Image SuperResolution

using GANs

Team 15

Srivatsava Kesanupalli
MT18054

Subhani Shaik
MT18117

Akhil Palla
MT18130

Problem Statement

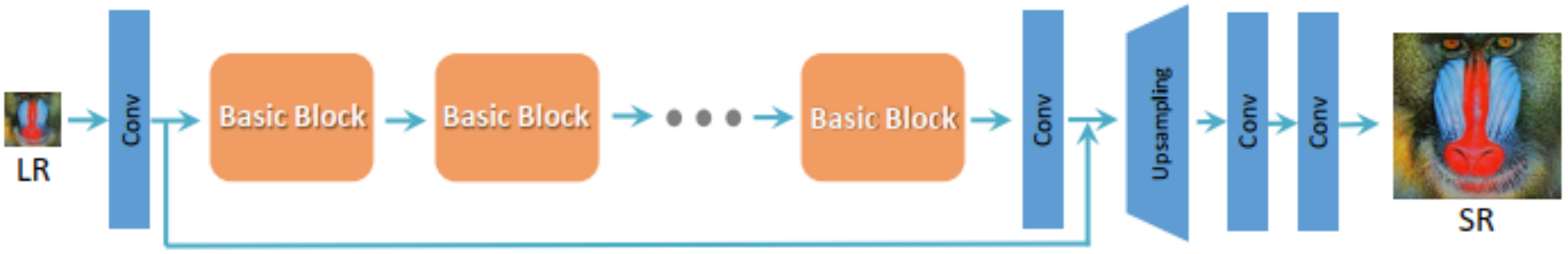
Super resolution is the problem of artificially enlarging a low resolution image to recover a plausible high resolution version. Image Super Resolution (SR) is particularly useful in forensics, biometrics. This is a classical computer vision problem. We implemented a Deep Learning based approach to super resolve existing lower resolution images.

Dataset

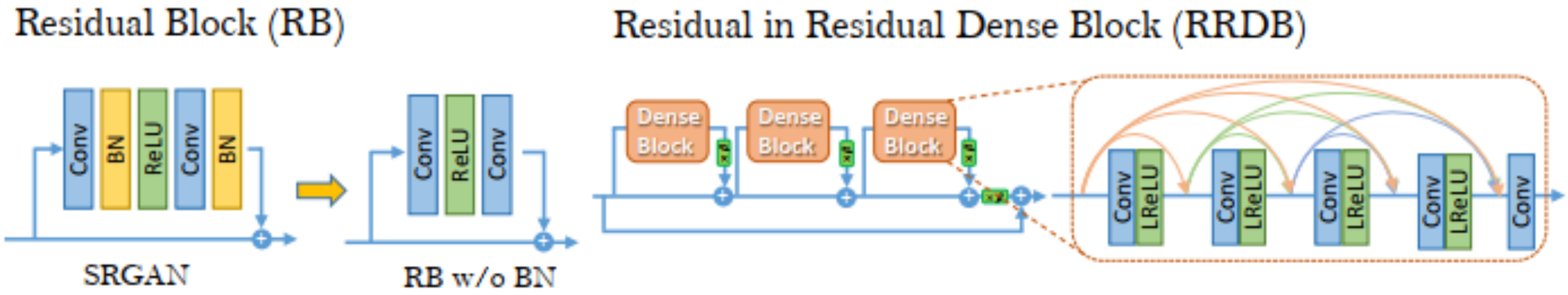
Low Resolution Images which are a part of DIV2K dataset provided by NTIRE 2017, 2018 challenges on Image Super Resolution improvement. We use this dataset so as to compare our results with current state-of-the-art.

