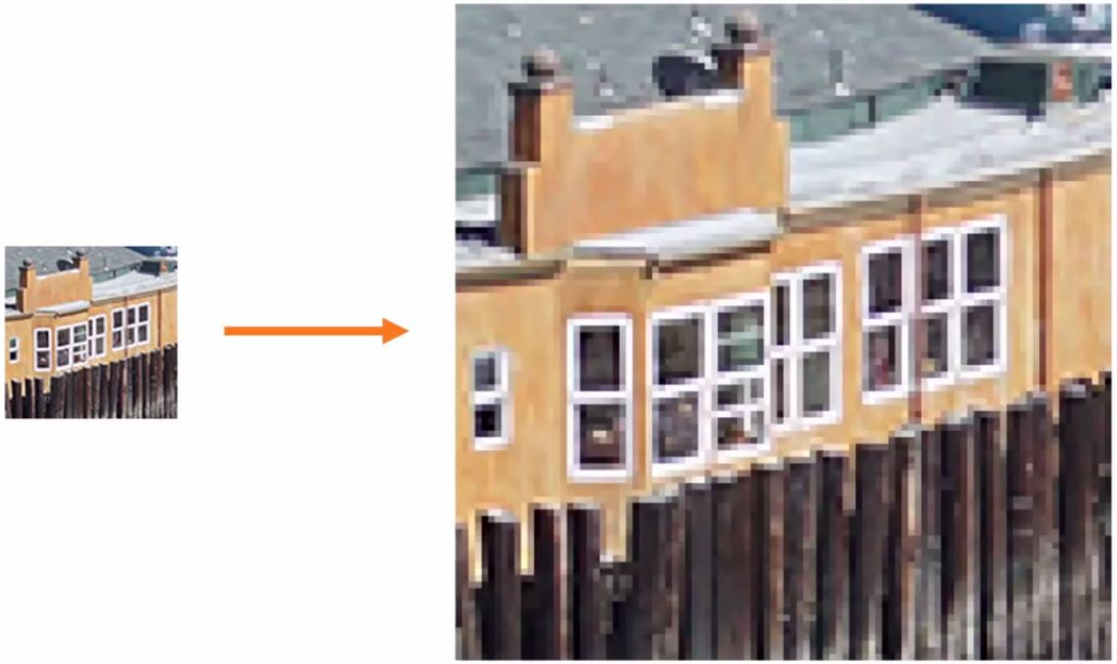
SISR Categories



Interpolation Based SISR



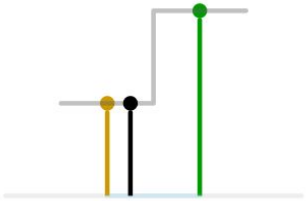
Interpolation Based SISR



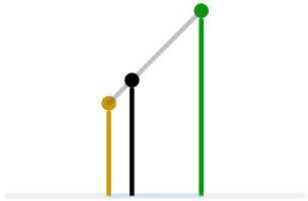
Nearest-neighbor interpolation

Bilinear interpolation

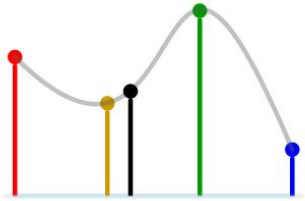
Bicubic interpolation



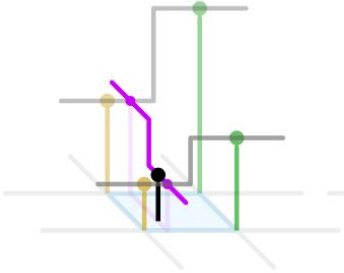
1D nearest-neighbour



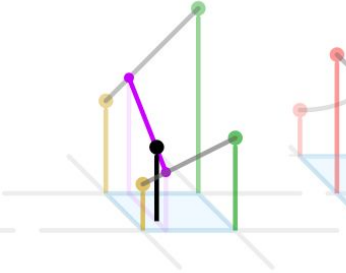
Linear



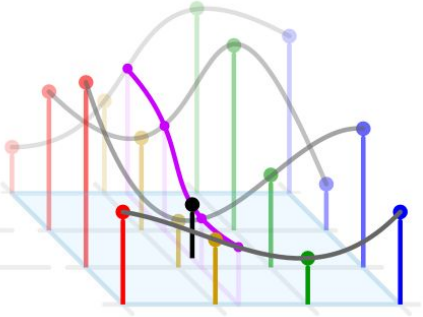
Cubic



2D nearest-neighbour

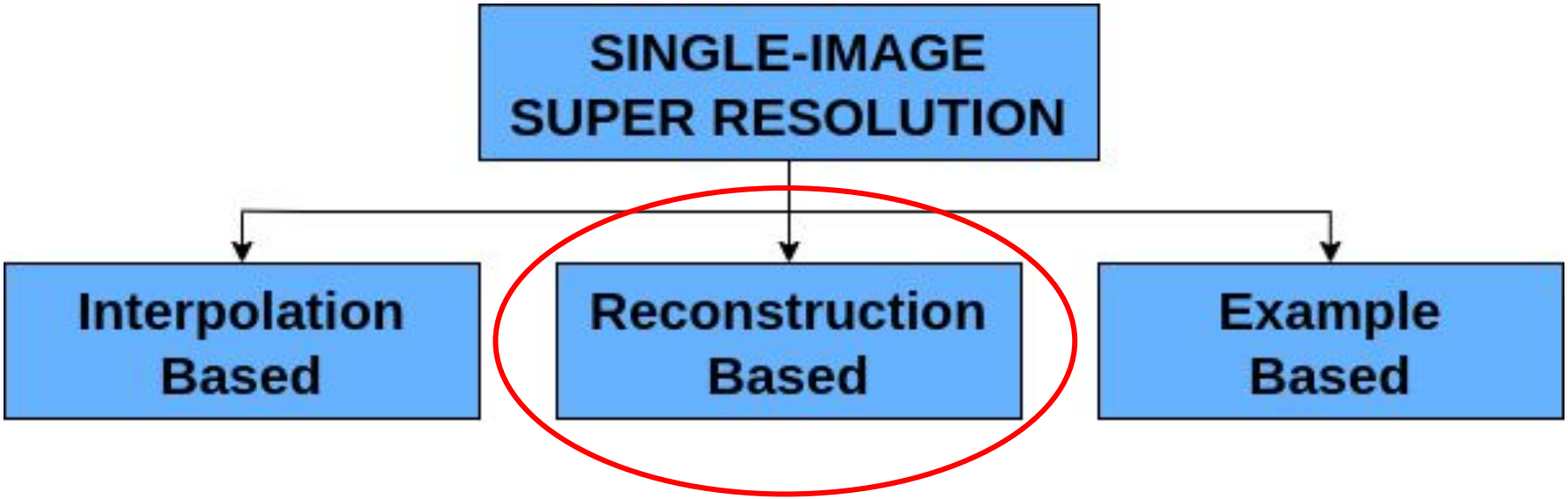


Bilinear

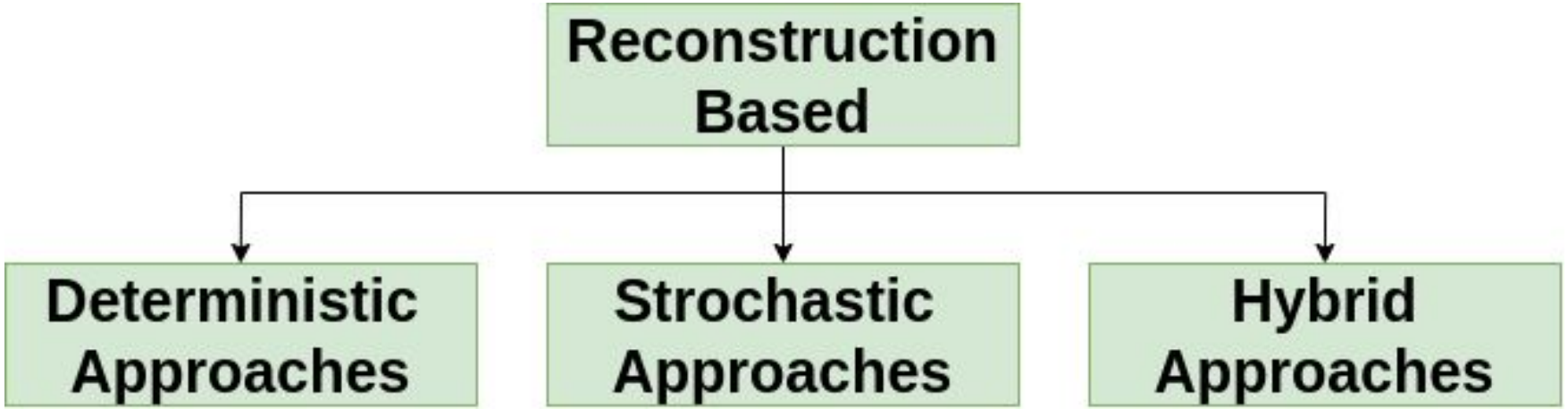


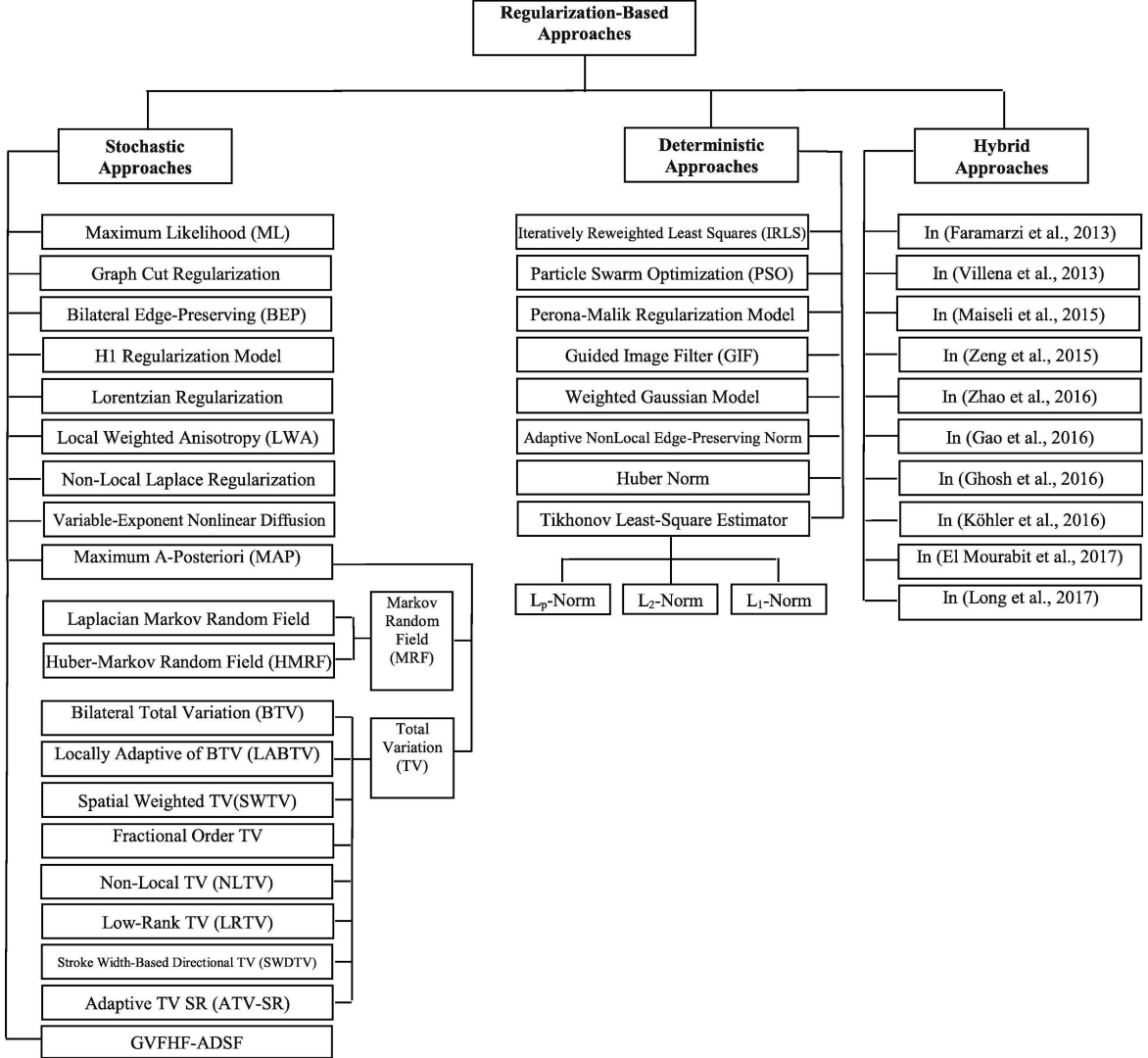
Bicubic

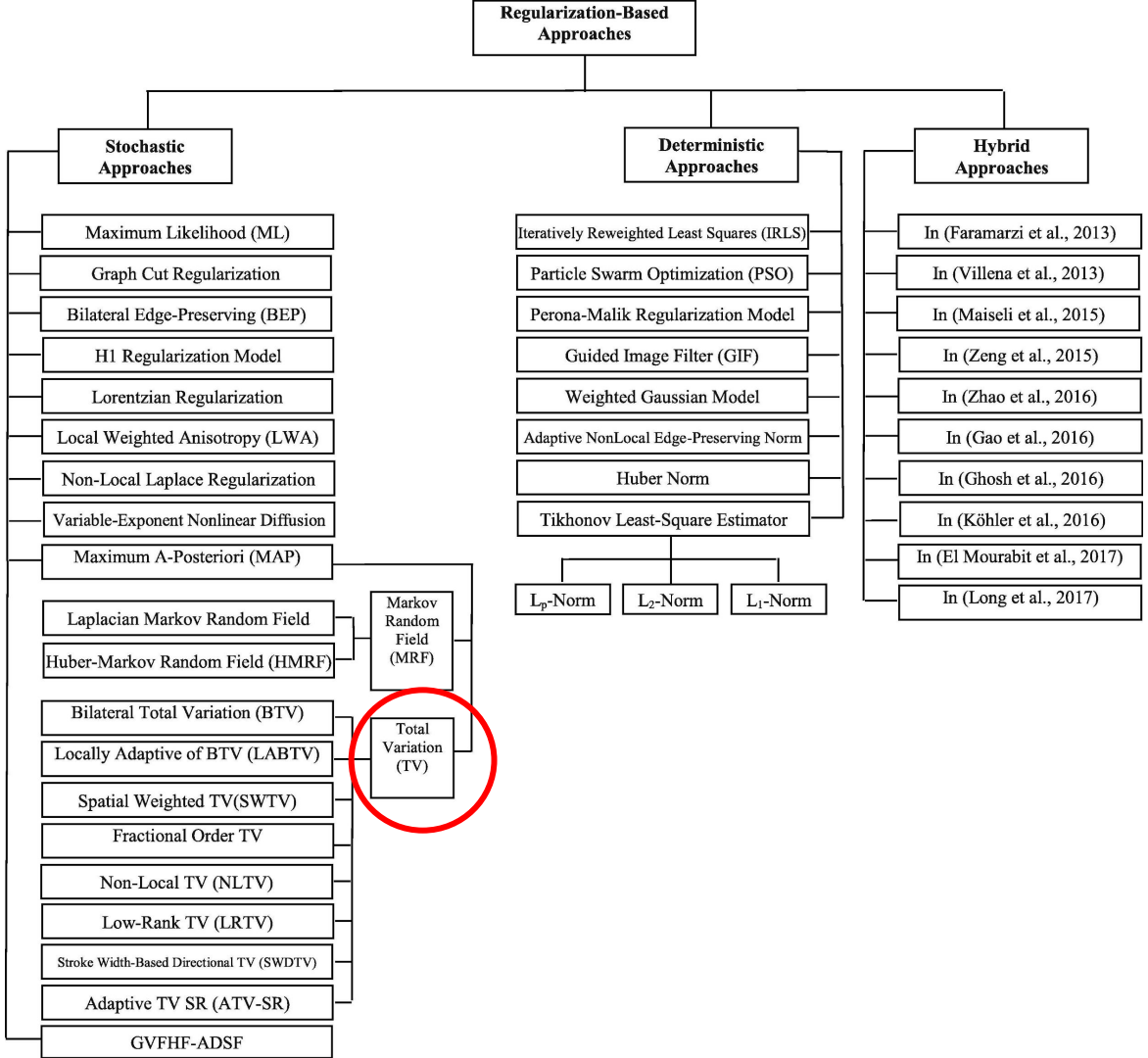
SISR Categories



Reconstruction Based SISR




Regularization-Based Approaches
Stochastic Approaches
Deterministic Approaches
Hybrid Approaches
Maximum Likelihood (ML)
Graph Cut Regularization
Bilateral Edge-Preserving (BEP)
H1 Regularization Model
Lorentzian Regularization
Local Weighted Anisotropy (LWA)
Non-Local Laplace Regularization
Variable-Exponent Nonlinear Diffusion
Maximum A-Posteriori (MAP)
Laplacian Markov Random Field
Huber-Markov Random Field (HMRF)
