Super-Resolution GANs Transforming Satellite Imagery for Mining

{Specifically Namibia}

By Luke Heitman

Problem

Mining is a legacy industry that has not fully adopted modern technologies, yet it heavily relies on satellite imagery to locate natural resource deposits.

Challenge

Low-resolution imagery limits effectiveness of possible downstream ML tasks in identifying these deposits.

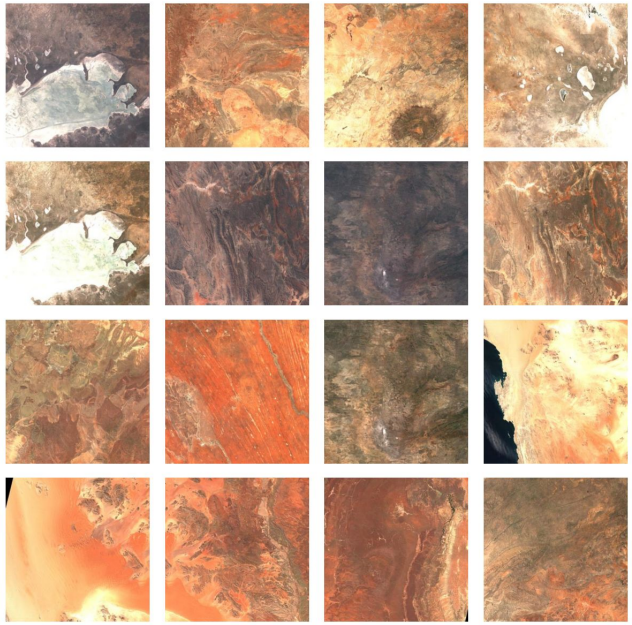
Solution

Implement GANs to enhance the quality of low-resolution imagery.

Timeline

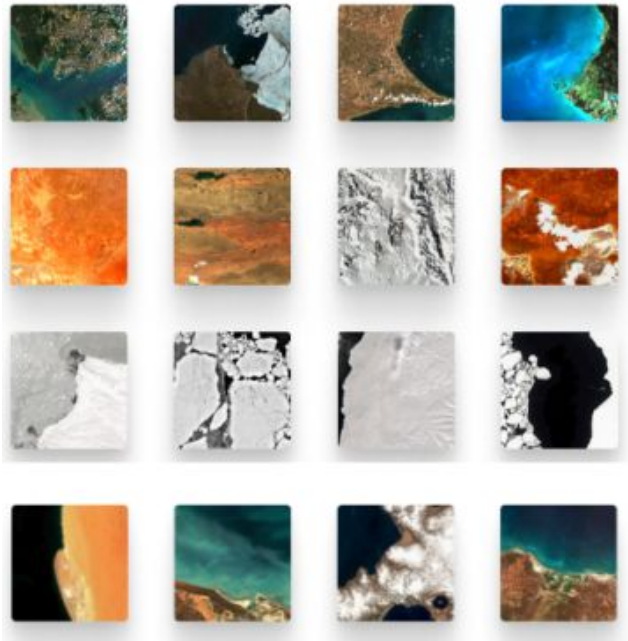
Sentinel-2 Data

Source: Scraped Copernicus Dataspace
Location: Namibia
Images: 50 Pairs {25 low-res, 25 high-res}
Resolution: LR 128x128, HR 512x512



Landshapes-4041

Source: From Sentinel-2. Here.
Location: Whole Earth
Images: 4041
Resolution: 1024x1024



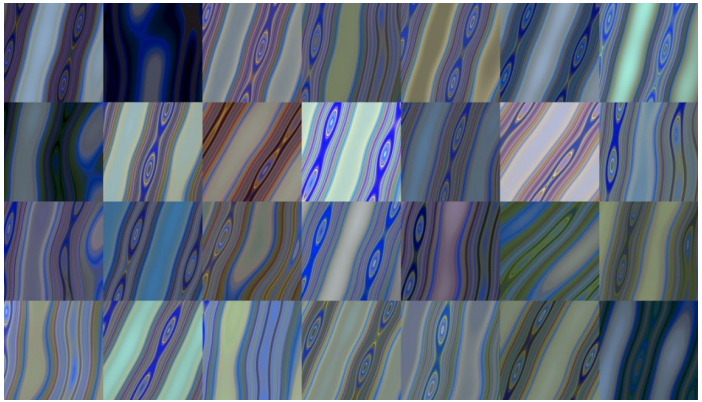
Training StyleGAN3

Plan

1. Train StyleGAN3 on Landshapes-4041
2. Encode low-res images into the model
3. Compute results compared to ground truth high-res image

