Beyond a Gaussian Denoiser: Residual Learning of Deep CNN for Image Denoising

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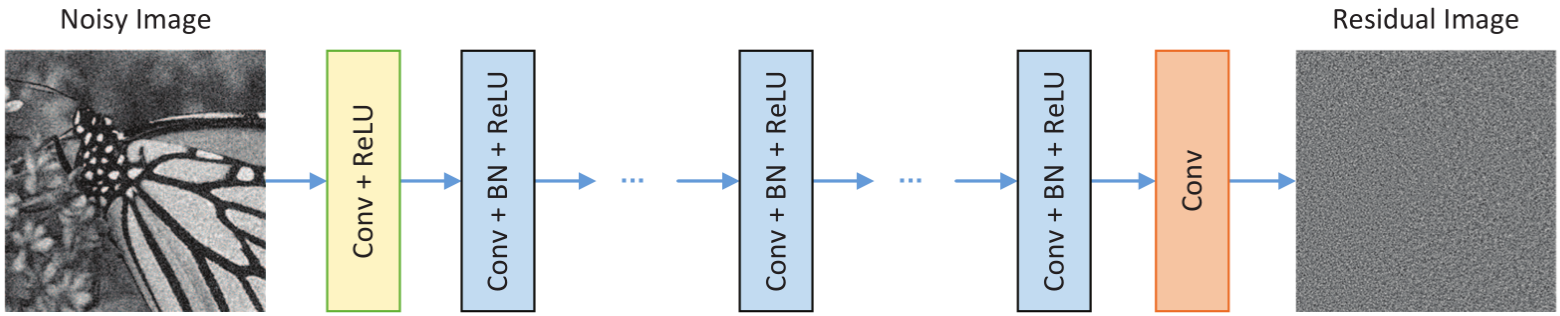
Introduction

What we do

We take one step forward by investigating the construction of feed-forward denoising convolutional neural networks to embarce the progress in very deep architecture, learning algorithm, and regularization method into image denosing. Our DnCNN model is able to handle Gaussian denosing with unkown noise level. Specifically, batch normalization are utilized to speed up the training process as well as boost the denosing performance.

Architecture



Algorithms

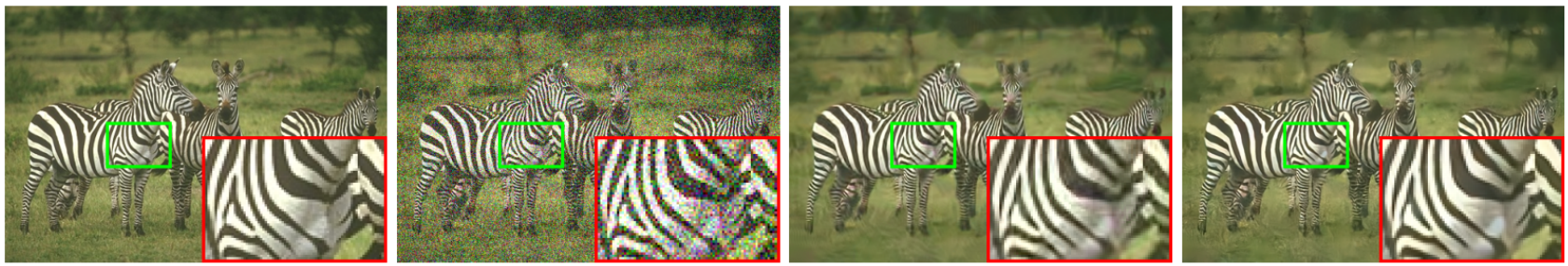
The input of DnCNN is a noisy observation:

$$\mathbf{y} = \mathbf{x} + \mathbf{v} \tag{1}$$

For DnCNN, we adopt the residual learning formulation to train a residual mapping $\mathcal{R}(\mathbf{y}) \approx \mathbf{v}$, and the we have $\mathbf{x} = \mathbf{y} - \mathcal{R}(\mathbf{y})$. Formally, the averaged mean squared error between the desired residual images and estimated ones from noisy input

$$\ell(\ ) = \frac{1}{2N} \sum_{i=1}^{N} \left\| \mathcal{R}\left(\mathbf{y}_i;\ \right) - \left(\mathbf{y}_i - \mathbf{x}_i\right) \right\|_F^2 \tag{2}$$

Experiments



Further

Ongoing Optimization

- For other kinds of noise
- Image haze removal based on CNN? (how to build dataset?)
- Still some bugs remained