Markov Random Field (MRF)
Bilateral Total Variation (BTV)
Locally Adaptive of BTV (LABTV)
Spatial Weighted TV(SWTV)
Fractional Order TV
Non-Local TV (NLTV)
Low-Rank TV (LRTV)
Stroke Width-Based Directional TV (SWDTV)
Adaptive TV SR (ATV-SR)
Total Variation (TV)
GVFHF-ADSF
Iteratively Reweighted Least Squares (IRLS)
Particle Swarm Optimization (PSO)
Perona-Malik Regularization Model
Guided Image Filter (GIF)
Weighted Gaussian Model
Adaptive NonLocal Edge-Preserving Norm
Huber Norm
Tikhonov Least-Square Estimator
Lp-Norm
L2-Norm
L1-Norm
In (Faramarzi et al., 2013)
In (Villena et al., 2013)
In (Maiseli et al., 2015)
In (Zeng et al., 2015)
In (Zhao et al., 2016)
In (Gao et al., 2016)
In (Ghosh et al., 2016)
In (Köhler et al., 2016)
In (El Mourabit et al., 2017)
In (Long et al., 2017)


Regularization-Based Approaches
Stochastic Approaches
Deterministic Approaches
Hybrid Approaches
Maximum Likelihood (ML)
Graph Cut Regularization
Bilateral Edge-Preserving (BEP)
H1 Regularization Model
Lorentzian Regularization
Local Weighted Anisotropy (LWA)
Non-Local Laplace Regularization
Variable-Exponent Nonlinear Diffusion
Maximum A-Posteriori (MAP)
