

Exploration of Super Resolution Image Enhancement

Alexander Nishio, Data Science, Purdue University

Seongha Park, Mathematics and Computer Science, Argonne National Laboratory

Introduction

Super-resolution is a image processing technique used to improve images through enhancing the resolution of a low-quality image. It plays a critical role in various fields for restoring old images, analyzing distant satellite images, and analyzing microscopic organisms in medical diagnoses. As technological and scientific advancements continue to improve, there is an increase in demand for image enhancement tools to create greater discoveries. This project serves to explore different types of super-resolution models and understand the feasibility of deploying such models into laboratory systems.

Background

I explored two models in this project: Real-ESRGAN and SUPIR, which are two of the best super resolution models in their own domain. Below is a general overview of the two models:

Real-ESRGAN (GAN Model)

- A Generator and a Discriminator competes against each other in performance
- Generator creates fake images to fool the Discriminator
- Discriminator tries to guess the real image between the generated image and the actual image
- Runs into issues if the Discriminator or the Generator is not effective enough

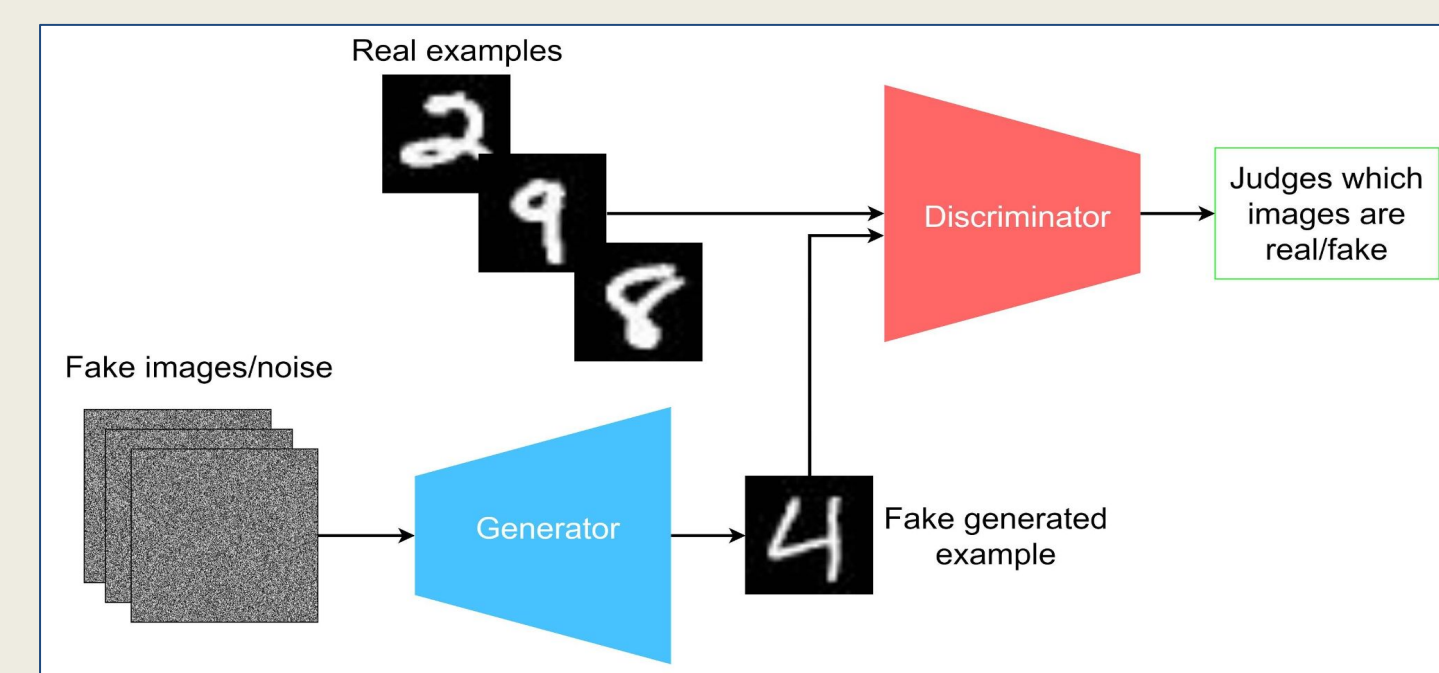


Figure 1: Diagram of a Generative Adversial Network (GAN) Model

SUPIR (Diffusion Model)

- A type of generator
- Adds noise to the original image and slowly denoises the image to learn complex patterns
- Adjusts loss to make sure the image is as high quality as possible
- There is an attached text prompt option to help guide the model to the correct output
 - Can plug in a Natural Language Processing Model for nice results
- Extremely computationally expensive, and the model is very large