Link

State-of-the-art



SRGAN with Basic Blocks



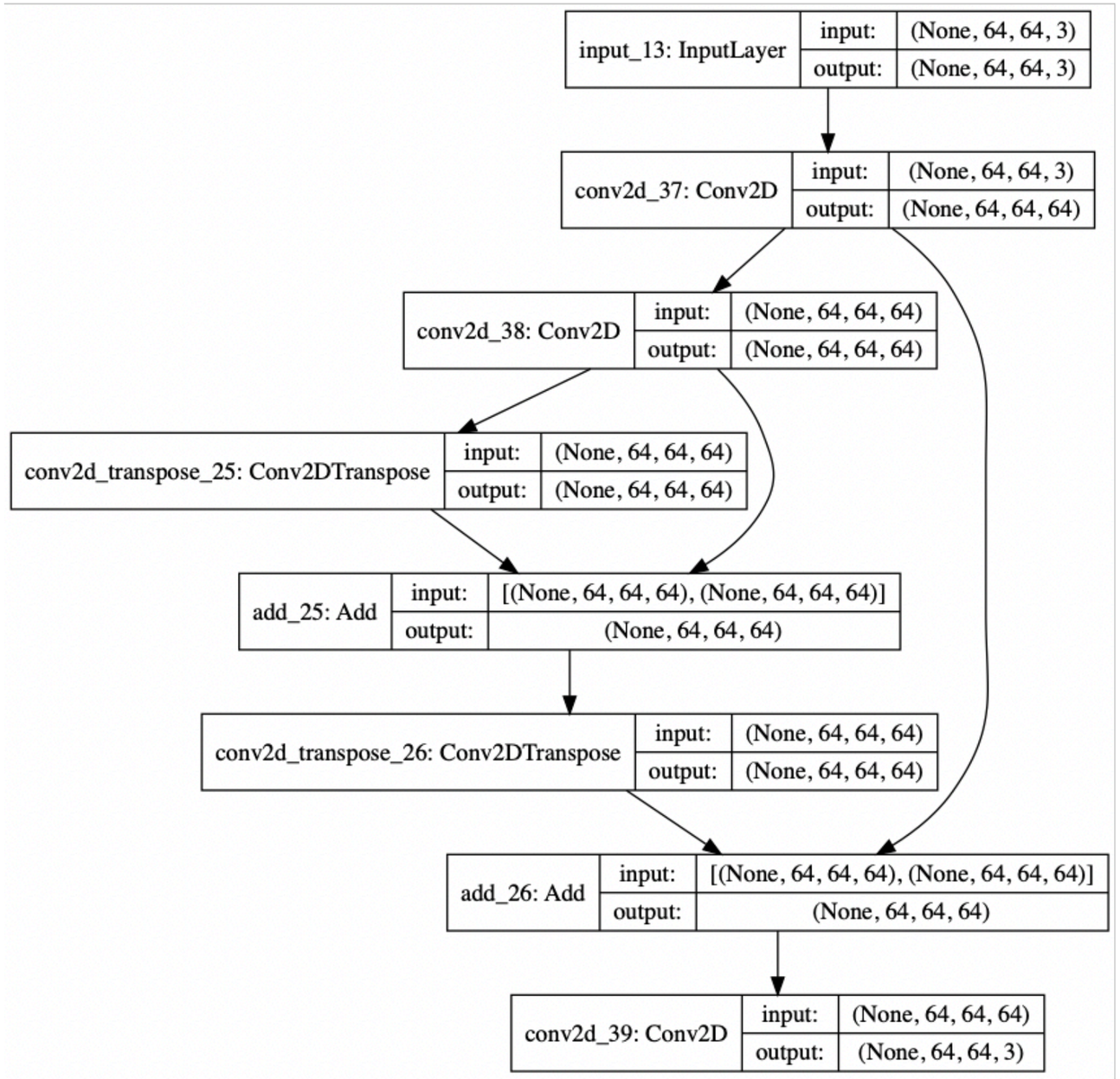
Enhanced SRGAN with RRDB Blocks

Initial Work - Baseline

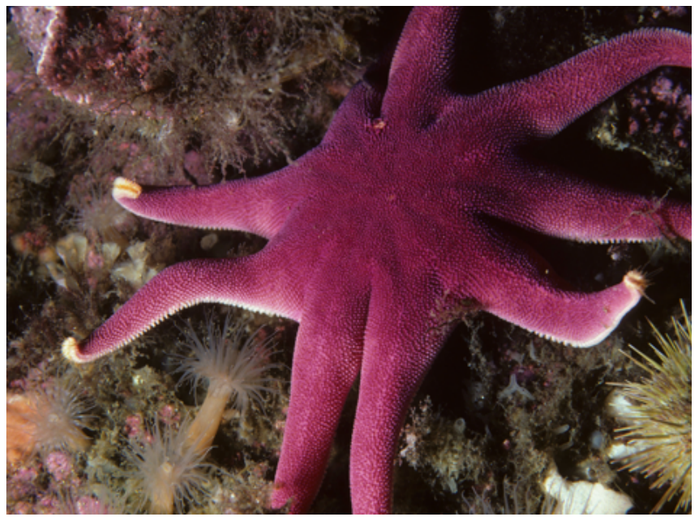
5 Convolutional Layers

Input Size:	64 x 64 x 3 (resized from 32 x 32 x 3)
Output Size:	64 x 64 x 3 (Super-resolved by 2 times)
Loss Function:	MSE Loss
Optimiser:	Adam
Batch size:	128
No. of epochs:	30
Training Data:	800 images x 4 patches/image
Val. Data:	100 images x 4 patches/image
Metric:	PSNR