Laplacian Markov Random Field
Huber-Markov Random Field (HMRF)
Markov Random Field (MRF)
Bilateral Total Variation (BTV)
Locally Adaptive of BTV (LABTV)
Spatial Weighted TV(SWTV)
Fractional Order TV
Non-Local TV (NLTV)
Low-Rank TV (LRTV)
Stroke Width-Based Directional TV (SWDTV)
Adaptive TV SR (ATV-SR)
Total Variation (TV)
GVFHF-ADSF
Iteratively Reweighted Least Squares (IRLS)
Particle Swarm Optimization (PSO)
Perona-Malik Regularization Model
Guided Image Filter (GIF)
Weighted Gaussian Model
Adaptive NonLocal Edge-Preserving Norm
Huber Norm
Tikhonov Least-Square Estimator
L_p-Norm
L_2-Norm
L_1-Norm
In (Faramarzi et al., 2013)
In (Villena et al., 2013)
In (Maiseli et al., 2015)
In (Zeng et al., 2015)
In (Zhao et al., 2016)
In (Gao et al., 2016)
In (Ghosh et al., 2016)
In (Köhler et al., 2016)
In (El Mourabit et al., 2017)
In (Long et al., 2017)

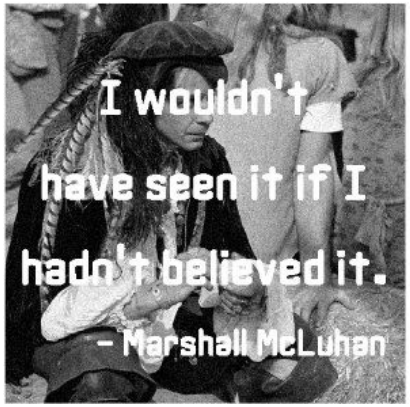

Original
Noisy image
Denoised image

Original

Noisy image

Denoised image

Noisy and corrupted image



TV inpainted image, $\tau = 0.85$

(a) original image

(b) blurred image, SNR=8.47dB

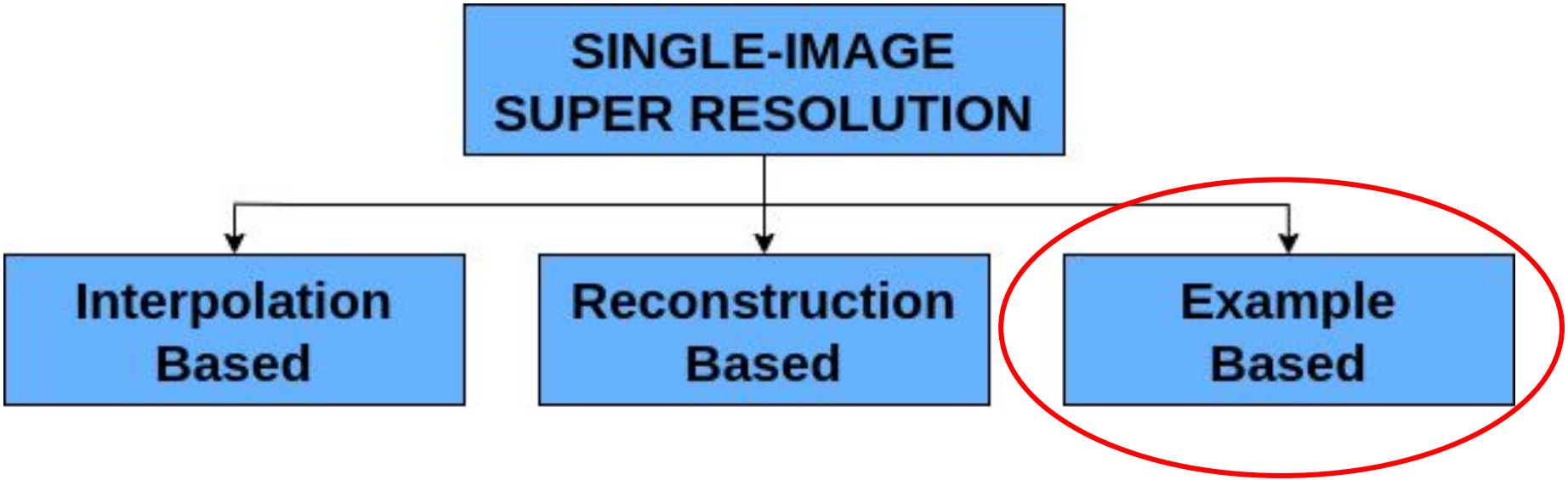
(c) split Bregman algorithm, SNR=12.79dB

