Image Colorizer

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Background

- Traditional manual colorization is time consuming and requires a lot of skill
- Convert grayscale images into realistic and visually appealing color images in a short amount of time

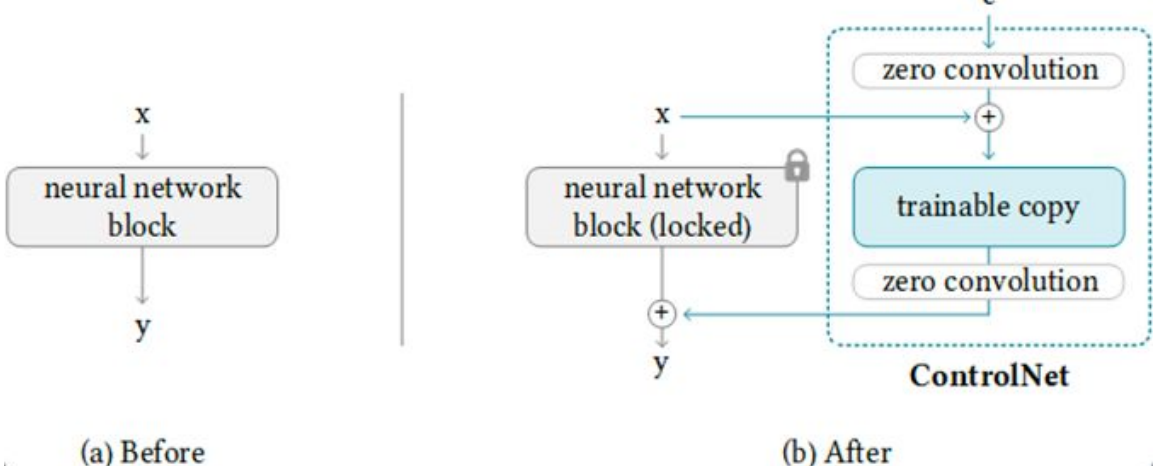
Final Goal:

- Achieve moderate accuracy in color prediction and quality over a variety of images and ensure images are visually appealing

Approach

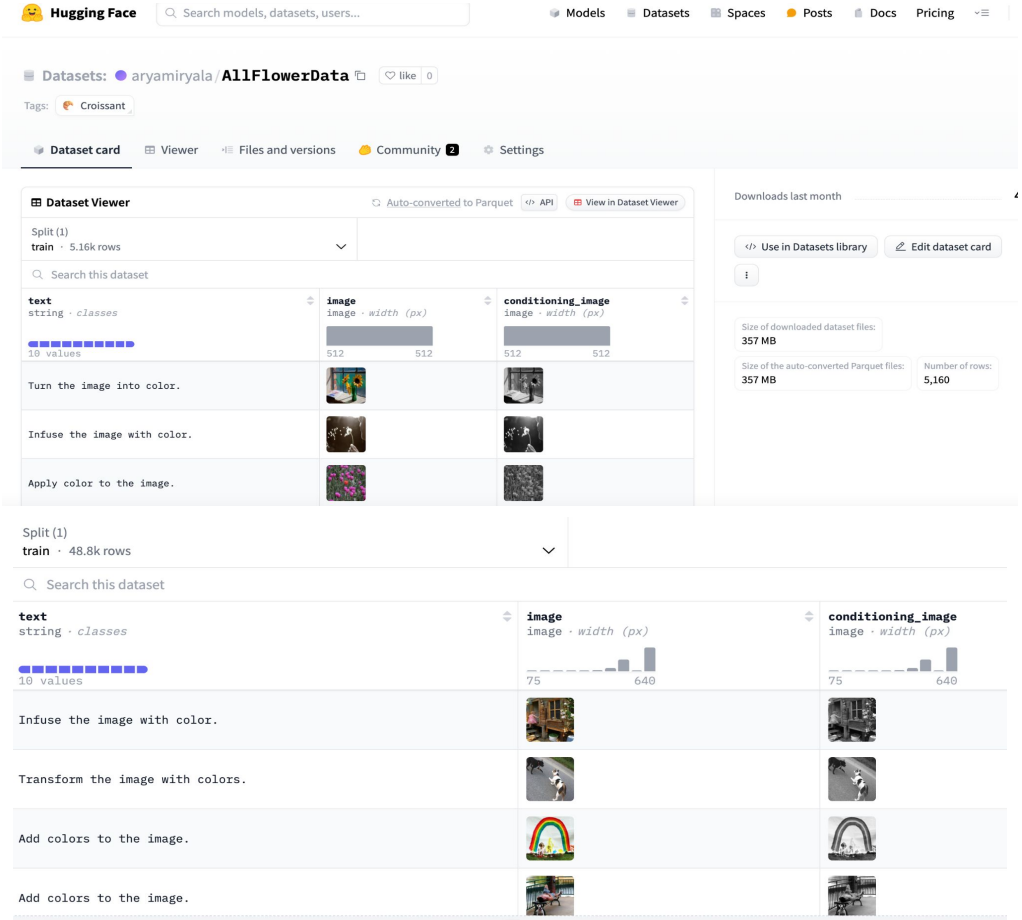
- Stability ai stable diffusion model
  - Initially trained with runwayml/stable-diffusion-v1-5 model but was older compared to stability ai and weren't getting good results

