The Rest of the Owl

Image Generation Using Conditional GANs

by Joshua Gottlieb

How to draw an owl

1.

1. Draw some circles

2.

2. Draw the rest of the fucking owl

Data Acquisition

Roughly ~30,000 images scraped from:

- Adobe Stock
- Fine Art America
- VectorStock

2381 images manually selected.

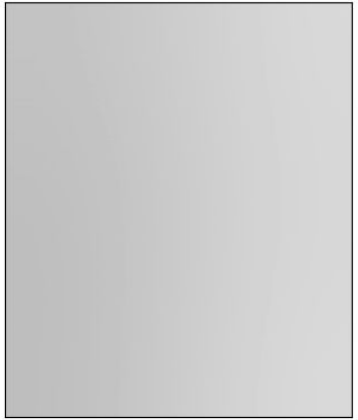
80/20 split into train and test.


Owl

Ground Truth

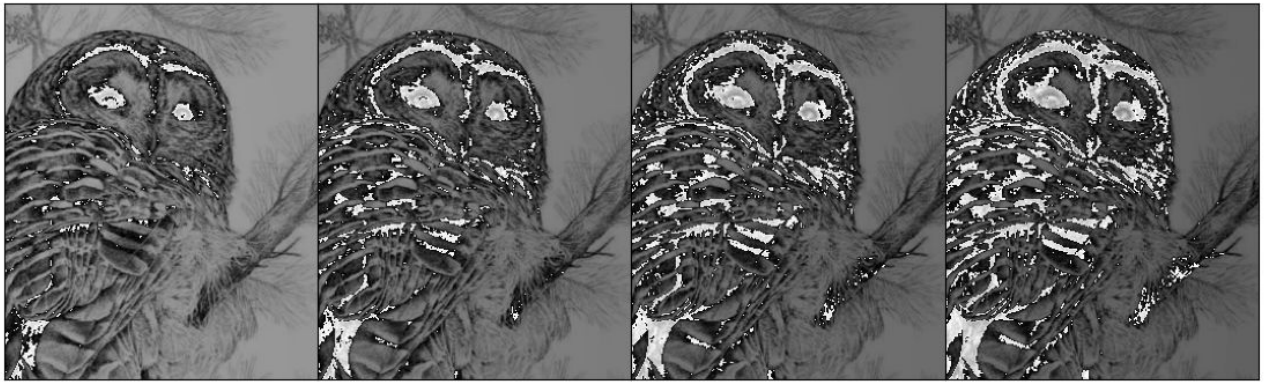
Weak Blur

$- \gamma$



Strong Blur

$=$



Gamma: 0.48 Gamma: 0.6 Gamma: 0.67 Gamma: 0.72

Threshold 0.01
Gamma: 0.48

