Image Super-Resolution

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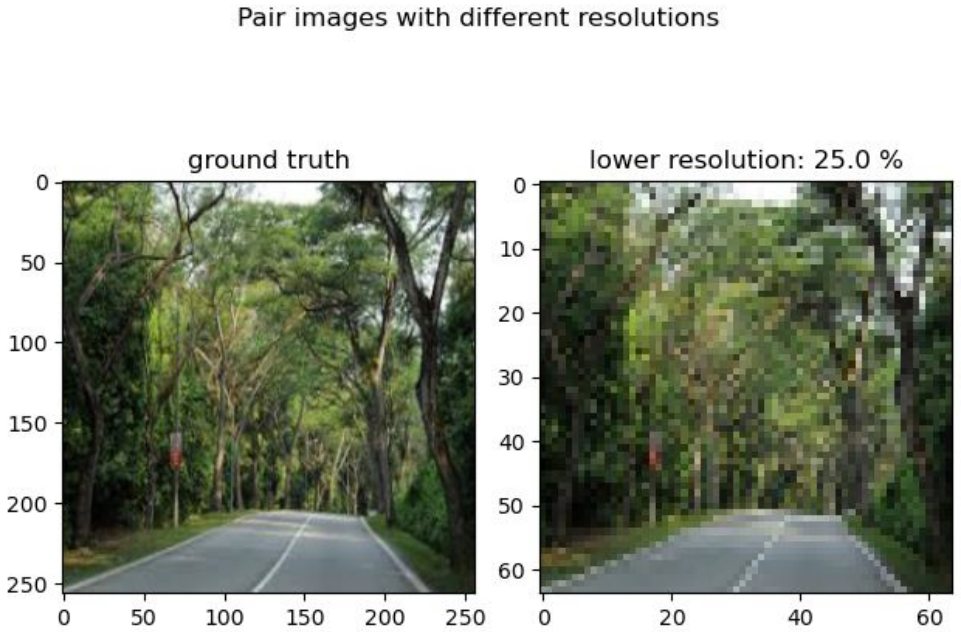
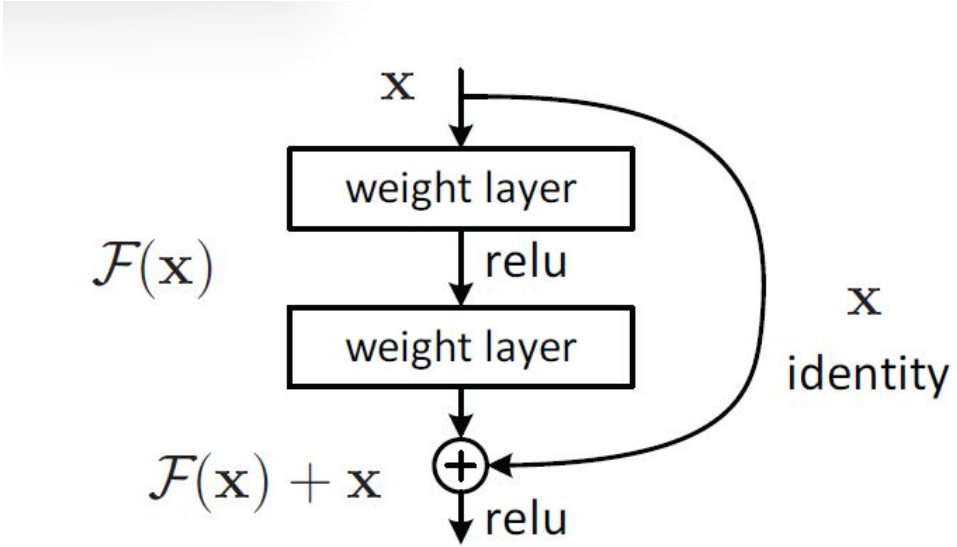
Motivation



- To transform image with low resolution into plausible image with higher resolution

Residual Neural Network

- Skip connection
- Batch Normalization
- RELU



Source: He, et al, 2015, “Deep Residual Learning for Image Recognition”, Microsoft Research, link: https://arxiv.org/abs/1512.03385

Convolutional Neural Network Model

- Upscaling, e.g. Convolutional Transpose (Conv2DTranspose)
- Blocks of Residual Neural Network
- CNN layer (Conv2D) as output