- Fine-tuning with ControlNet
  - With a ControlNet model, you can provide an additional control image to condition and fine-tune Stable Diffusion model.



Data Preparation

- Image data found through Kaggle and Coco.
- Dataset was deployed on Hugging Face
- Dataset was structured in a specific format for our model to use: text prompt, original image, conditioning image (greyscale version)
- Initially trained our model on 5k images of flower data to see results
- Then trained model on Coco images - around 50k images



Data Preprocessing

Preprocessing Steps

- Convert all images to black and white
- Make sure all images were same resolution (512x512). Most common chosen resolution for Diffusion model because it balances detail and computational efficiency
- Randomly assign text prompts to each image & conditioning image, i.e. something along the lines of “Colorize this image”
- Prepare a JSON file with the text prompt, and paths to the image and conditioning image
- Make a script that took data from JSON file and pushes the data to Hugging Face Hub for easy access for our model


```
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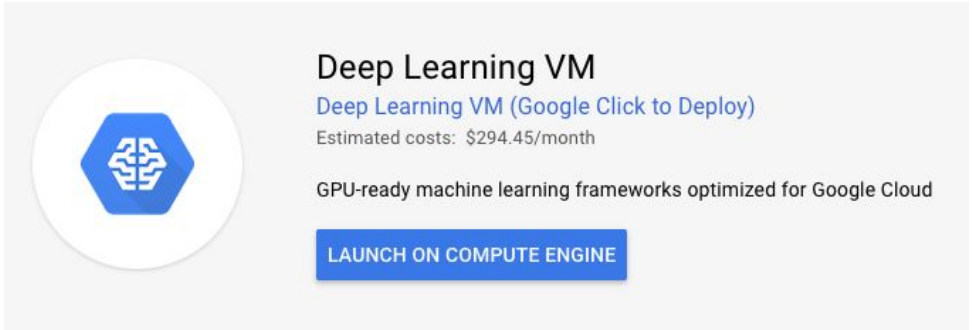