Threshold 0.03
Gamma: 0.6

Threshold 0.05
Gamma: 0.67

Threshold 0.07
Gamma: 0.72

Ground-Truth

Threshold 0.01
Gamma: 0.32

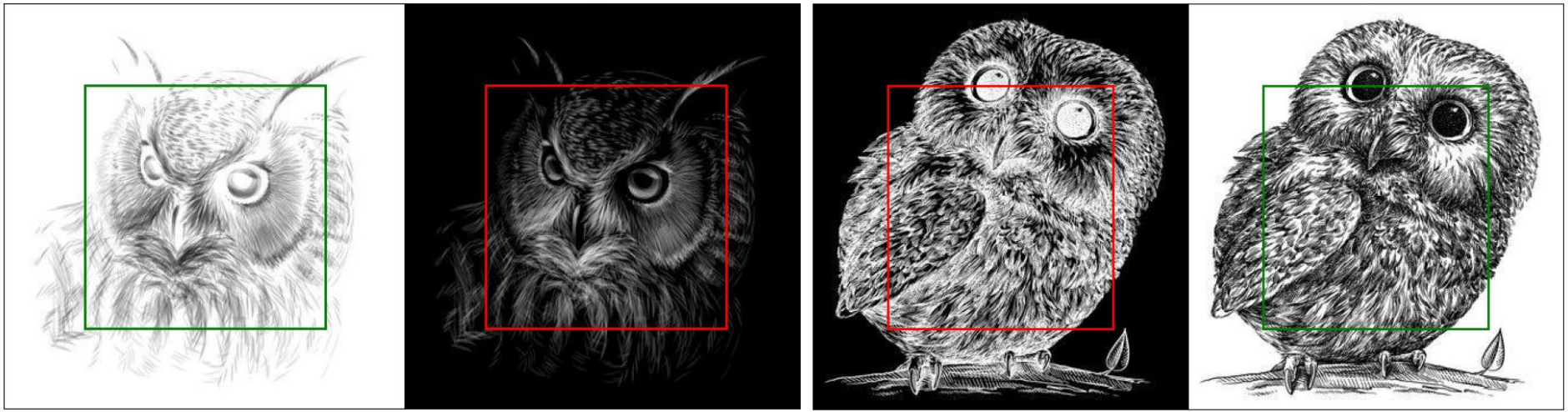
Threshold 0.03
Gamma: 0.4

Threshold 0.05
Gamma: 0.47

Threshold 0.07
Gamma: 0.53

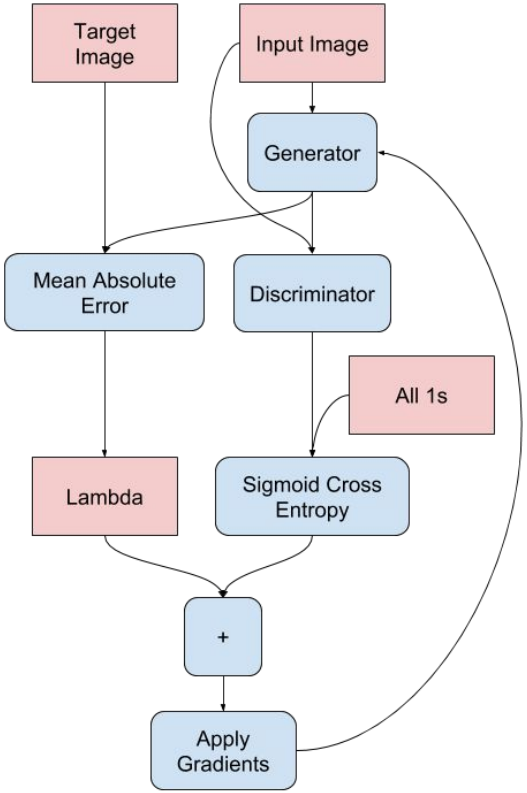
Ground-Truth

Inverted vs. Regular

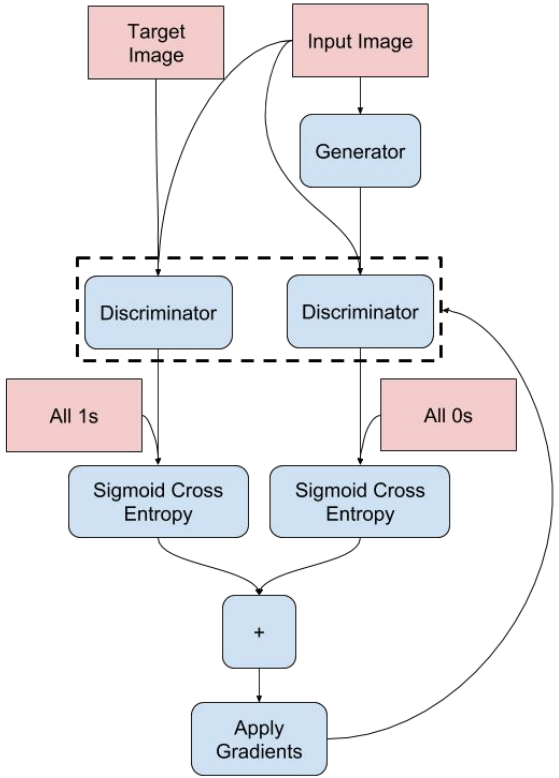


~55% of images regular, ~45% of images inverted

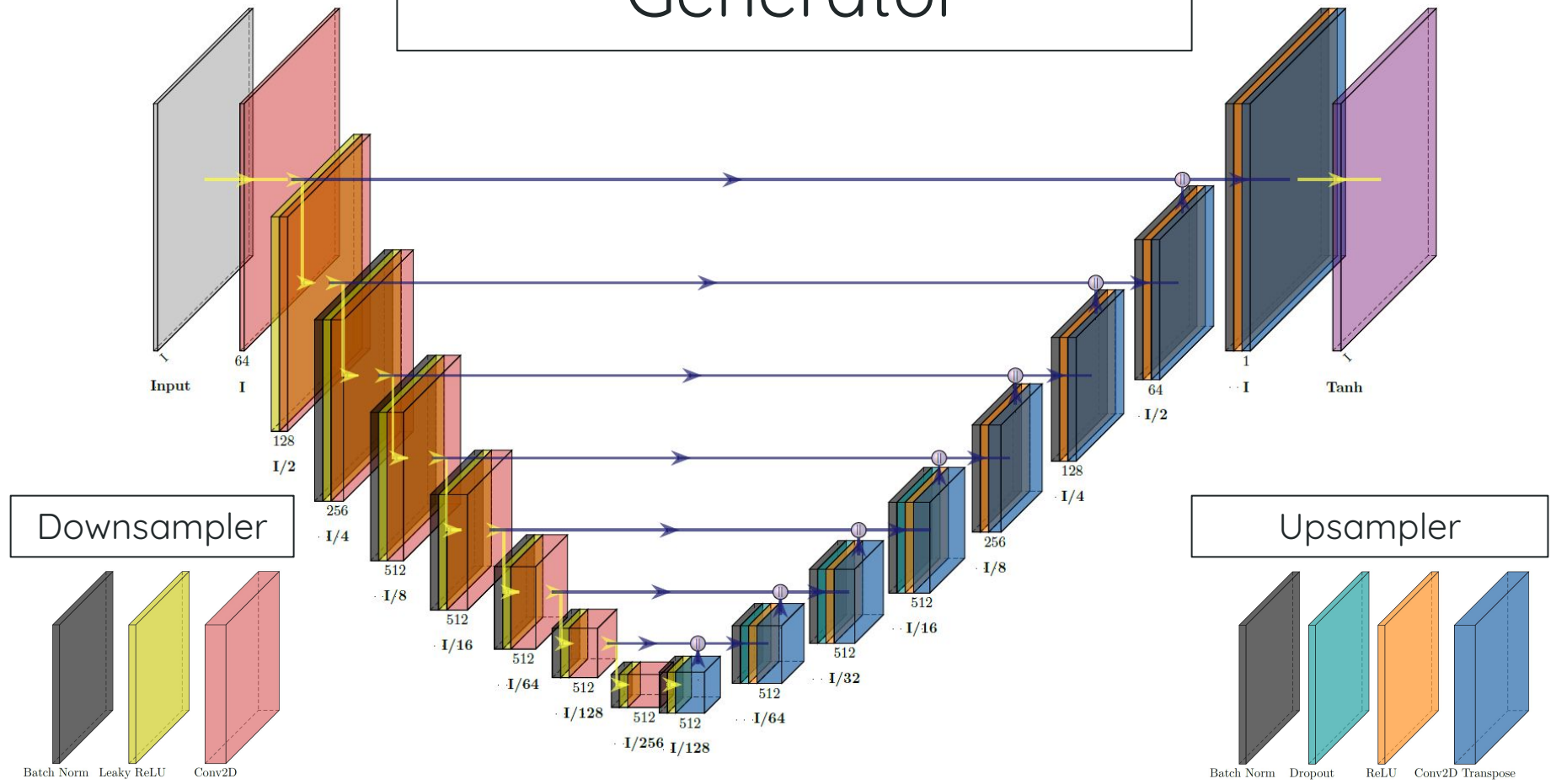
Generator Training Loop



Discriminator Training Loop



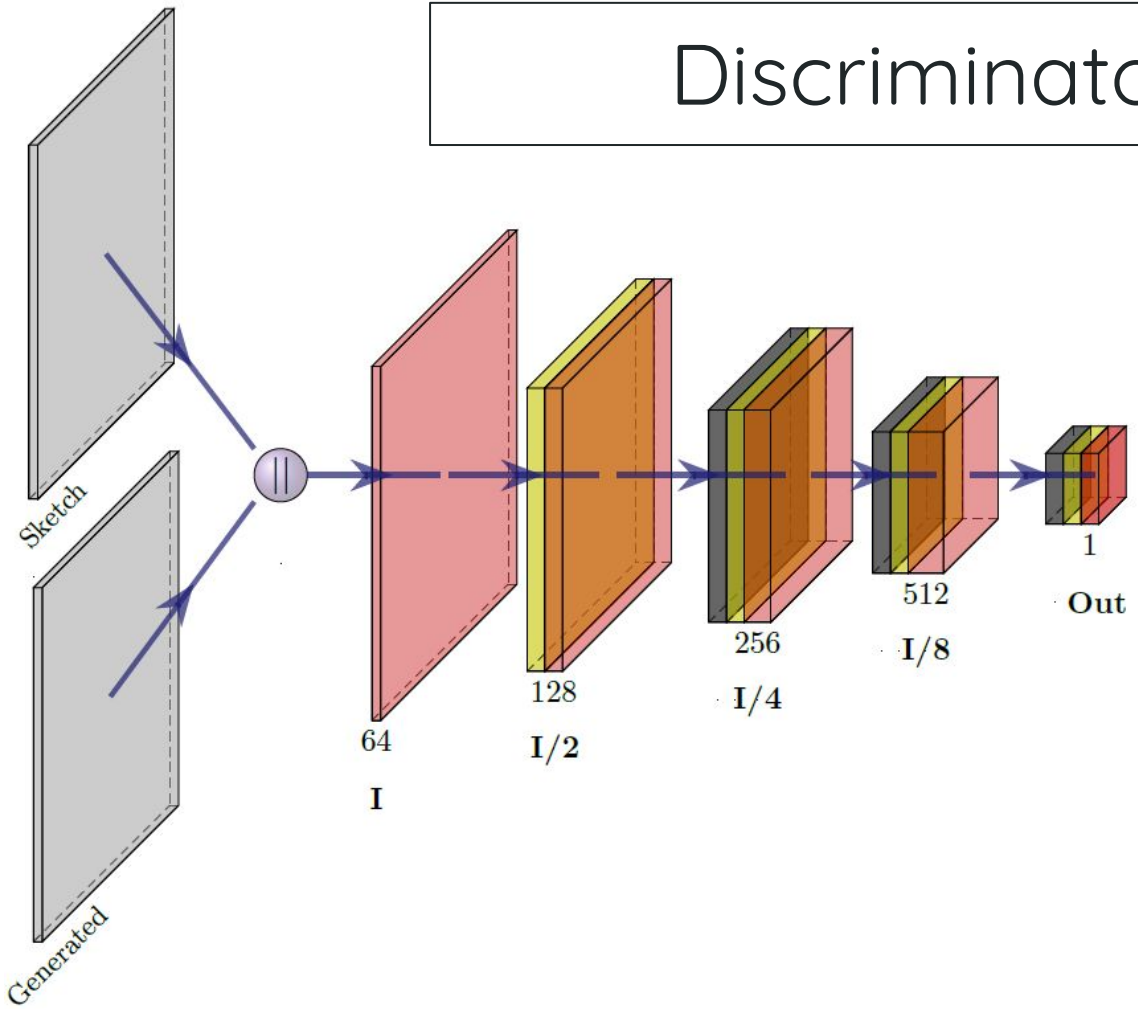