(d) Algorithm 1, SNR=12.91dB

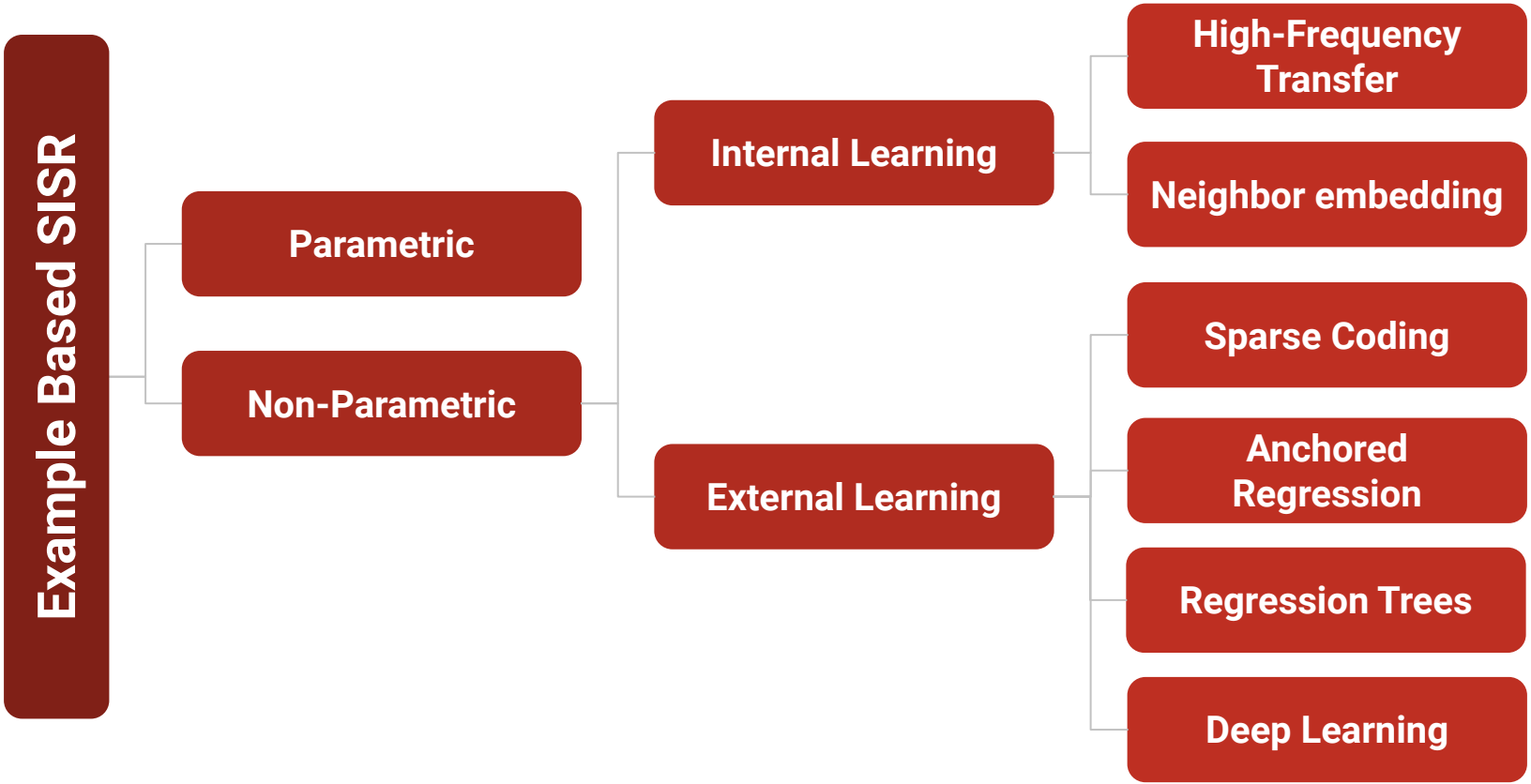
Spatial Weighted Total Variation (2012)

Bilateral Total Variation (2013)

