Single Image Super-Resolution for Medical Image Analysis

Supervisor : Prof. Angshuman Paul

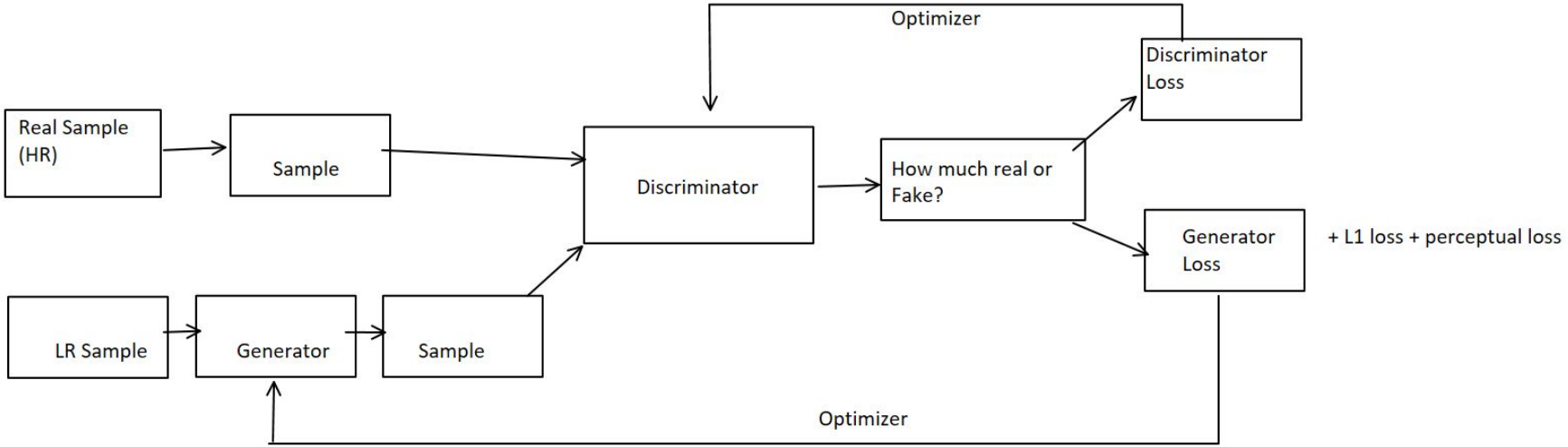
- SISR - Technique to convert low resolution image to High Resolution.

- Trained ESRGAN based model (originally trained on DIV2K dataset) on BreakHis dataset.
- BreakHis (Breast Cancer Histopathological) contains about 7000 images of breast tumor tissue containing benign and malignant samples. Dataset divided into 70:10:20 for training, validation and testing.

  We generated LR images by downsampling (by a factor of 4) and adding some noise to HR images,

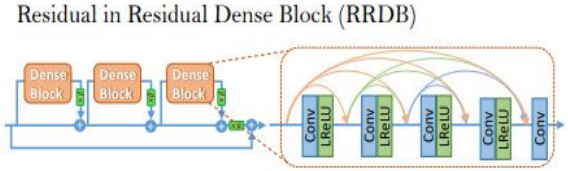
  which are in dataset.