Generator



Downsampler

Upsampler

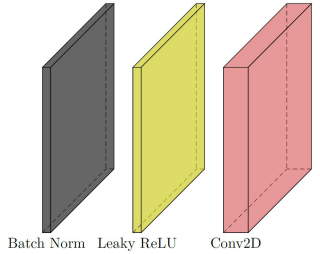
Discriminator



Output is an image of size (29, 29).

Binary Cross Entropy computes Sigmoid.

Downsampler



pix2pix Loss Functions

$$\mathcal{L}_{cGAN}(G,D) = \mathbb{E}_{x,y}\left[\ln D(x,y)\right] + \mathbb{E}_{x,z}\left[\ln\left(1 - D\big(x, G(x,z)\big)\right)\right]$$

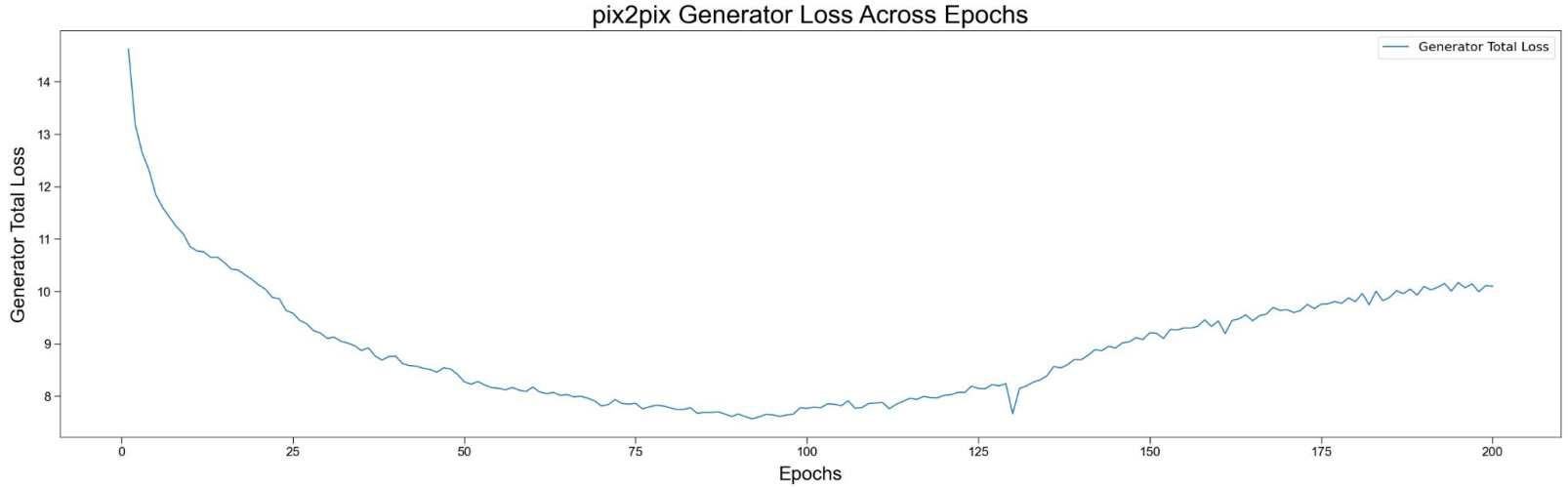
$$\mathcal{L}_{L1}(G) = \mathbb{E}_{x,y,z}\left[\|y - G(x,z)\|_1\right] \qquad \mathcal{L}_{pix2pix} = \mathcal{L}_{cGAN} + 100 \cdot \mathcal{L}_{L1}$$