Problem

1. Training StyleGAN3 from scratch is really hard and compute intensive
    a. Trained for 20 hrs on 1 A100 GPU

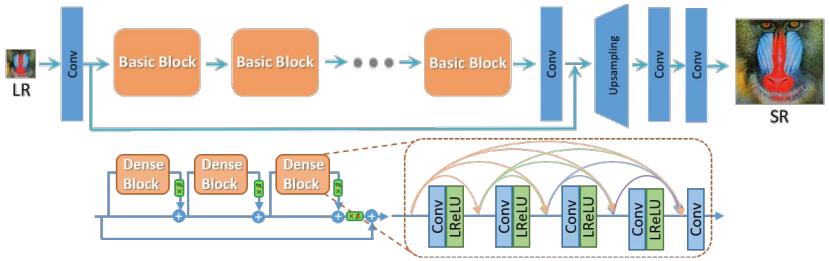


Use ESRGAN

by Xintao Wang et al

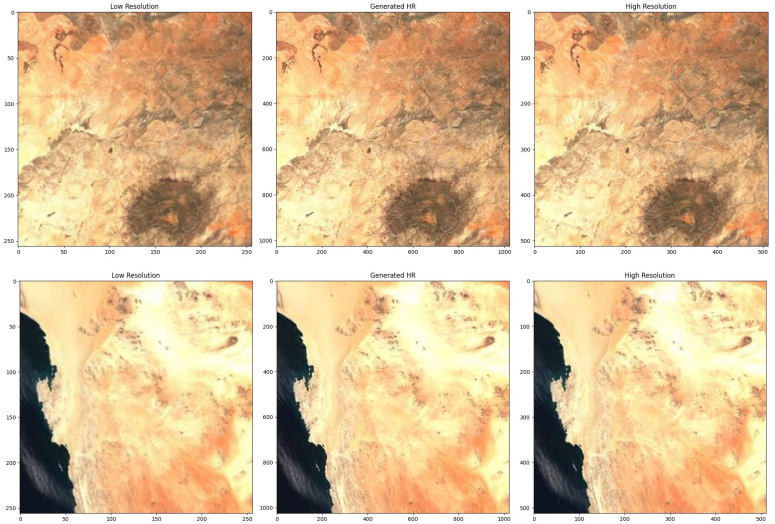
Plan

1. Test ESRGAN with my Images
2. 128x128 → 512x512
3. Compute Metrics of Generated Image
    a. Structural Similarity Index Measure
        Score: -1(complete dissimilarity) to 1(perfect similarity)
    b. Peak Signal-to-Noise Ratio
        Compares high-res and generated image by calculating the ratio between max. Possible power of a signal and the power of corrupting noise



Average PSNR: 30.20 dB

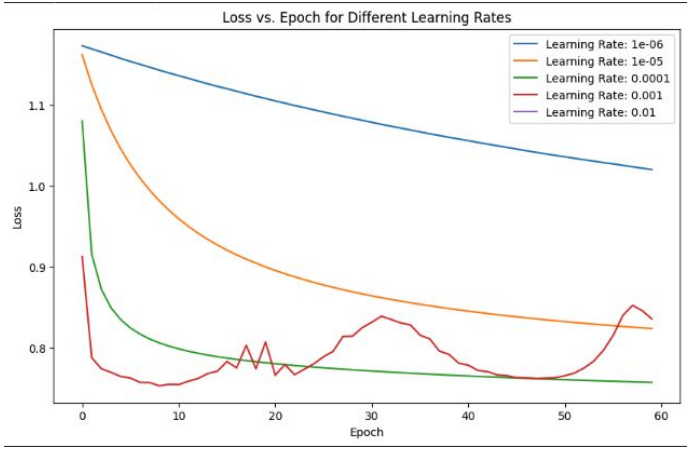
Average SSIM: 0.7521



Finetune ESRGAN

Plan

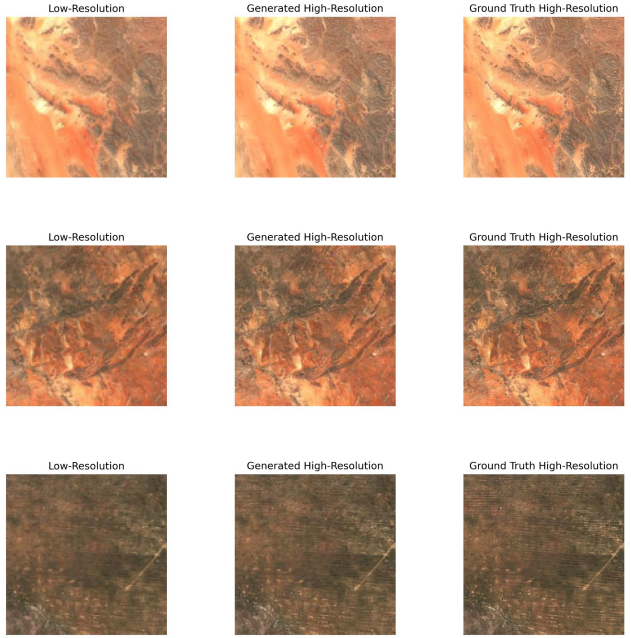
1. Finetune ESRGAN RRDB_ESRGAN_x4
2. Train on 22 images → Test on 3
    a. 128x128 → 512x512