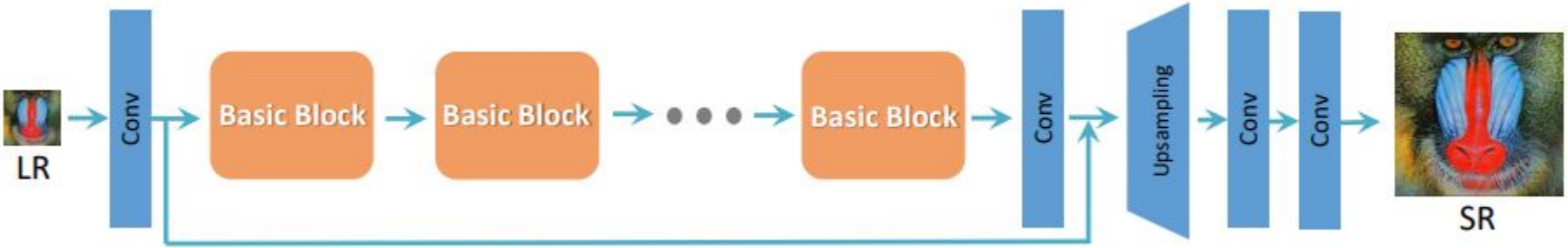
Model


Optimizer
Discriminator Loss
Real Sample (HR)
Sample
Discriminator
How much real or Fake?
Generator Loss
+ L1 loss + perceptual loss
LR Sample
Generator
Sample
Optimizer

Generator

RRDB Basic block





Discriminator

- Relative Discriminator

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

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

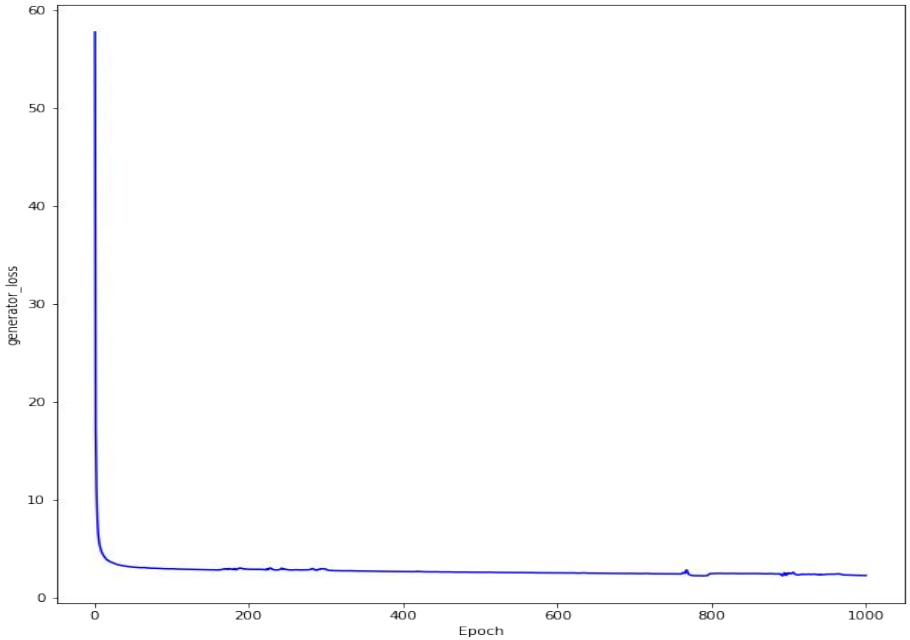
Discriminator loss

$$L_D^{Ra} = -\mathbb{E}_{x_r}[\log(D_{Ra}(x_r, x_f))] - \mathbb{E}_{x_f}[\log(1 - D_{Ra}(x_f, x_r))].$$