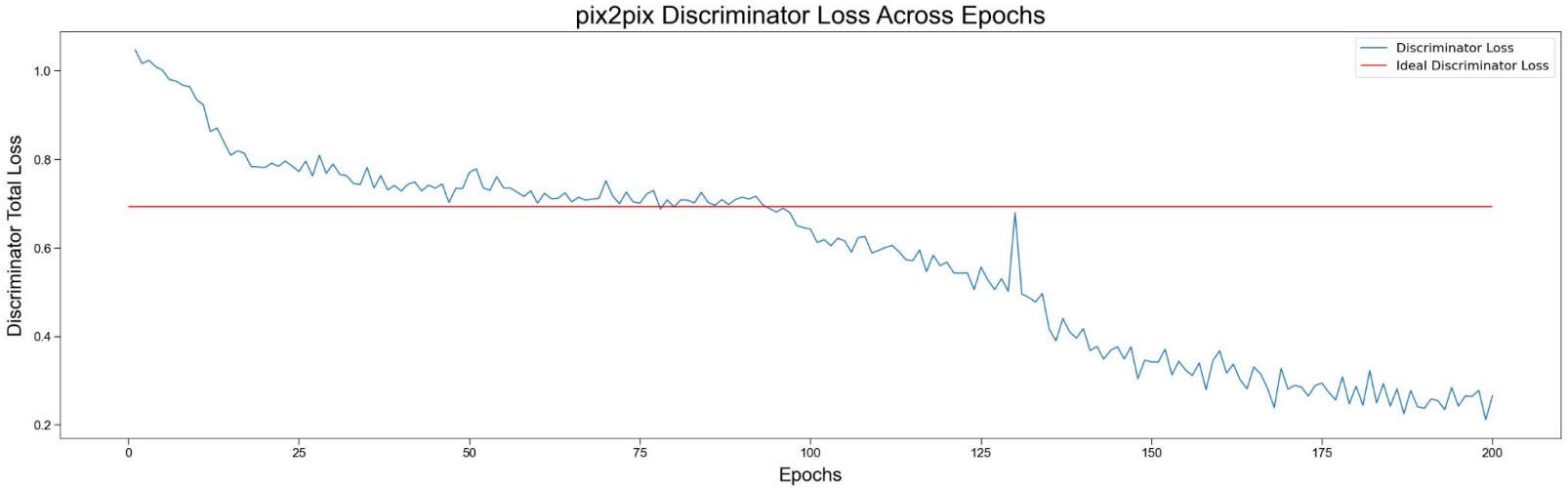
Autopainter Loss Functions

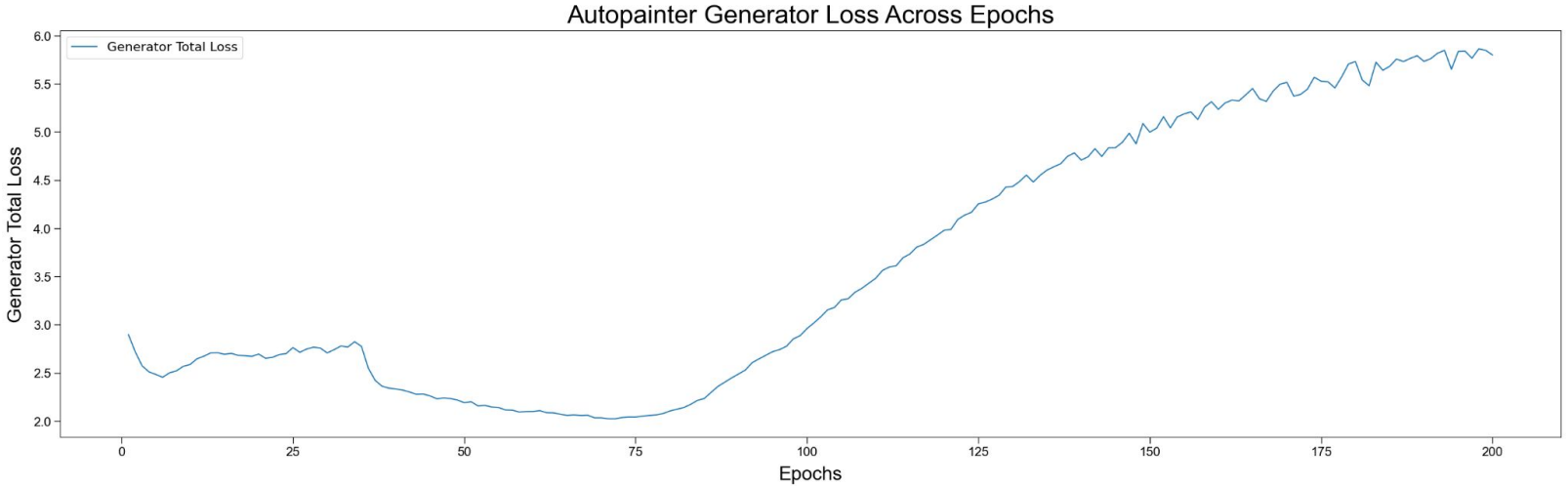
$$\mathcal{L}_{feature}(G,\phi) = \mathbb{E}\left[\|\phi_j(y) - \phi_j\big(G(x,z)\big)\|_2\right]$$ Using VGG16, Conv3_3