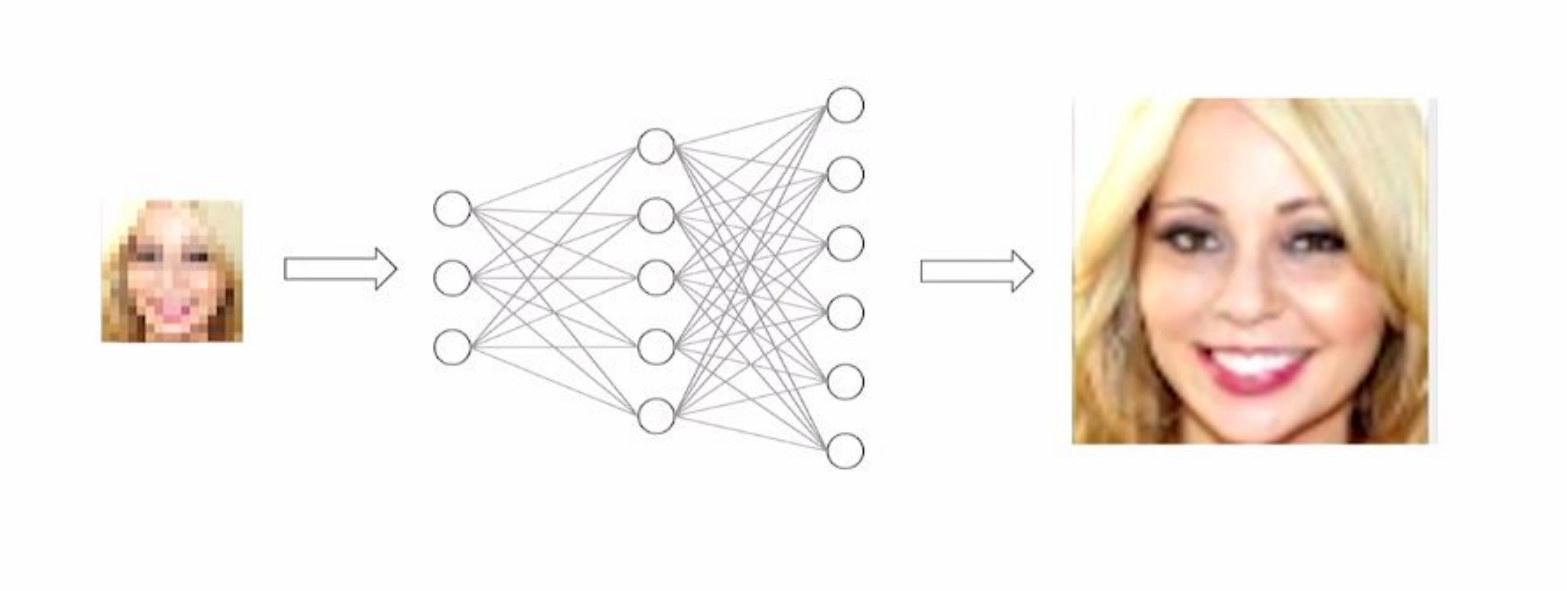
SISR Categories



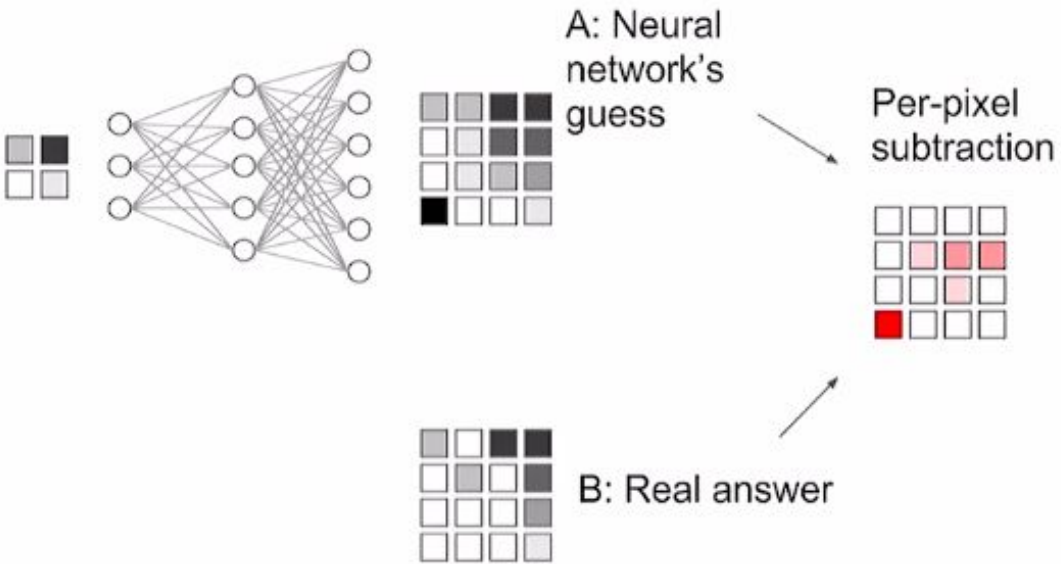
Example Based SISR



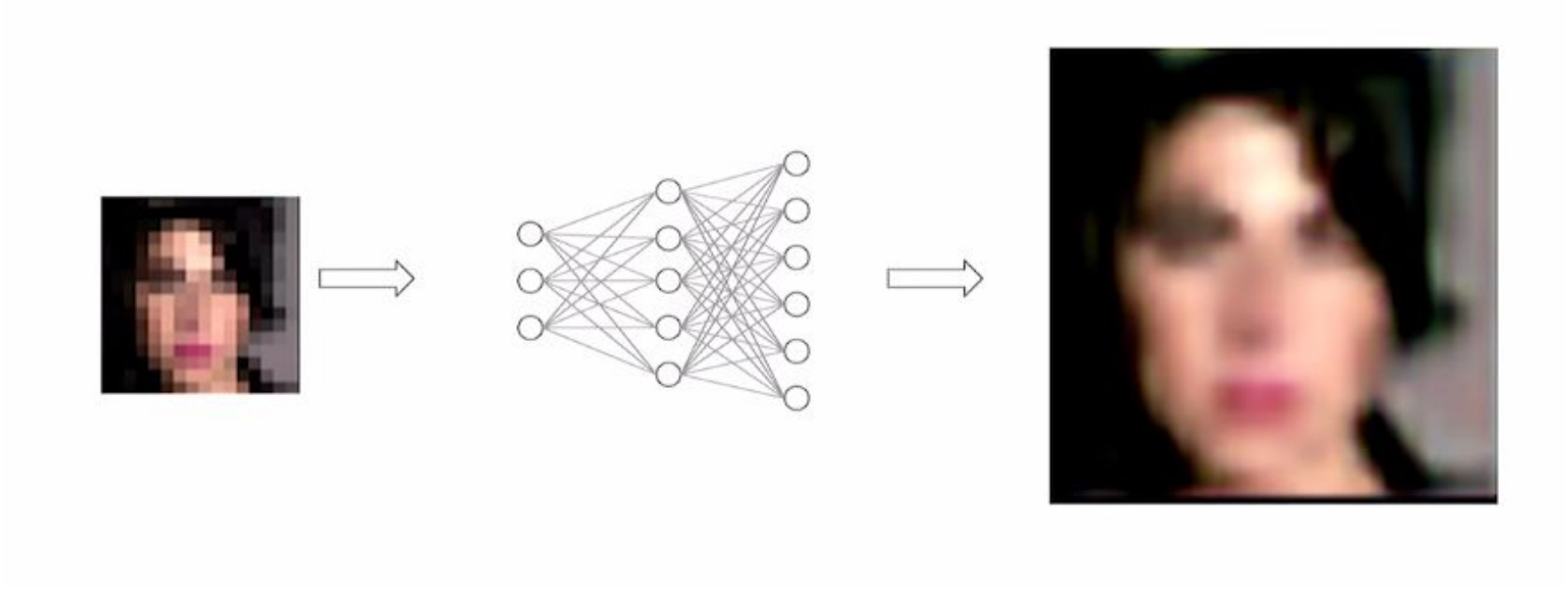
SRCNN



SRCNN

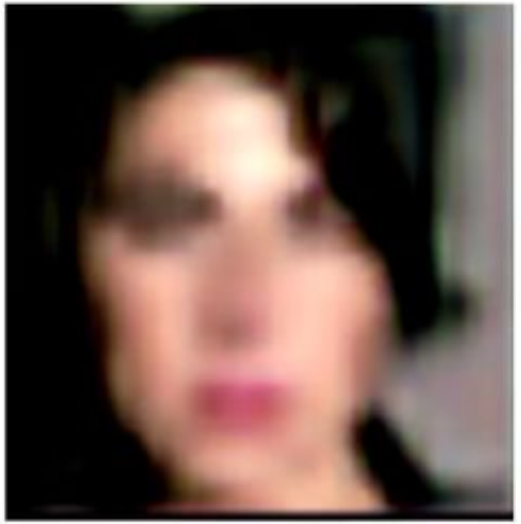

A: Neural network's guess
Per-pixel subtraction
B: Real answer

SRCNN



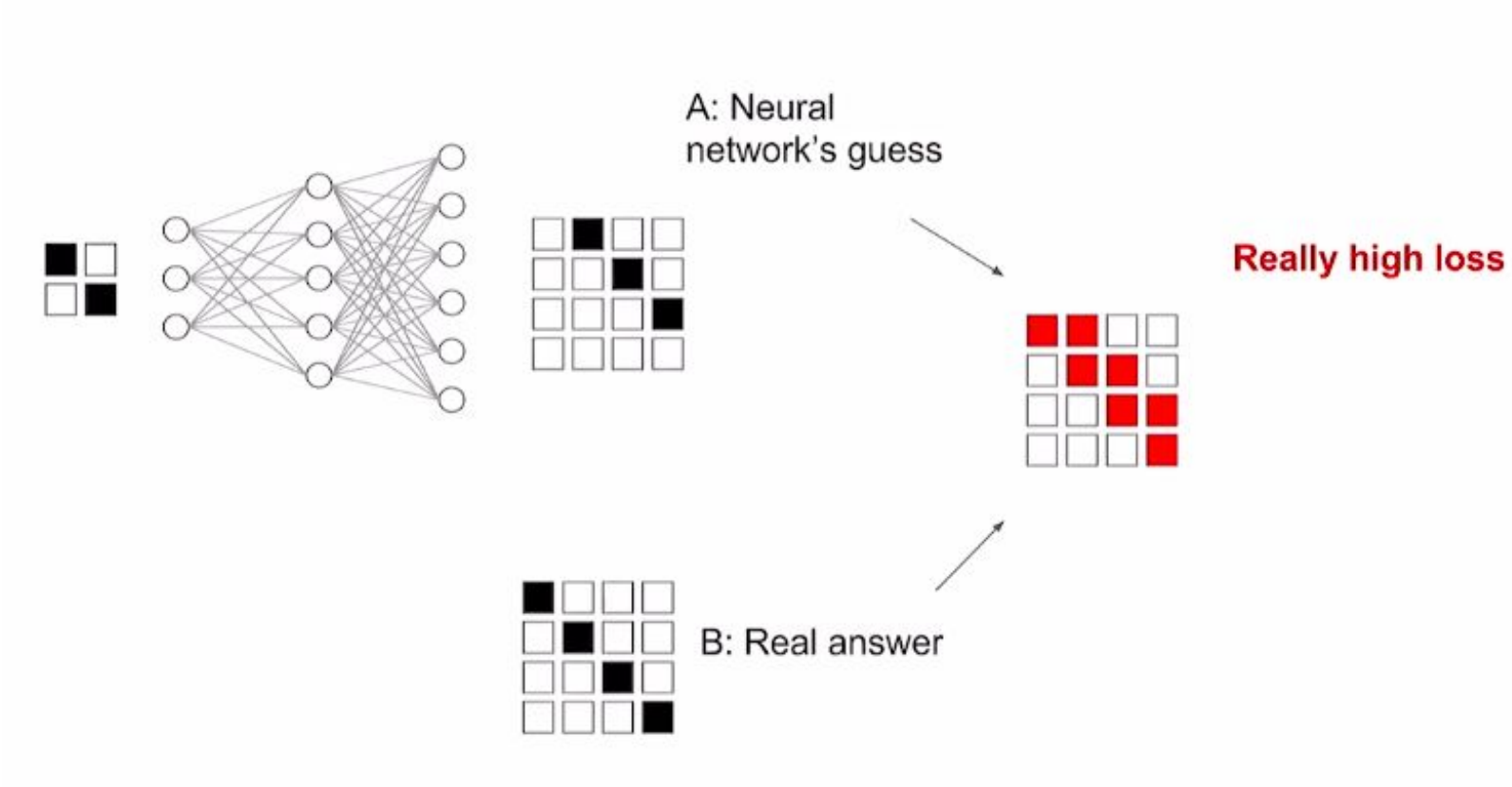
SRCNN

Bicubic interpolation

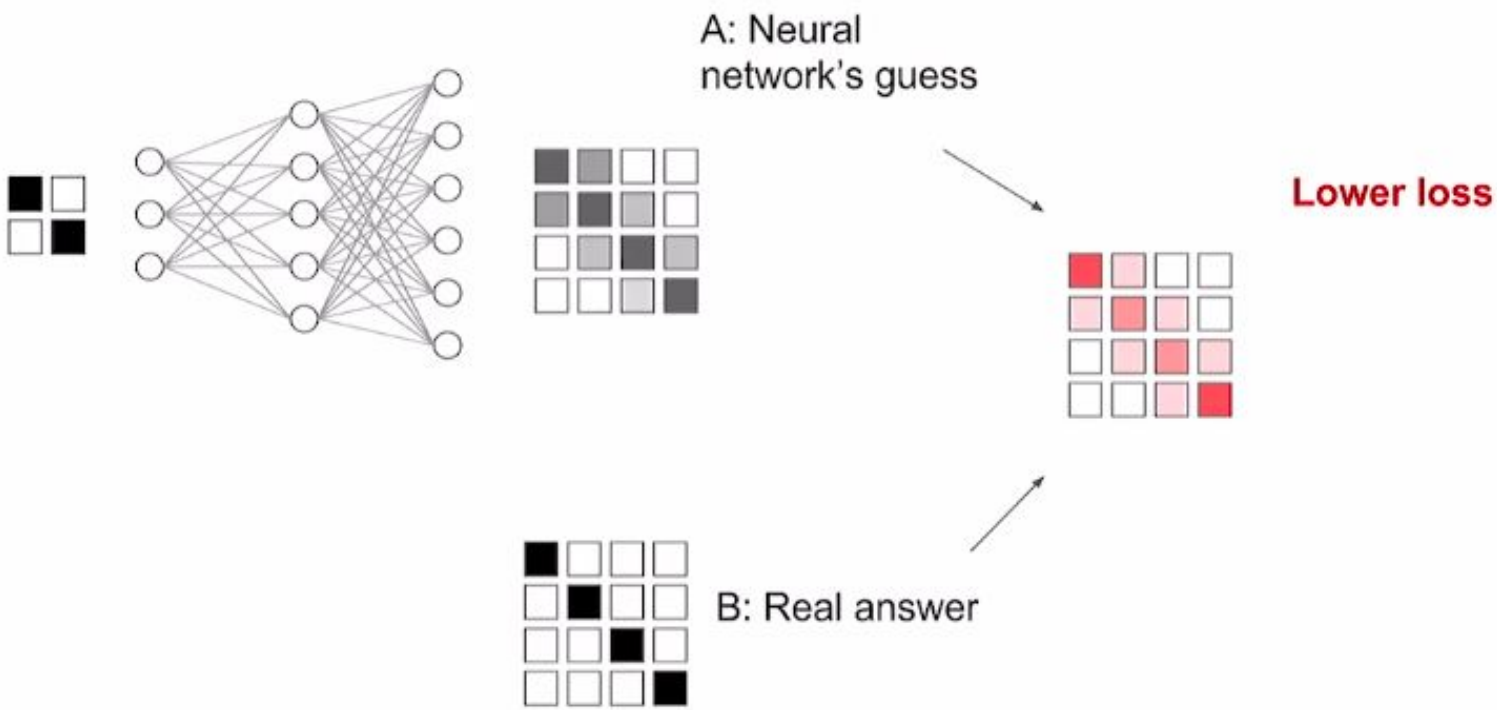


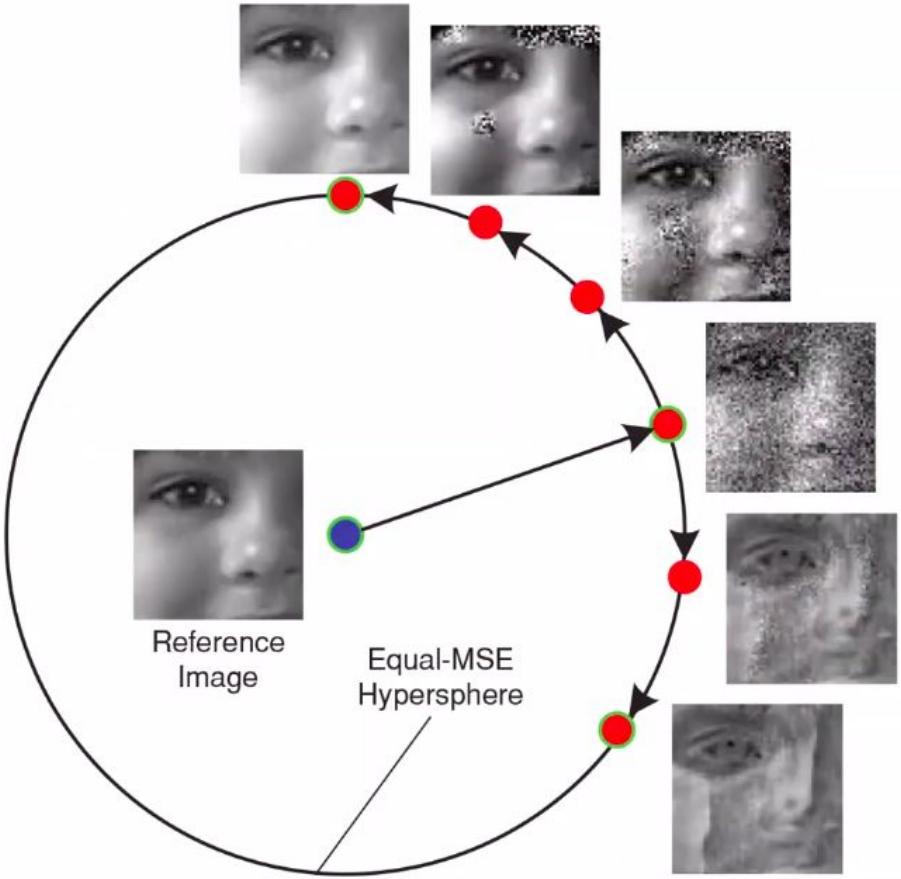
Neural network

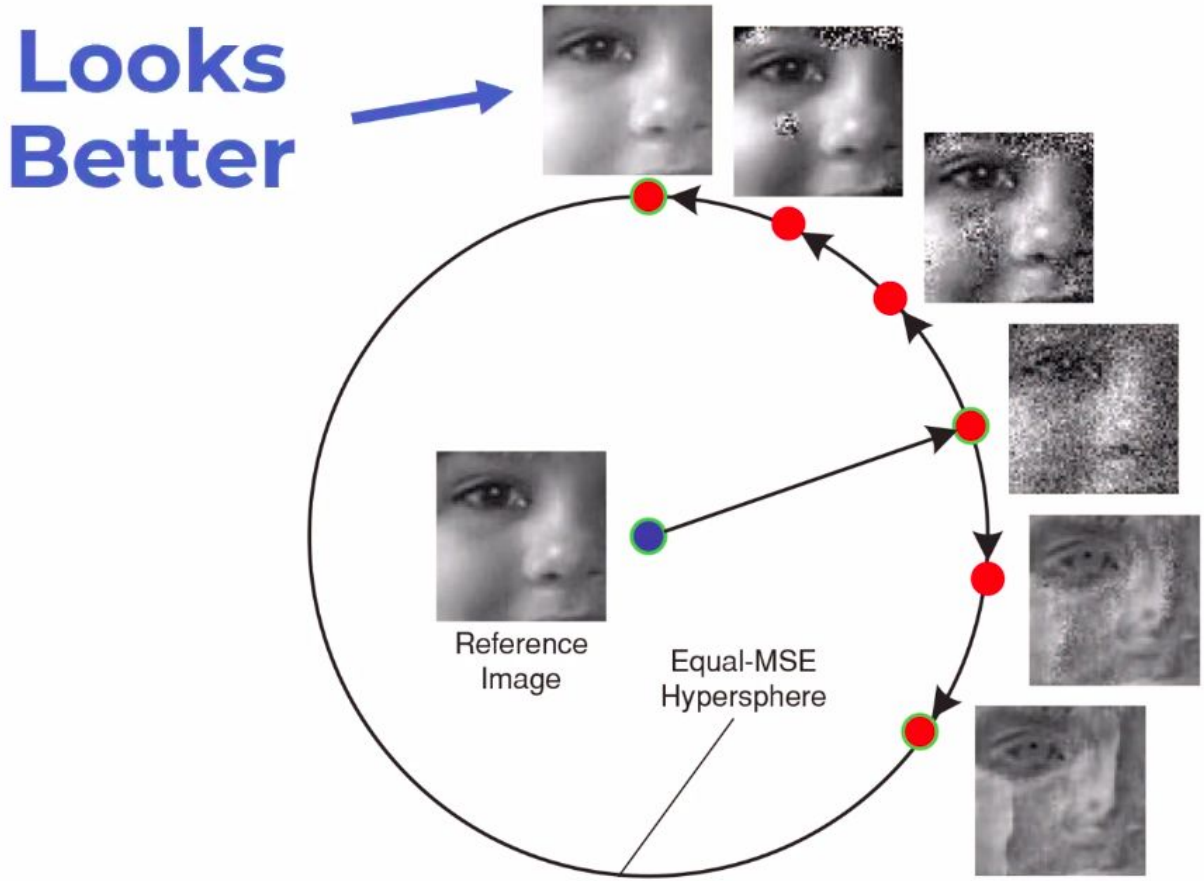
SRCNN



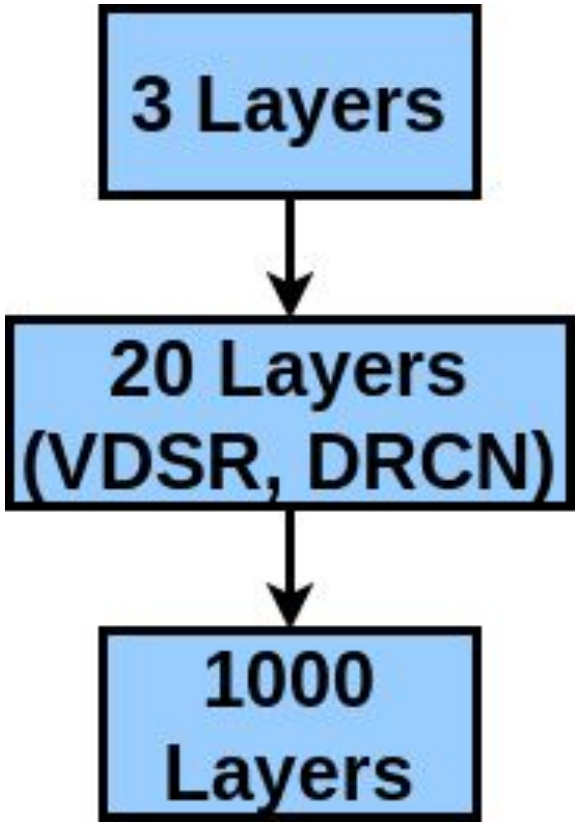
SRCNN




Reference
Image
Equal-MSE
Hypersphere


Looks
Better
Reference
Image