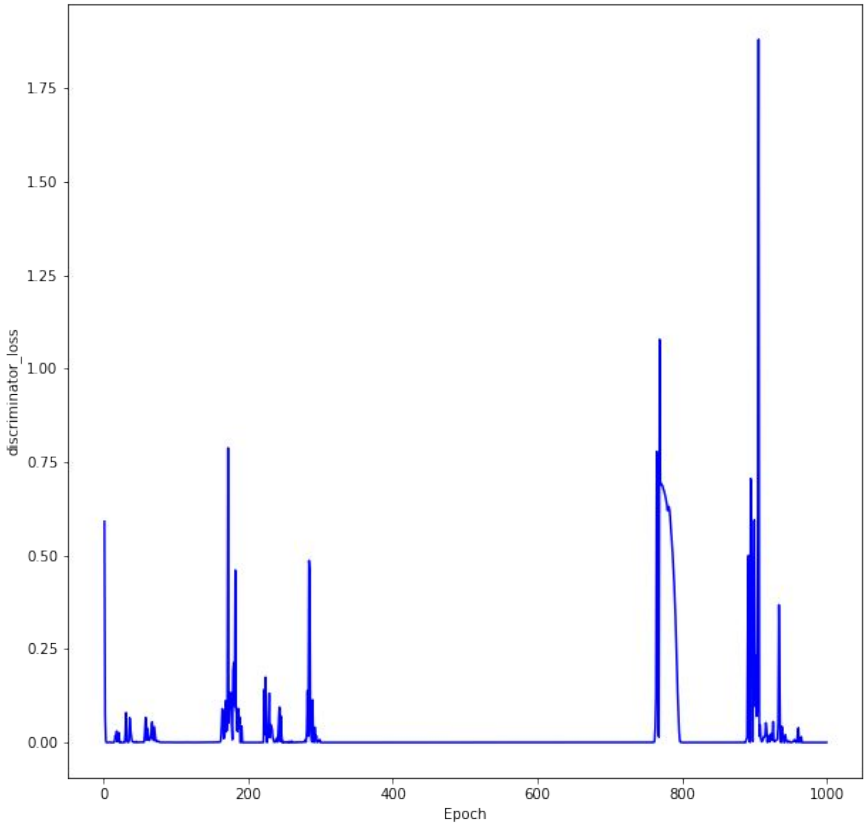
Generator Loss

$$L_G^{Ra} = -\mathbb{E}_{x_r}[\log(1 - D_{Ra}(x_r, x_f))] - \mathbb{E}_{x_f}[\log(D_{Ra}(x_f, x_r))]$$

+ Perceptual loss (based on a fine-tuned VGG network for material recognition)
+ L1 loss (1-norm distance between recovered image G(xi) and the ground-truth y)