SR-CNN



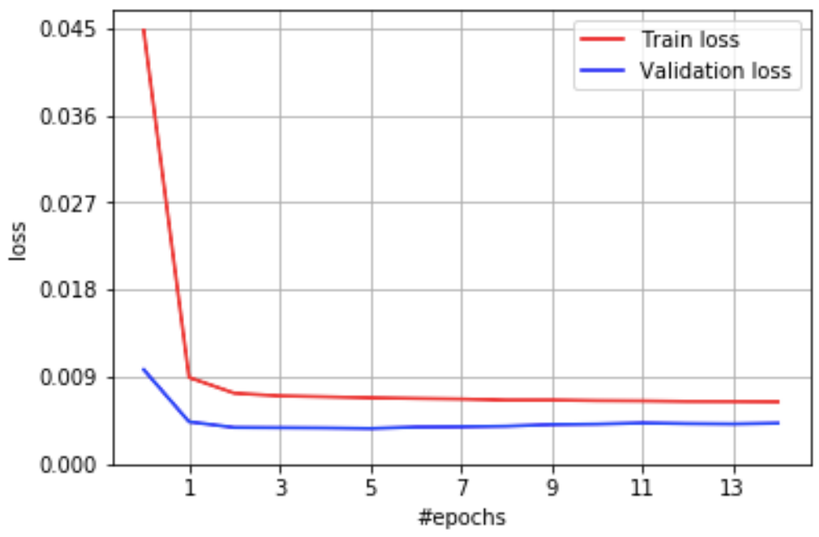
Results & Analysis



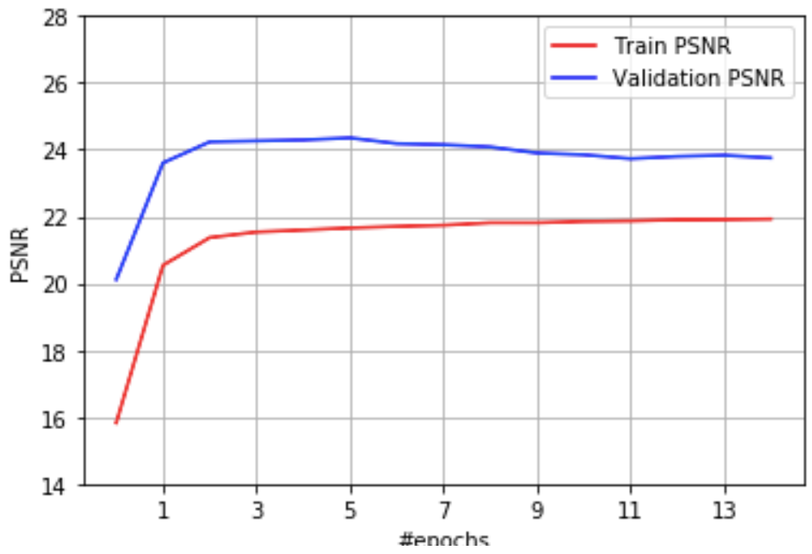
High Resolution

Low Resolution(resized)
PSNR - **30.69 dB** w.r.t HR image

Super Resolved
PSNR - **30.87 dB** w.r.t HR image

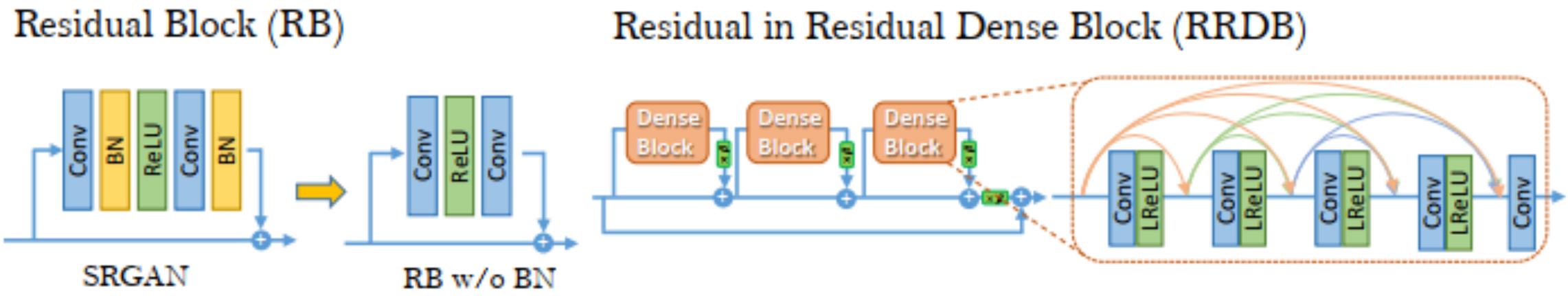


Train vs. Validation Loss



Train vs. Validation PSNR

Enhanced Super Resolution GAN - our current work



Enhanced SRGAN

- Improvements over SRGAN include replacing original basic blocks with RRDB blocks
- Removed all the batch-norm layers
- Perceptual loss used before activation features