Equal-MSE
Hypersphere

Scalability?



How To Overcome This Issue?

Euclidean distance / Mean squared error MSE

$$||\tilde{I} - I||_2^2 = \frac{1}{NMC} \sum_{ij} \left(\tilde{I}_{ij} - I_{ij}\right)^2$$

How To Overcome This Issue?

Euclidean distance / Mean squared error MSE

$$||\tilde{I} - I||_2^2 = \frac{1}{NMC} \sum_{ij} \left(\tilde{I}_{ij} - I_{ij}\right)^2$$

Perceptual loss (2016)

$||\phi(\widetilde{I}) - \phi(I)||_2^2$ *MSE in VGG feature space*

How To Overcome This Issue?

Euclidean distance / Mean squared error MSE

$$||\tilde{I} - I||_2^2 = \frac{1}{NMC} \sum_{ij} \left(\tilde{I}_{ij} - I_{ij}\right)^2$$

Perceptual loss (2016)

$||\phi(\tilde{I}) - \phi(I)||_2^2$ *MSE in VGG feature space*

Texture loss / Style transfer (2015)

$||G\left(\phi(\tilde{I})\right) - G(\phi(I))||_2^2$ *MSE of correlation in VGG feature space*

How To Overcome This Issue?

Euclidean distance / Mean squared error MSE

$$||\tilde{I} - I||_2^2 = \frac{1}{NMC} \sum_{ij} \left(\tilde{I}_{ij} - I_{ij}\right)^2$$

Perceptual loss (2016)

$||\phi(\tilde{I}) - \phi(I)||_2^2$ *MSE in VGG feature space*

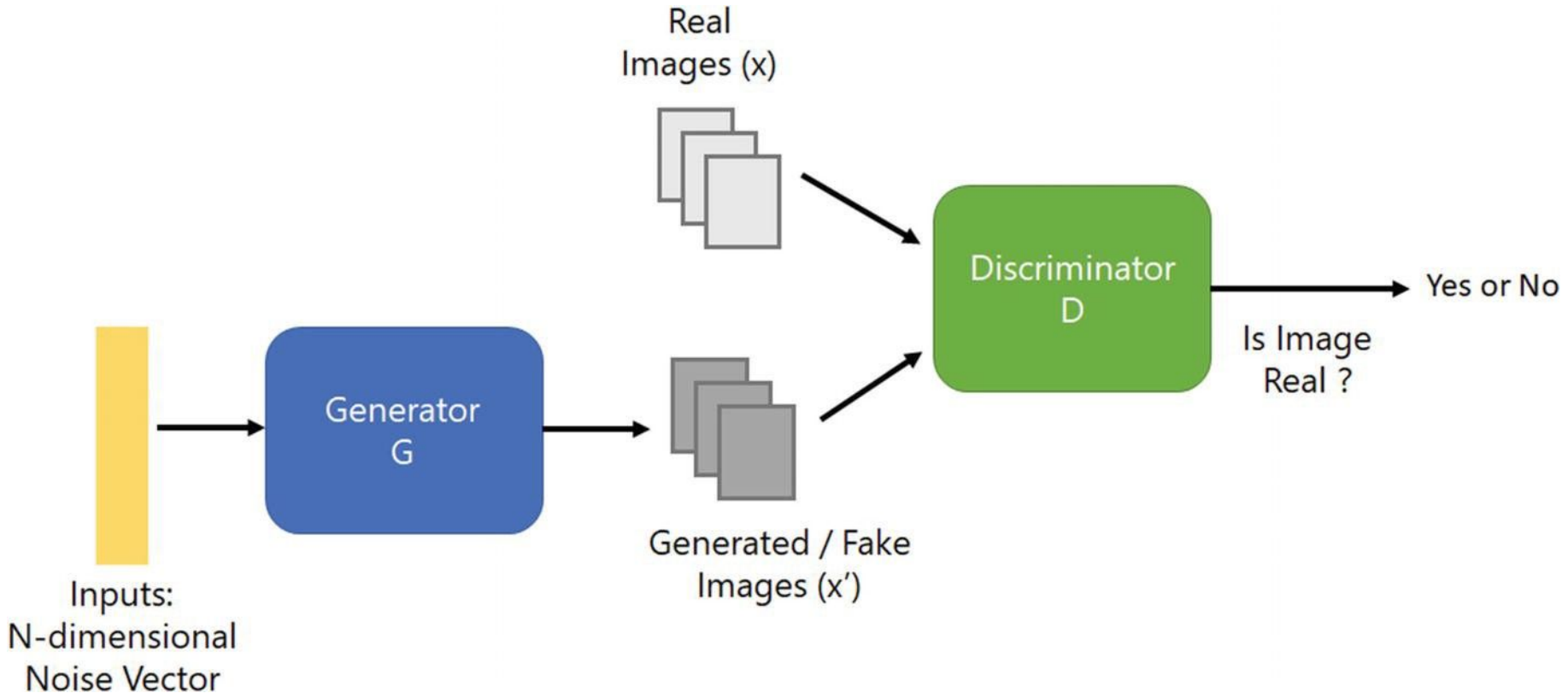
Texture loss / Style transfer (2015)

$||G\left(\phi(\tilde{I})\right) - G(\phi(I))||_2^2$ *MSE of correlation in VGG feature space*