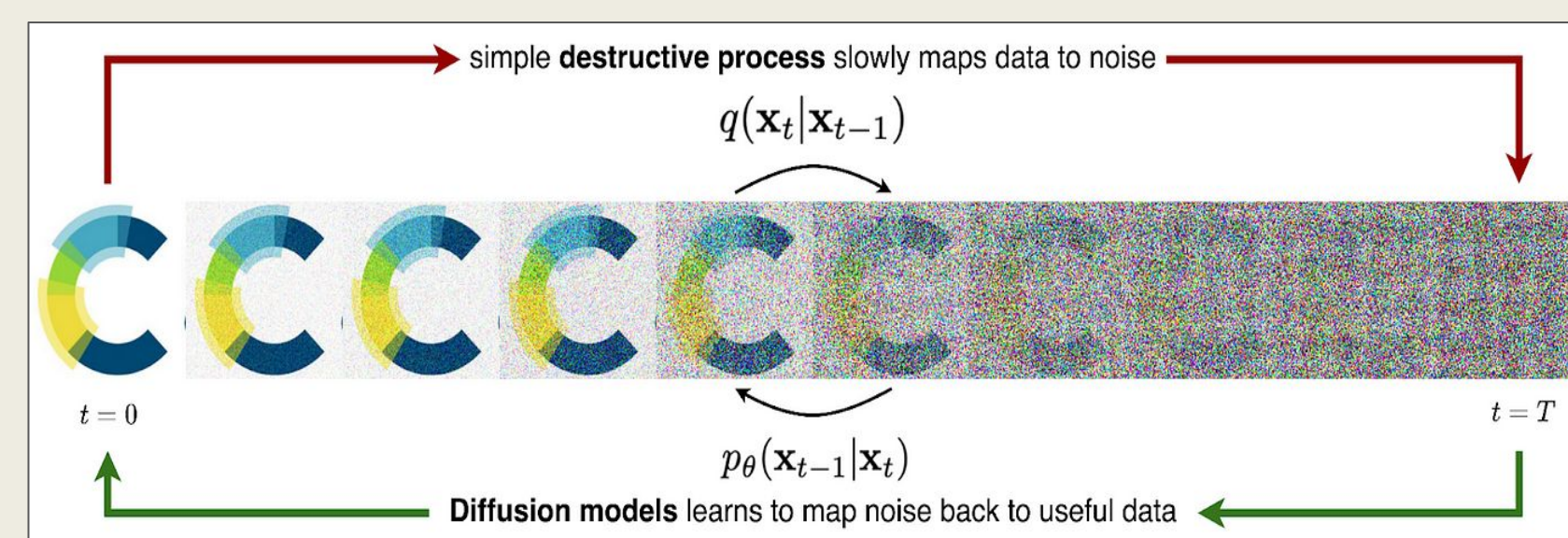


Figure 2: Diagram of a Diffusion Model

Results

Below are the results highlighting the advantages SUPIR has over Real-ESRGAN:

Advantages of Real-ESRGAN:

- Small model (<1 GB)
 - Requires <1 GB of VRAM
- Runs on CPU as well
- Fast compute time
- Deployable on Edge

Disadvantages of Real-ESRGAN

- Poor results if the image quality is too small
- Image enhancement is not very apparent

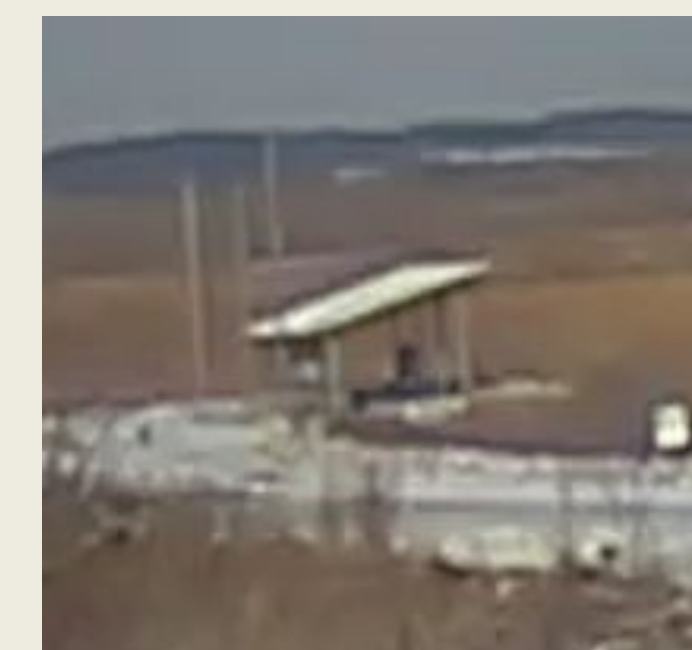
Advantages of SUPIR:

- The image enhancement is much more powerful compared to Real-ESRGAN

Disadvantages of SUPIR:

- Extremely large model (30-40 GB)
 - Requires 4-10 GB of VRAM
- Requires GPU
- Inefficient for large batch sizes
- Poor results if no text provided
- Poor at rendering text

Input: 220x190



Real-ESRGAN 4x



~10 seconds

SUPIR with prompt



~70 seconds

SUPIR without prompt



~70 seconds

Figure 3: Comparison of Results between the Two Models

Conclusion

We explored the advantages and disadvantages of Real-ESRGAN and SUPIR and determined that it is difficult to deploy super resolution models into the laboratory systems, since current technology does not provide a proper balance between number of computational resources, time, and quality generated.

Future Goals:

- Finish the deployment of models onto Lab Sage Nodes
- Implement a Slack Bot
- Create a Web Interface / Gradio for more customization