Cycle-Consistent Super Resolution Generative Adversarial Network

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Motivation

This project aims to use Cycle-Consistent Generative Adversarial Networks (CycleGANs) and perceptual loss to improve the state-of-the-art for the Super Resolution (SR) task.

This approach is based on the idea that if a network can learn how to compress an image, it can learn how to enhance an image.

The model has knows no prior information about the data other than the input, so unpaired data is used as opposed to paired data.

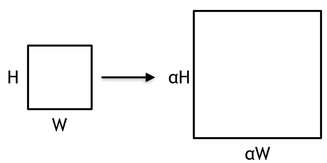

Figure 1: SR example, where α > 1

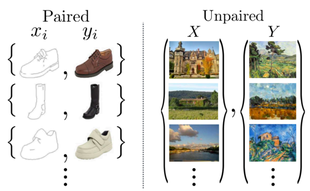

Figure 2: Paired vs. Unpaired data

Related Work

Ledig et al. has developed SRGAN, which produces 4x upscaling while maintaining photo-realistic qualities, but uses paired samples.

Zhu et al. shows that photos can be generated with shallower depth of field, which suggests photo enhancement is a suitable area for CycleGAN, but has not applied it to super resolution.

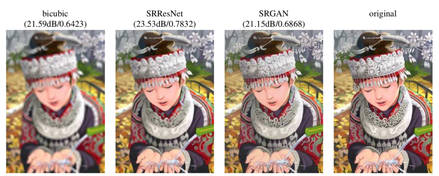

Figure 3: SRGAN Results

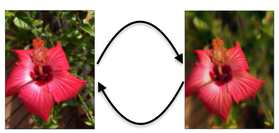

Figure 4: CycleGAN Results

References

[1] C. Ledig et al. Photo-realistic single image super-resolution using a generative adversarial network. *CVPR*, 2017.
[2] J. Zhu et al. Unpaired image-to-image translation using cycle-consistent adversarial networks.*CVPR*, 2017.

CycleSRGAN

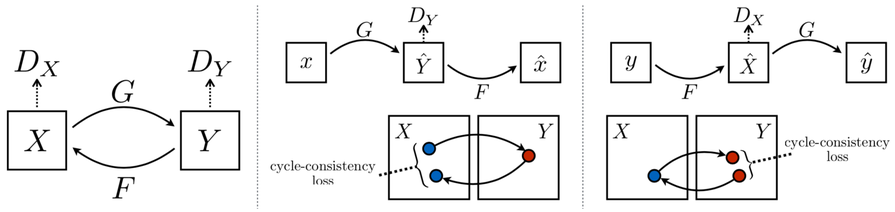

Figure 5: CycleGAN Structure

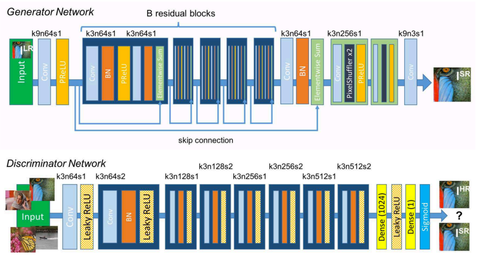

Figure 6: Generator/Discriminator of SRGAN

$$\mathscr{L}_{LSGAN} = \mathbb{E}_{x\sim p_{data}(x)}[D_Y(G(x))^2 + (D_X(x)-1)^2] + \mathbb{E}_{y\sim p_{data}(y)}[D_X(F(y))^2 + (D_Y(y)-1)^2]$$

$$\mathscr{L}_{CYC} = \mathbb{E}_{x\sim p_{data}(x)}[\,\|F(G(x)) - x\|_1] + \mathbb{E}_{y\sim p_{data}(y)}[\,\|G(F(y)) - y\|_1]$$

$$\mathscr{L}_{SR} = \mathbb{E}_{x\sim p_{data}(x)}[\,\|\phi(x) - \phi(F(G(x)))\|_2^2] + \mathbb{E}_{y\sim p_{data}(y)}[\,\|\phi(y) - \phi(G(F(y)))\|_2^2]$$

$$\longrightarrow \quad \mathscr{L} = \mathscr{L}_{LSGAN} + \lambda_1 \mathscr{L}_{CYC} + \lambda_2 \mathscr{L}_{SR}$$

Experimental Results

Parameter	Value
Learning rate	0.0002
Epochs	100
Train set size	1600
λ_1	10
λ_2	5

Table 1: Parameter values of CycleSRGAN

	MSE	SSIM	PSNR
Image 1	0.07	0.75	11.48
Image 2	0.02	0.64	16.67
Image 3	0.14	0.44	8.47
Image 4	0.02	0.77	17.66
Image 5	0.03	0.47	15.03
Image 6	0.07	0.75	11.42
Image 7	0.06	0.71	12.36

Table 2: Evaluation metrics for generated image compared to "ground truth"

Figure 7: (Top) Input images,(Middle) Results of CycleSRGAN, (Bottom) "Ground truth" images