Training

- Google Colab
- Google Cloud Deep Learning Virtual Machines
  - L4 GPU



Model 1

- Learning Rate: 1e-5
- Dataset: ~5k images
- Train epochs: 10
- Diffusion model: runwayml/stable-diffusion-v1-5

Original

Input

Output

Model 2

- Learning Rate: 1e-4
- Dataset: ~5k images
- Train epochs: 10
- Diffusion model: stabilityai/stable-diffusion-v2-1

Original

Input

Output

Model 3

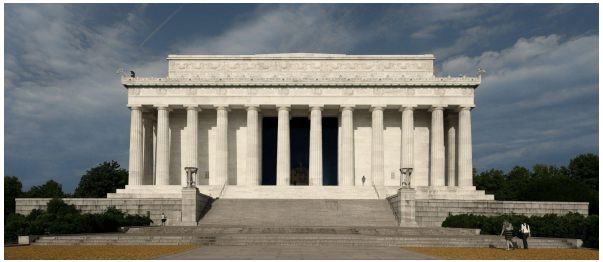
- Learning Rate: 1e-4
- Dataset: ~50k images
- Train epochs: 3 (18 hours)
- Diffusion model: stabilityai/stable-diffusion

Original

Input

Output

Results (with descriptive prompts)



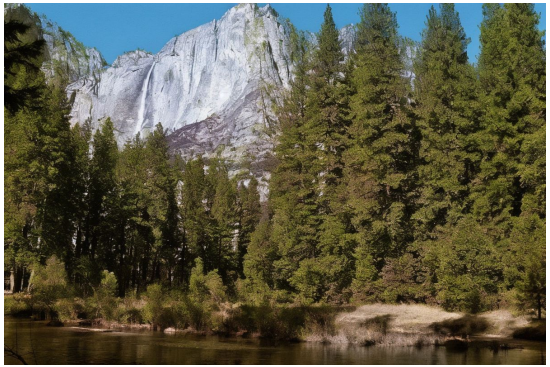
Cielab color space

Image quality enhancement

- Cielab has one channel for lightness L* and two for color (a* and b*)
- Combine L* channel of input image with color channels of output image

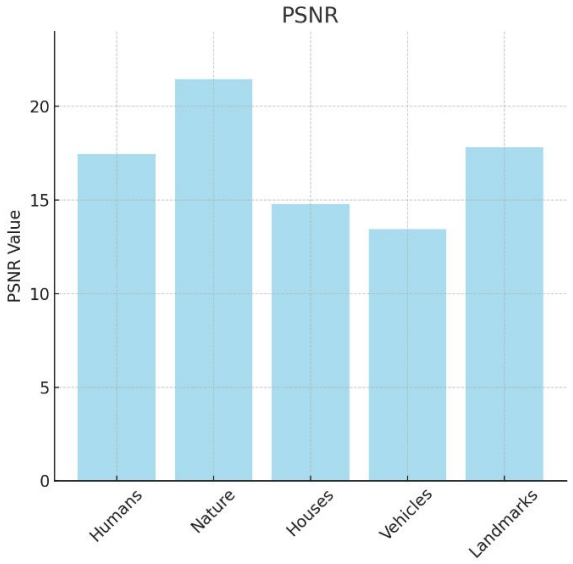
Input

Output



Enhanced output

Evaluation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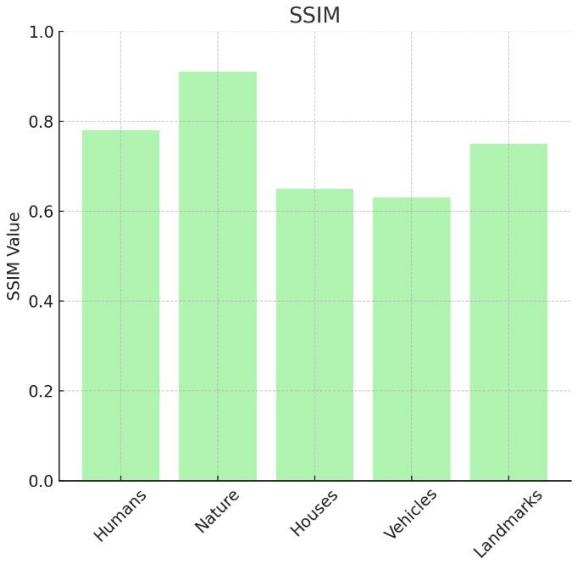
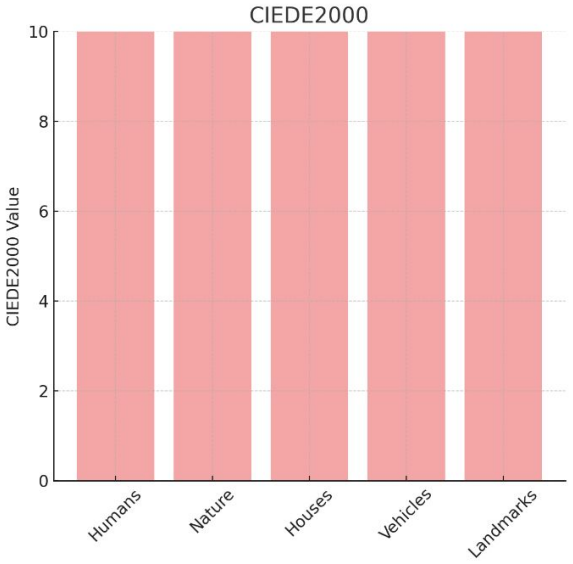
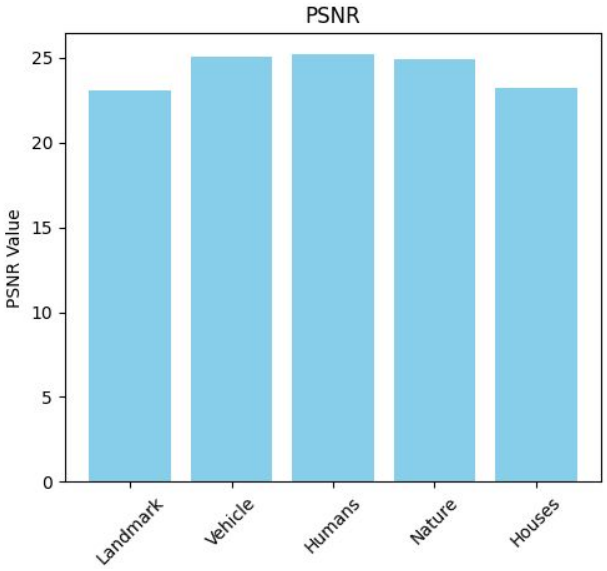
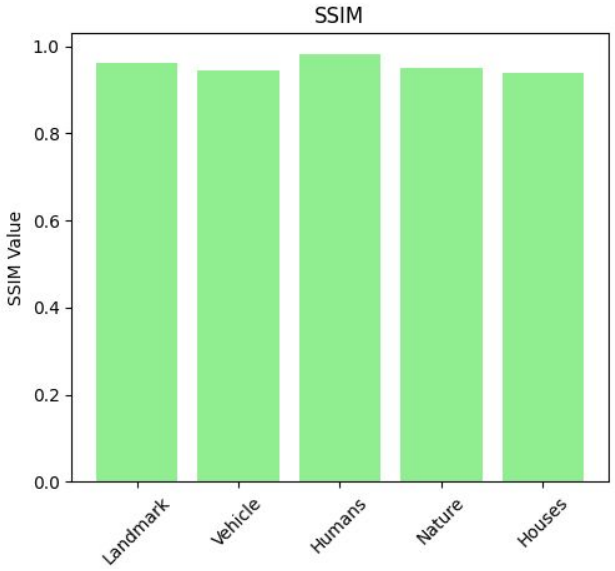
5
10
15
20
Humans