3. Compute Metrics of Generated Image
    a. Structural Similarity Index Measure
    b. Peak Signal-to-Noise Ratio

Average PSNR: 31.14 dB

Average SSIM: 0.8061



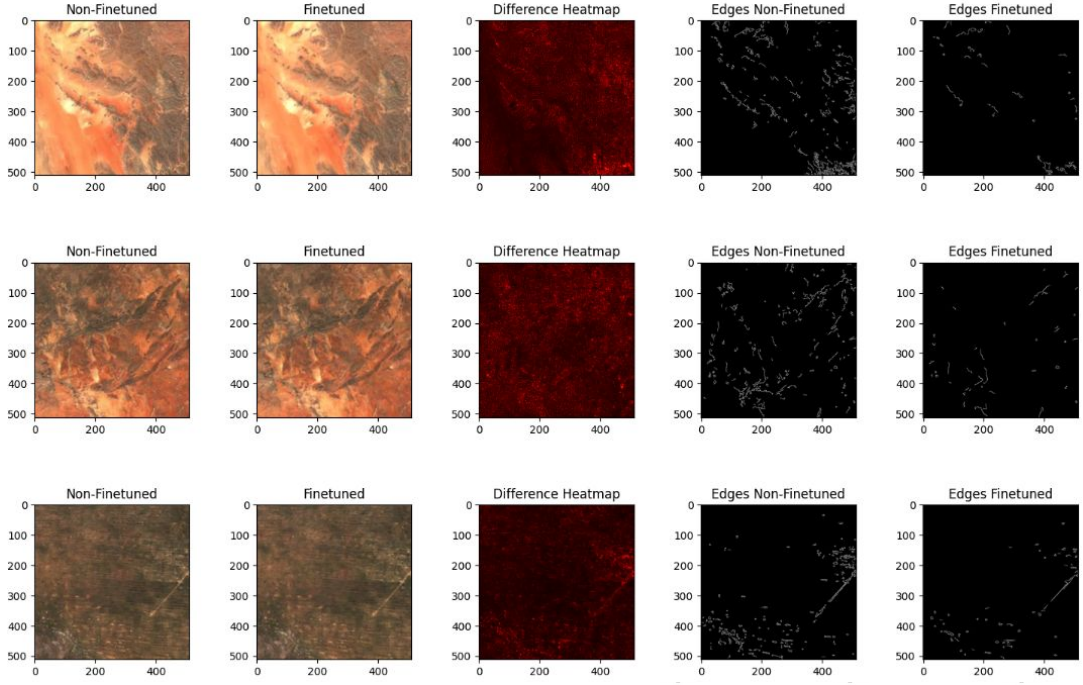
Comparing Results

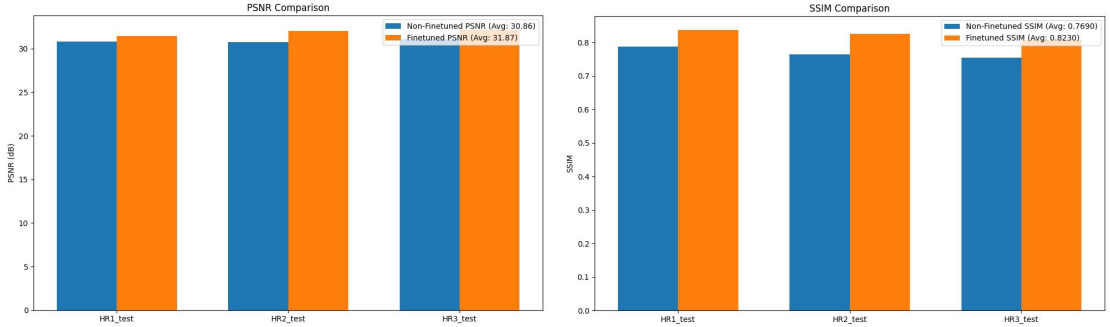
Fine Tuning ESRGAN Increased PSNR by 3.03%

$$\frac{(31.14\ \text{dB} - 30.20\ \text{dB})}{30.20\ \text{dB}}$$

Fine Tuning ESRGAN Increased SSIM by 11.79%

$$\frac{(0.8061 - 0.7521)}{0.7521}$$





Next Steps

1. Improve dataset
   a. Higher quality imagery from Sentinel-2 {R60, R10}
   b. Get more of it
2. Optimize ESRGAN Model further
3. Continue to try StyleGAN3

References

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