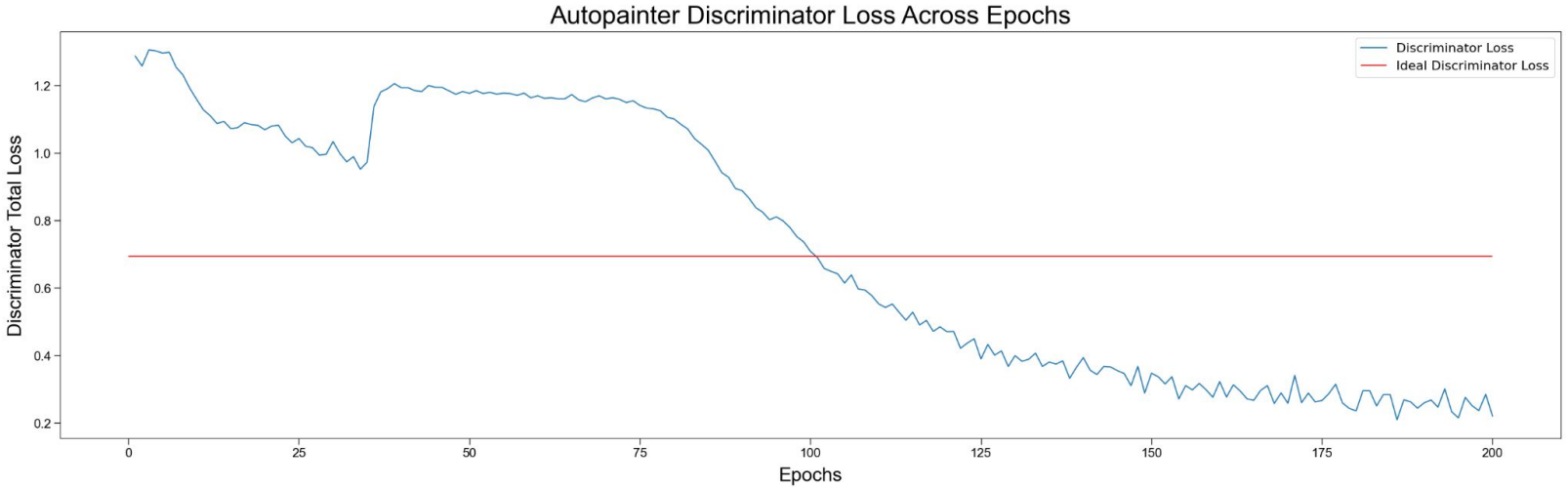
$$\mathcal{L}_{tv}(G) = \sqrt{\big(G(x,z)_{i+1,j} - G(x,z)_{i,j}\big)^2 + \big(G(x,z)_{i,j+1} - G(x,z)_{i,j}\big)^2}$$

$$\mathcal{L}_{autopainter} = \mathcal{L}_{cGAN} + 10 \cdot \mathcal{L}_{L1} + 10^{-5} \cdot \mathcal{L}_{tv} + 10^{-4} \cdot \mathcal{L}_{feature}$$


pix2pix Generator Loss Across Epochs
Generator Total Loss
Epochs
Generator Total Loss
14
13
12
11
10
9
8
0
25
50
75
100
125
150
175
200


pix2pix Discriminator Loss Across Epochs
Discriminator Total Loss
Epochs
Discriminator Loss
Ideal Discriminator Loss
1.0
0.8
0.6
0.4
0.2
0
25
50
75
100
125
150
175
200


Autopainter Generator Loss Across Epochs
Generator Total Loss
Generator Total Loss
Epochs
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
0
25
50
75
100
125
150
175
200