Epoch v/s generator loss

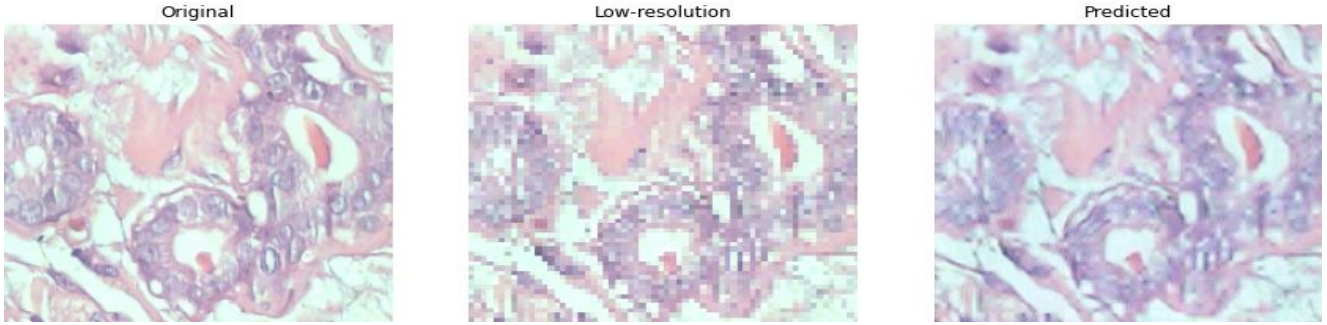


Epoch v/s Discriminator loss

Results

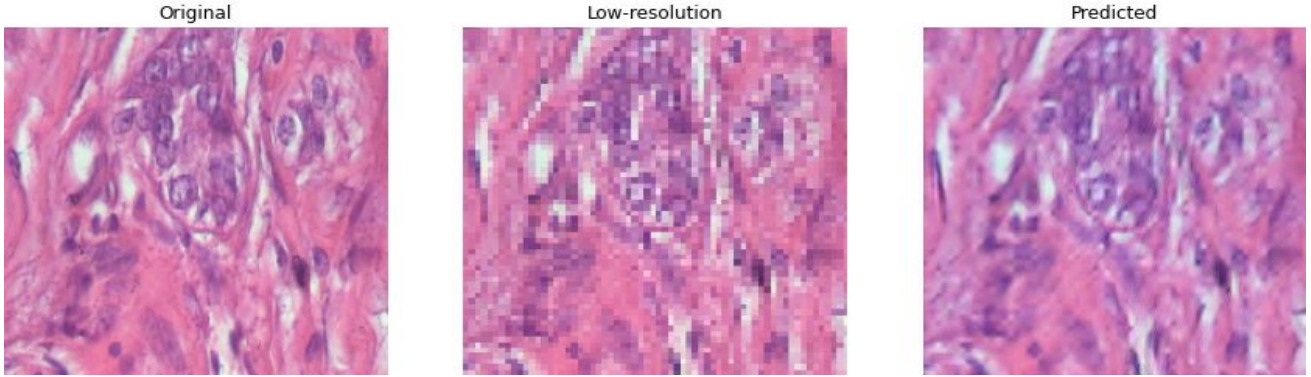
Benign

PSNR value (original and predicted) is 32.415963075887205 dB



Adenosis

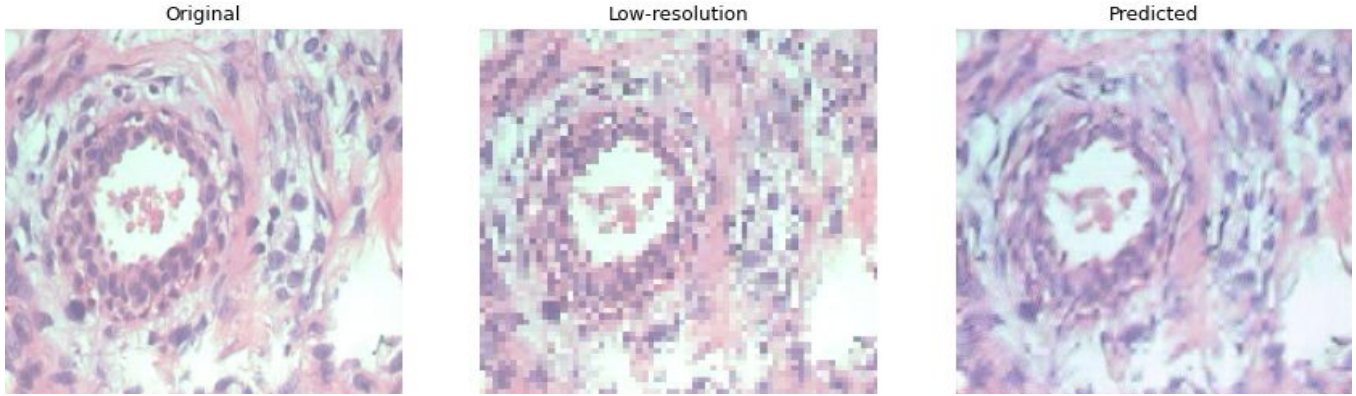
PSNR value (original and predicted) is 32.406104802649224 dB