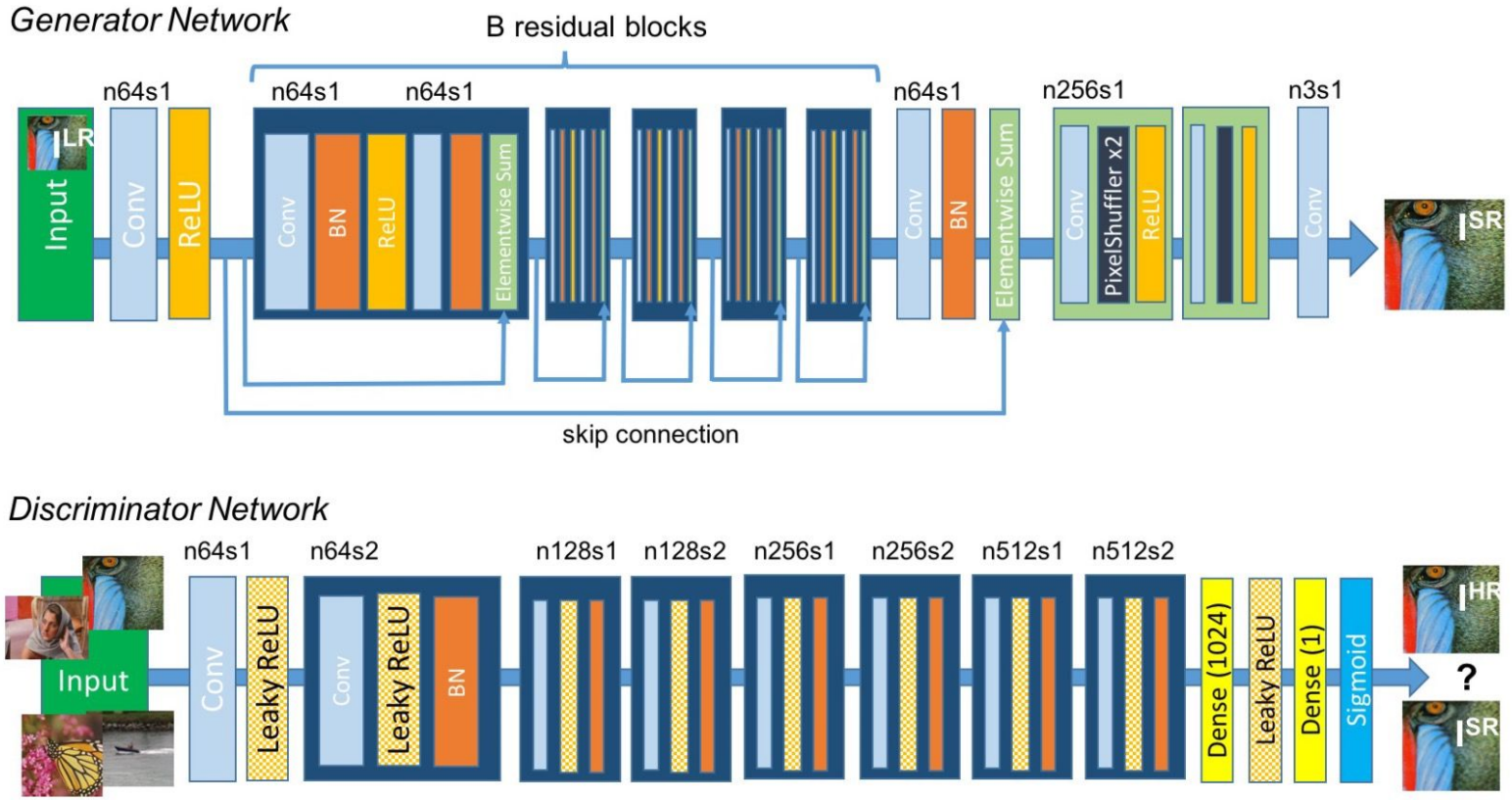
Adversarial loss / GANs (2014)

$D\left(\tilde{I}\right)$, $D(I) \in [0, 1]$ *Discriminator rates realism of image patches*

GANs

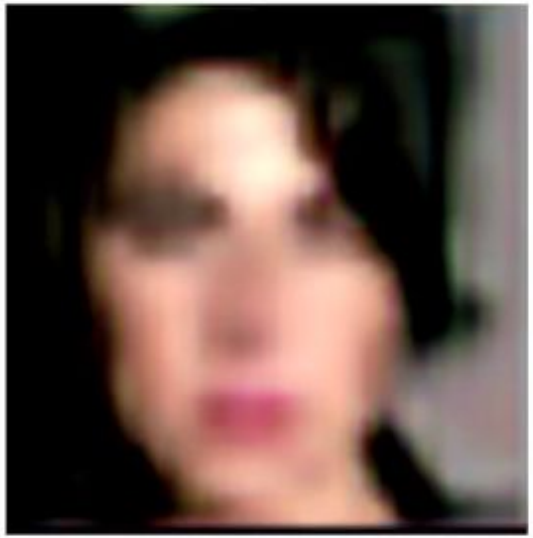

Real
Images (x)
Discriminator
D
Yes or No
Is Image
Real ?
Generator
G
Generated / Fake
Images (x')
Inputs:
N-dimensional
Noise Vector

SRGANs


Generator Network
B residual blocks
n64s1
n64s1
n64s1
n64s1
n256s1
n3s1
Input
LR
Conv
ReLU
Conv
BN
ReLU
Elementwise Sum
Conv
BN
Elementwise Sum
Conv
PixelShuffler x2
ReLU
Conv
SR
skip connection
Discriminator Network
n64s1
n64s2
n128s1
n128s2
n256s1
n256s2
n512s1
n512s2
Input
Conv
Leaky ReLU
Conv
Leaky ReLU
BN
Dense (1024)
Leaky ReLU
Dense (1)
Sigmoid
HR
?
SR

SRGANs

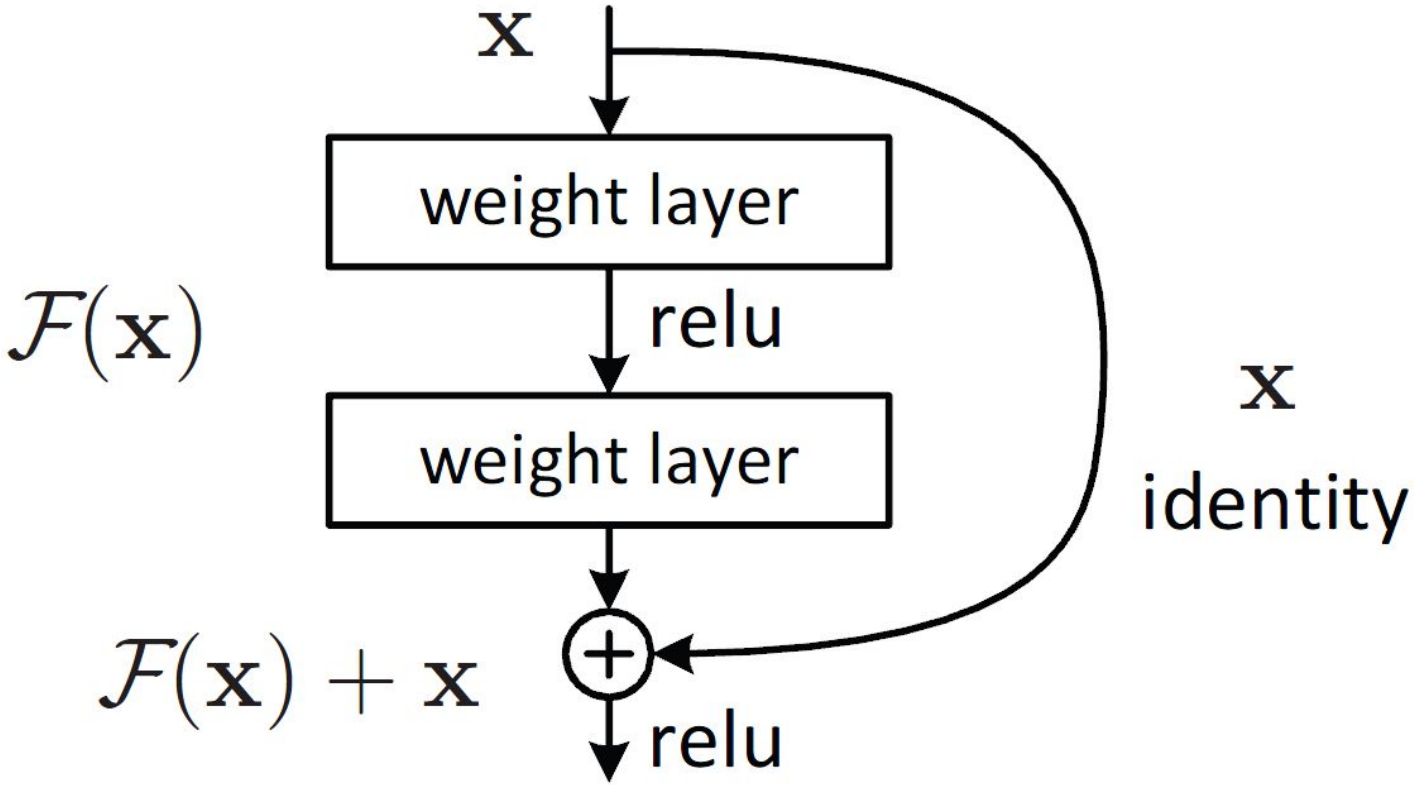
original



Per-pixel diff
neural network

GAN

How Can We Solve Learning Issues In CNNs?



How Can We Solve Learning Issues In CNNs?

Thank You For Your Attention!