- Relativistic Discriminator - Not just discriminate between real & fake$_{(generated)}$ images, but discriminate based on how natural the generated image is.

$$D(x_r) = \sigma(C(\text{Real})) \rightarrow 1 \quad \text{Real?}$$

$$D(x_f) = \sigma(C(\text{Fake})) \rightarrow 0 \quad \text{Fake?}$$

a) Standard GAN

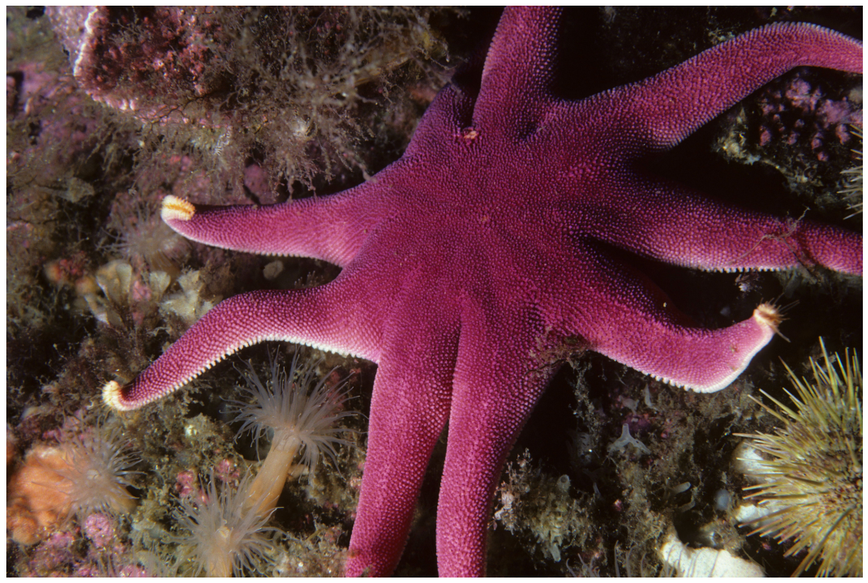
$$D_{Ra}(x_r, x_f) = \sigma(C(\text{Real}) - \mathbb{E}[C(\text{Fake})]) \rightarrow 1 \quad \text{More realistic than fake data?}$$

$$D_{Ra}(x_f, x_r) = \sigma(C(\text{Fake}) - \mathbb{E}[C(\text{Real})]) \rightarrow 0 \quad \text{Less realistic than real data?}$$