Fibroade

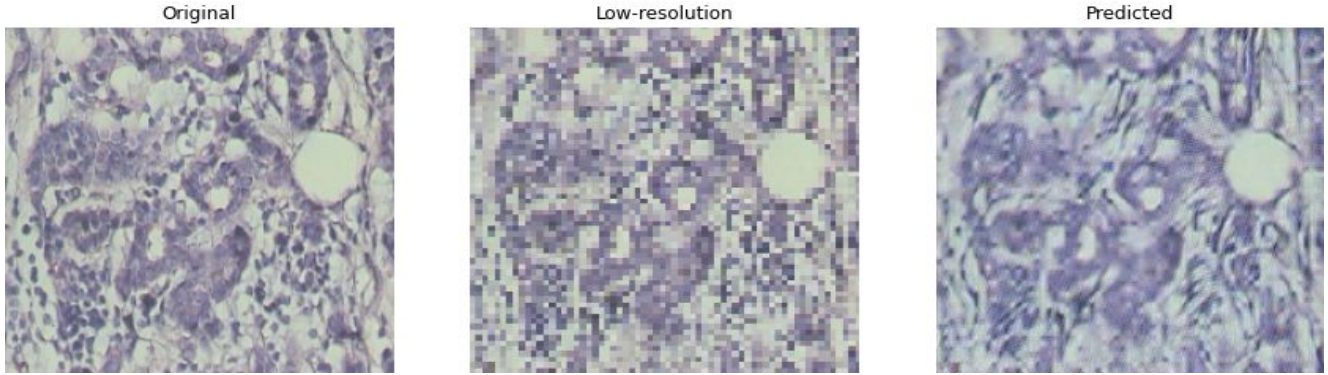
Phyllodes tumor

PSNR value (original and predicted) is 32.1932025177912 dB



Tabular adenoma

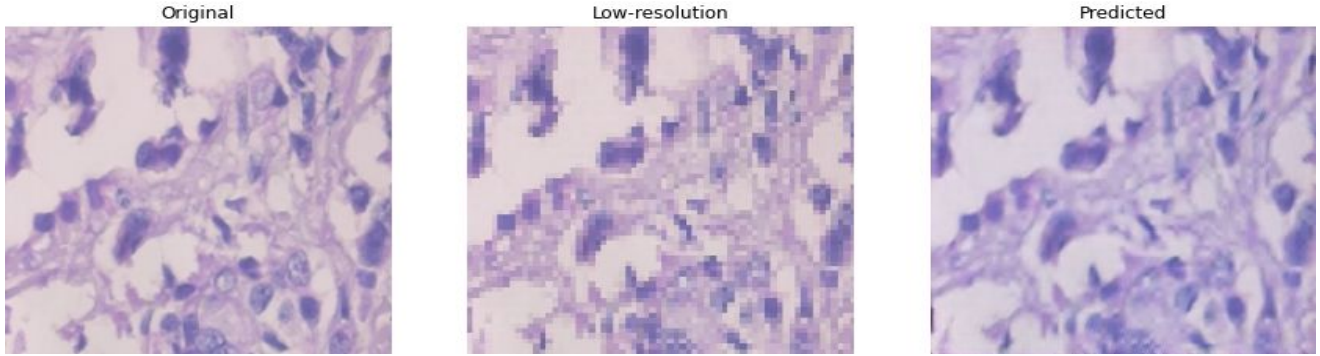
PSNR value (original and predicted) is 31.879976377135137 dB