- Metrics: MSE, MAE, PSNR, SSIM
- Adam optimizer for model fitting/learning

- Data from: https://www.kaggle.com/datasets/adityachandrasekhar/image-super-resolution/data
- After loading images from the data, downscaling is conducted, to simulate image with lower resolution

Peak Signal-to-Noise Ratio (PSNR)

$$MSE = \frac{1}{m\,n} \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} [I(i,j) - K(i,j)]^2.$$

The PSNR (in dB) is defined as

$$\begin{aligned} PSNR &= 10 \cdot \log_{10} \left(\frac{MAX_I^2}{MSE} \right) \\ &= 20 \cdot \log_{10} \left(\frac{MAX_I}{\sqrt{MSE}} \right) \\ &= 20 \cdot \log_{10}(MAX_I) - 10 \cdot \log_{10}(MSE). \end{aligned}$$

Source: https://en.wikipedia.org/wiki/Peak_signal-to-noise_ratio

Structural Similarity Index Measure (SSIM)

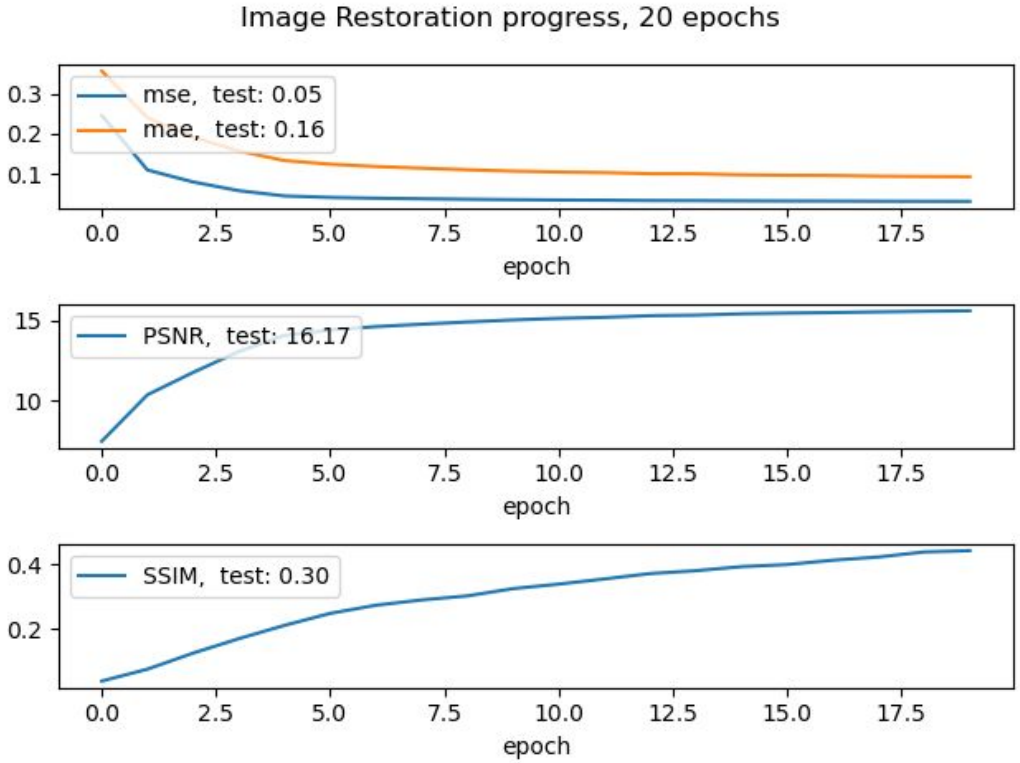
$$\mathrm{SSIM}(x, y) = \frac{(2\mu_x\mu_y + c_1)(2\sigma_{xy} + c_2)}{(\mu_x^2 + \mu_y^2 + c_1)(\sigma_x^2 + \sigma_y^2 + c_2)}$$

with:

- μ_x the pixel sample mean of x;
- μ_y the pixel sample mean of y;
- σ_x^2 the variance of x;
- σ_y^2 the variance of y;
- σ_{xy} the covariance of x and y;
- $c_1 = (k_1 L)^2$, $c_2 = (k_2 L)^2$ two variables to stabilize the division with weak denominator;
- L the dynamic range of the pixel-values (typically this is $2^{\#bits\ per\ pixel} - 1$);
- $k_1 = 0.01$ and $k_2 = 0.03$ by default.

Source: https://en.wikipedia.org/wiki/Structural_similarity

Model Evaluation



Results of Image Reconstruction