Nature
Houses
Vehicles
Landmarks

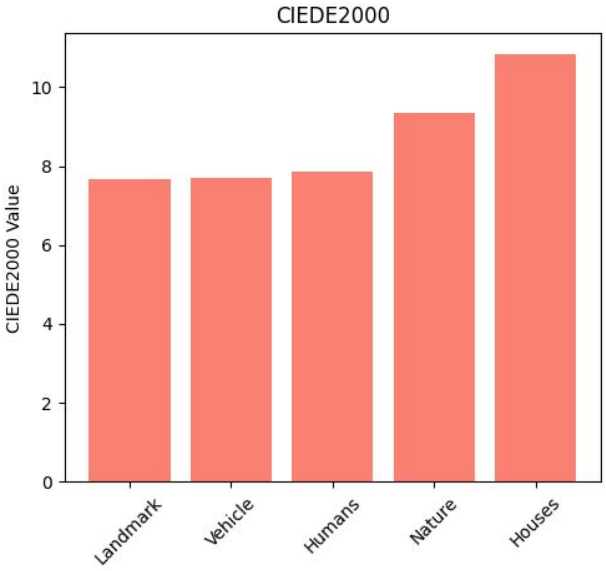

SSIM
SSIM Value
0.0
0.2
0.4
0.6
0.8
1.0
Humans
Nature
Houses
Vehicles
Landmarks


CIEDE2000
CIEDE2000 Value
0
2
4
6
8
10
Humans
Nature
Houses
Vehicles
Landmarks

Evaluation after hand making prompts







Limitations

- Couldn’t train on more images because of storage limitations -
  - resorted to training for multiple epochs because of this
  - Resorted to checkpoint training
- Lack of computational power
  - Did not have much access to powerful GPUs to train our model
  - Had to utilize L4’s for the most part which was not that great for our needs
- Time
  - Training the model with large amounts of data and for multiple epochs would take many hours at a time
  - Would take a while to improve upon our existing models significantly because of this

Conclusion + Future Goals

- Overall we achieved our goal of getting mediocre results given the resources that we had
- Learned the importance of having the right resources for training such a robust model on a large dataset
- In the future we would like to train for longer on a larger dataset if we are able to get the resources to do so

Thank You!