Autopainter Discriminator Loss Across Epochs
Discriminator Loss
Ideal Discriminator Loss
Discriminator Total Loss
Epochs
1.2
1.0
0.8
0.6
0.4
0.2
0
25
50
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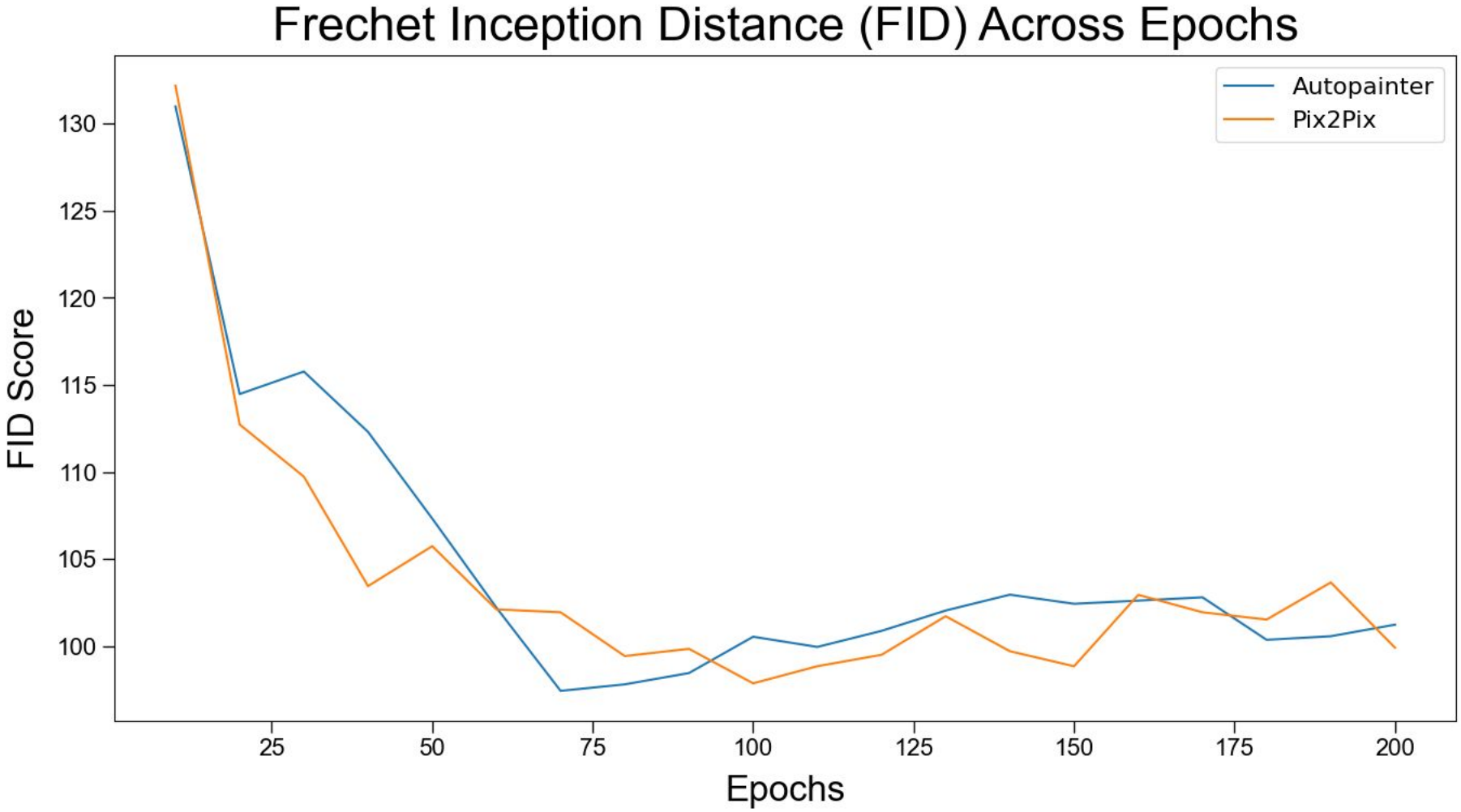
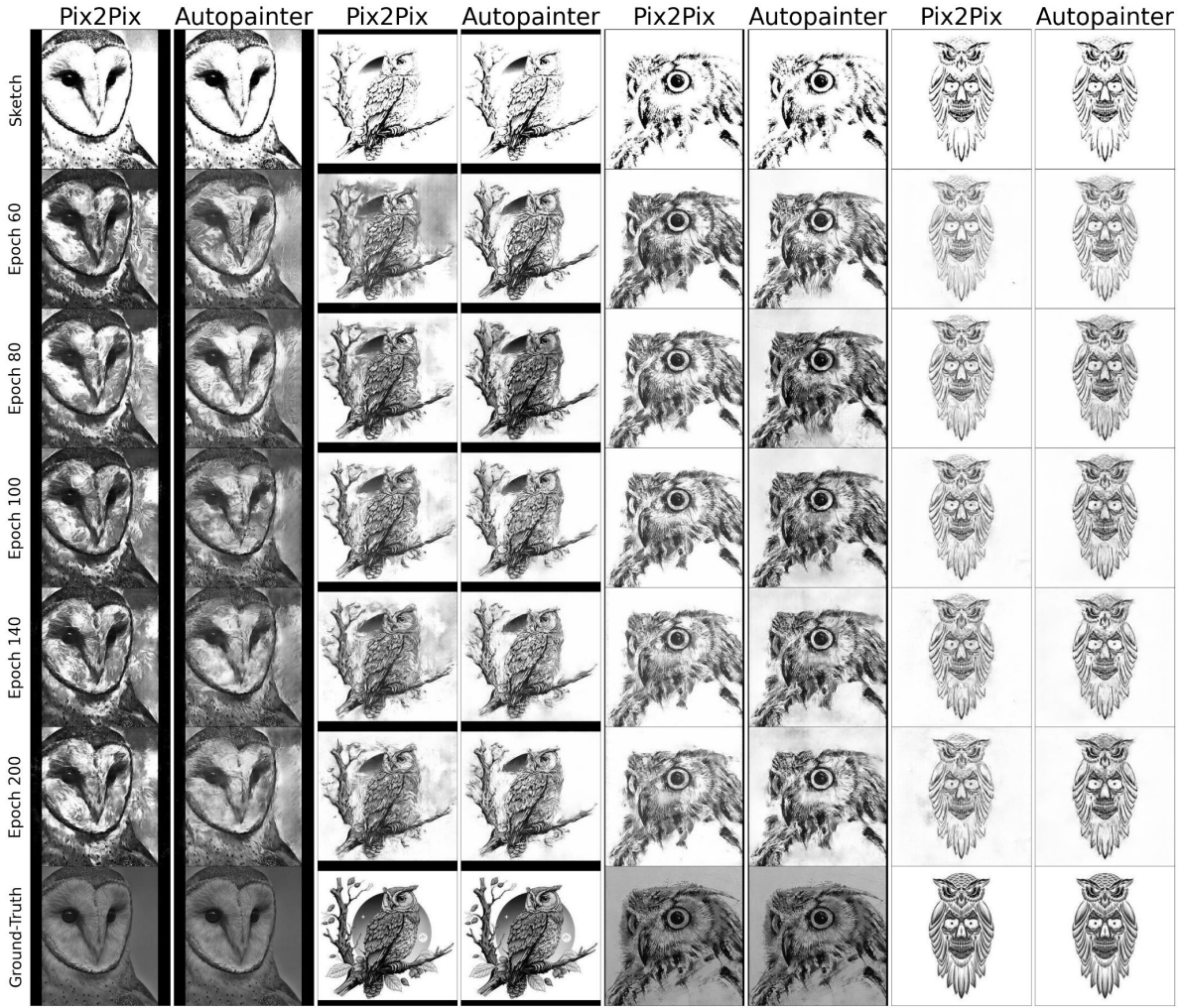
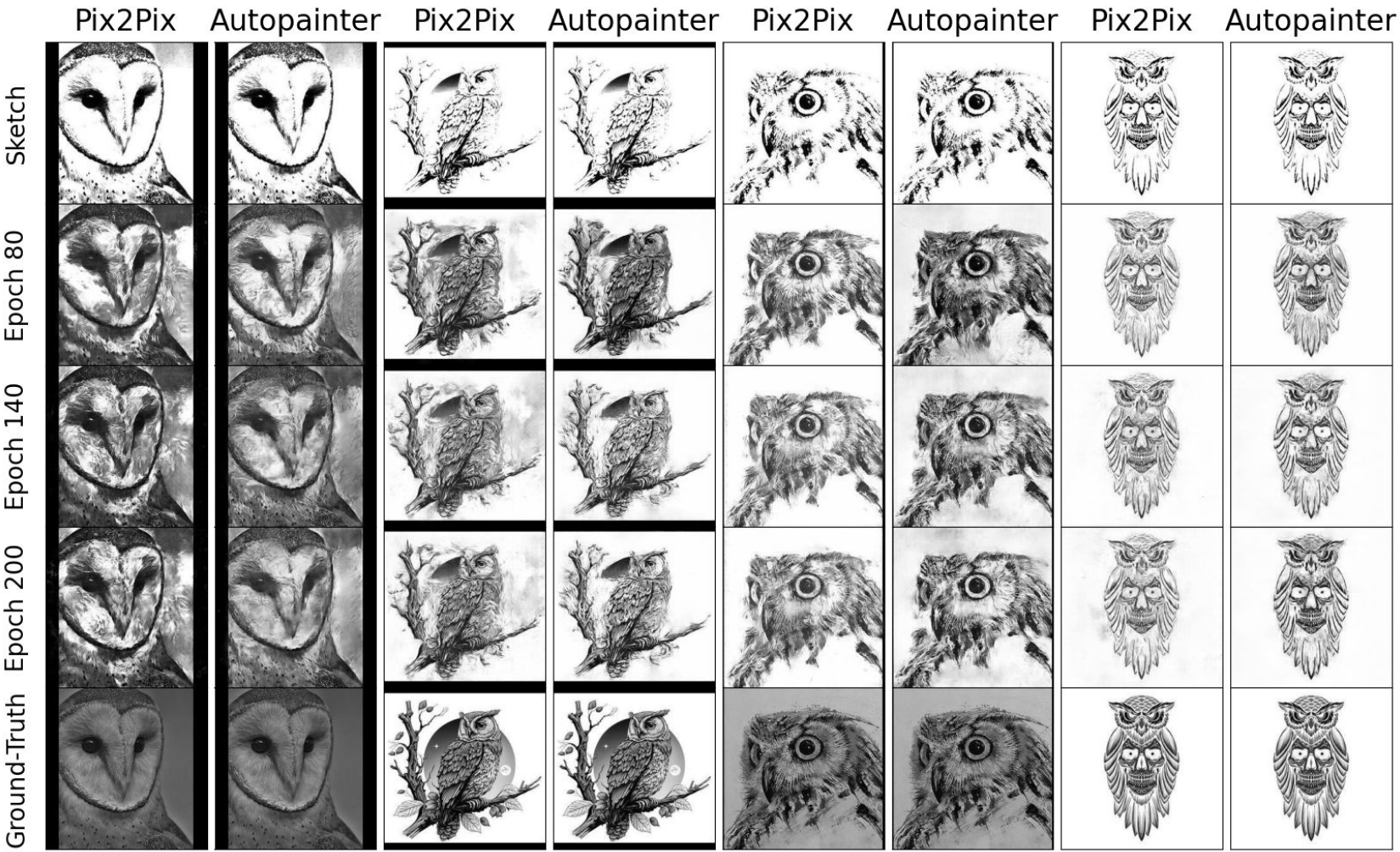
100
125
150
175
200