Malignant

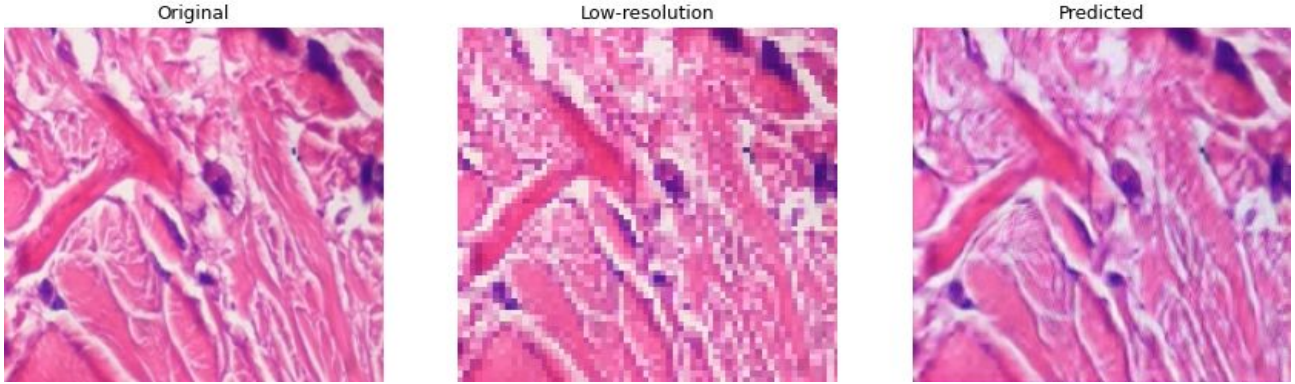
Ductal carcinoma

PSNR value (original and predicted) is 33.34659170028697 dB



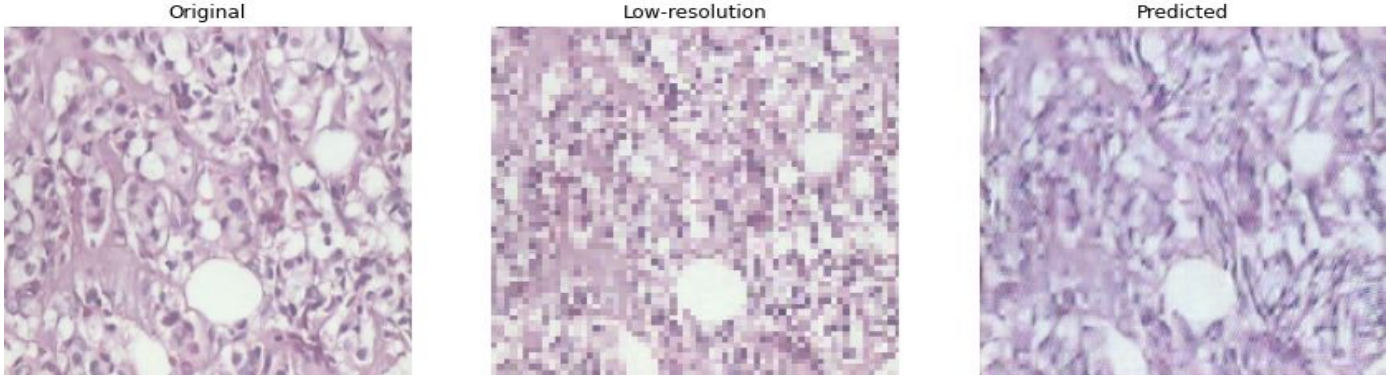
Lobular carcinoma

PSNR value (original and predicted) is 32.21149593084809 dB



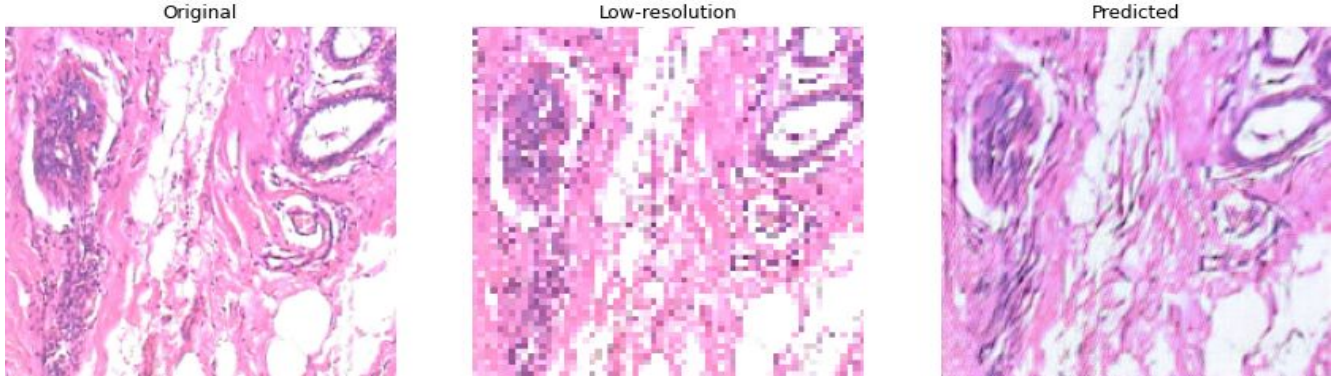
Mucinous carcinoma

PSNR value (original and predicted) is 31.95618417589163 dB



Papillary carcinoma

PSNR value (original and predicted) is 31.67354455871957 dB



- Average model for SISR

- PSNR value for test results are in range between 30-34

Thank You