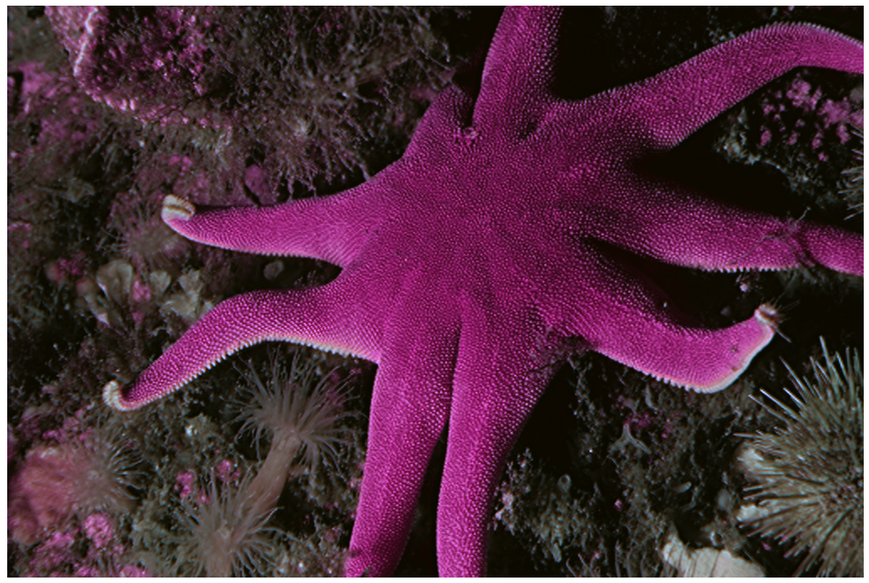
b) Relativistic GAN

RaGAN - Discriminator

Results



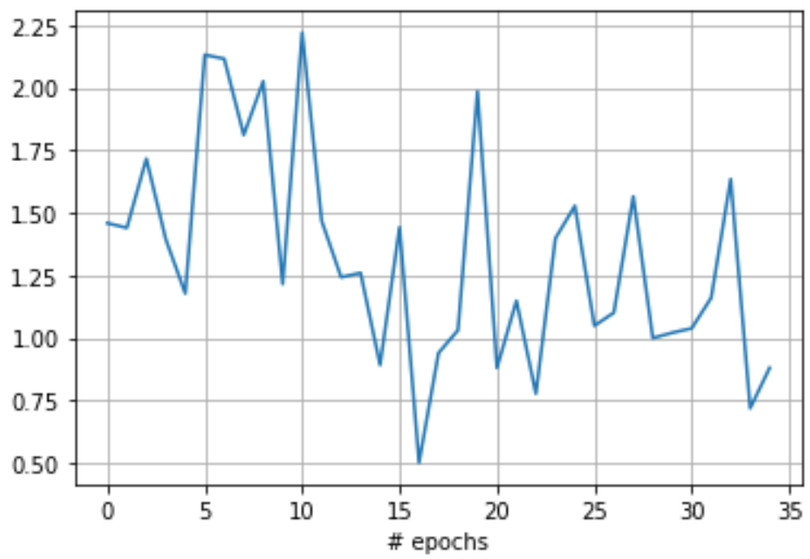
Original HR



SR Image - 28.887 dB

Original HR

SR Image - 28.348 dB



Loss plot

PSNR Plot

Potential for Future Work

- Enhance the model with spectral normalization
- Apply the work to super resolve low resolution video
- Improve the performance and submit work to super-resolution challenges

Individual Contribution

- Baseline: Subhani Shaik
- Advanced work: Srivatsava Kesanupalli
- Part of baseline, advanced work, literature survey done by all 3 of us

Dong *et al*., Image Super-Resolution Using Deep Convolutional Networks - IEEE Transactions on Pattern Analysis and Machine Intelligence 2016

Wang *et al*., ESRGAN - Enhanced Super-Resolution Generative Adversarial Networks - PRIM2018-Challenge, ECCV 2018