Frechet Inception Distance (FID) Across Epochs
Autopainter
Pix2Pix
FID Score
130
125
120
115
110
105
100
25
50
75
100
125
150
175
200
Epochs

Models and Scores - FID Scores

	30 Epochs	60 Epochs	80 Epochs	100 Epochs	140 Epochs	180 Epochs	200 Epochs
pix2pix (Best at 100)	109.733	102.114	99.433	**97.868**	99.711	101.529	99.914
Autopainter (Best at 70)	115.766	102.215	**97.809**	100.543	102.958	100.366	101.236


Pix2Pix
Autopainter
Pix2Pix
Autopainter
Pix2Pix
Autopainter
Pix2Pix
Autopainter
Sketch
Epoch 60
Epoch 80
Epoch 100
Epoch 140
Epoch 200
Ground-Truth


Pix2Pix
Autopainter
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Sketch
Epoch 80
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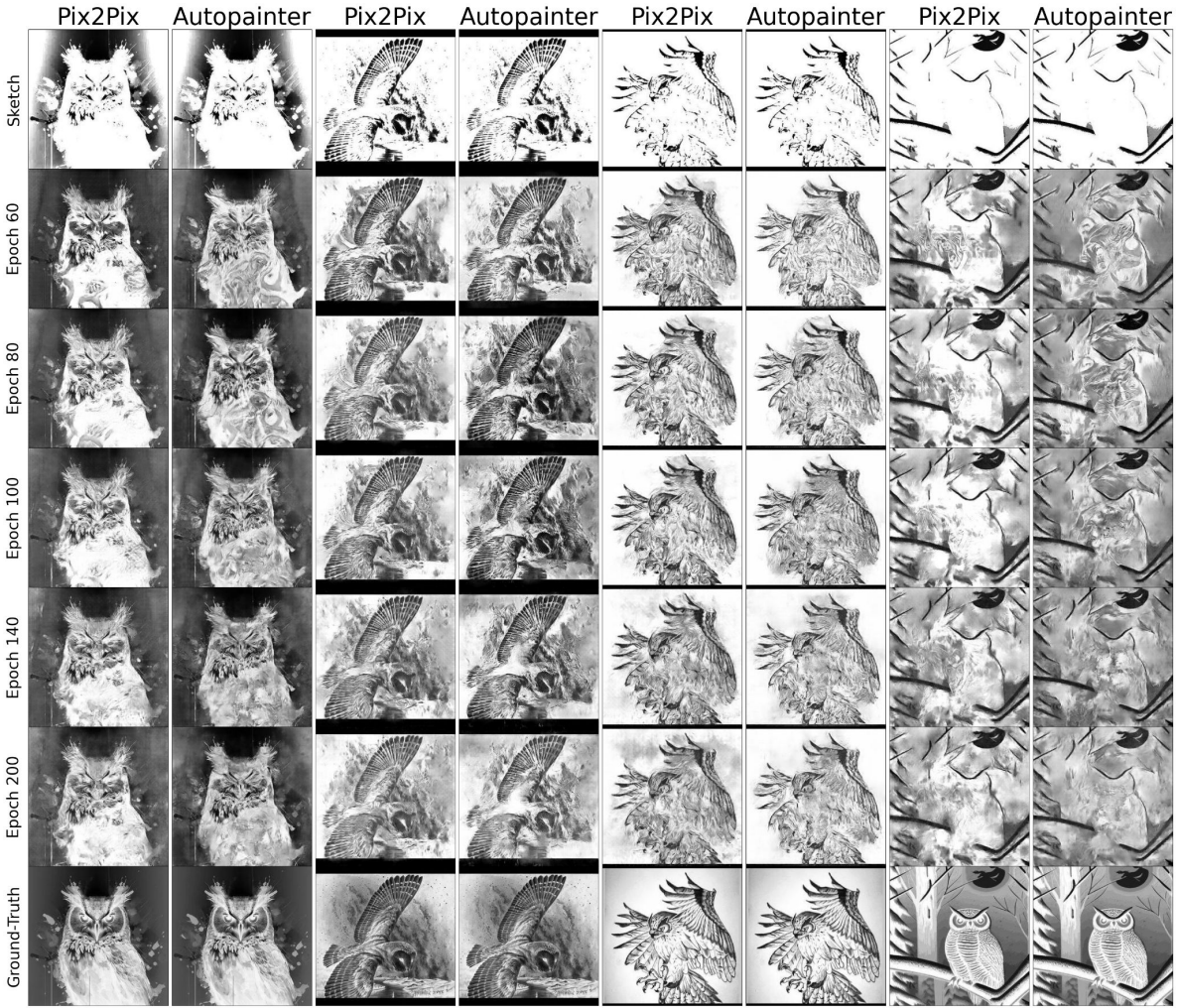
Pix2Pix
Autopainter
Pix2Pix
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Sketch
Epoch 60
Epoch 80
Epoch 100
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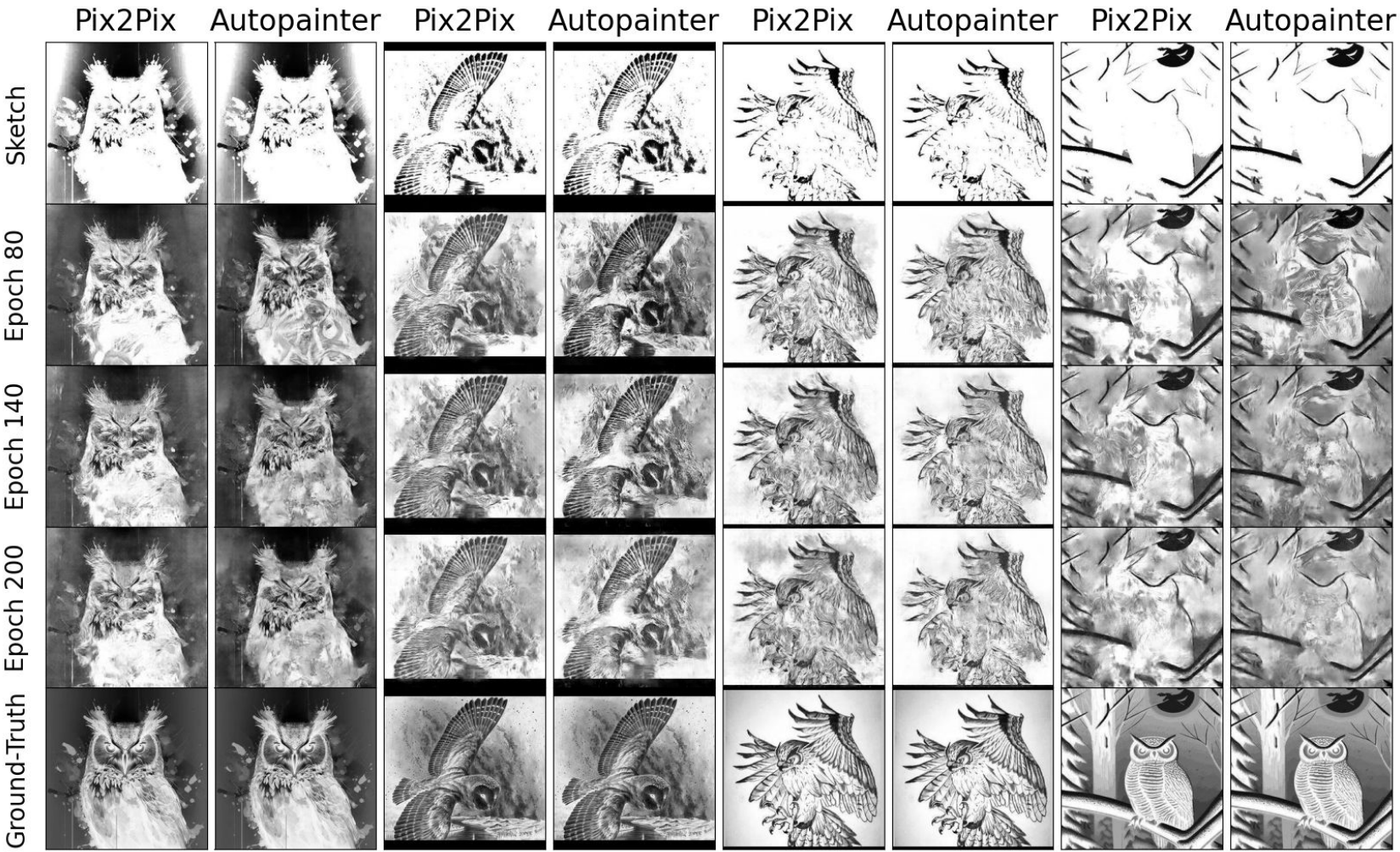
Pix2Pix
Autopainter
Pix2Pix
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Epoch 80
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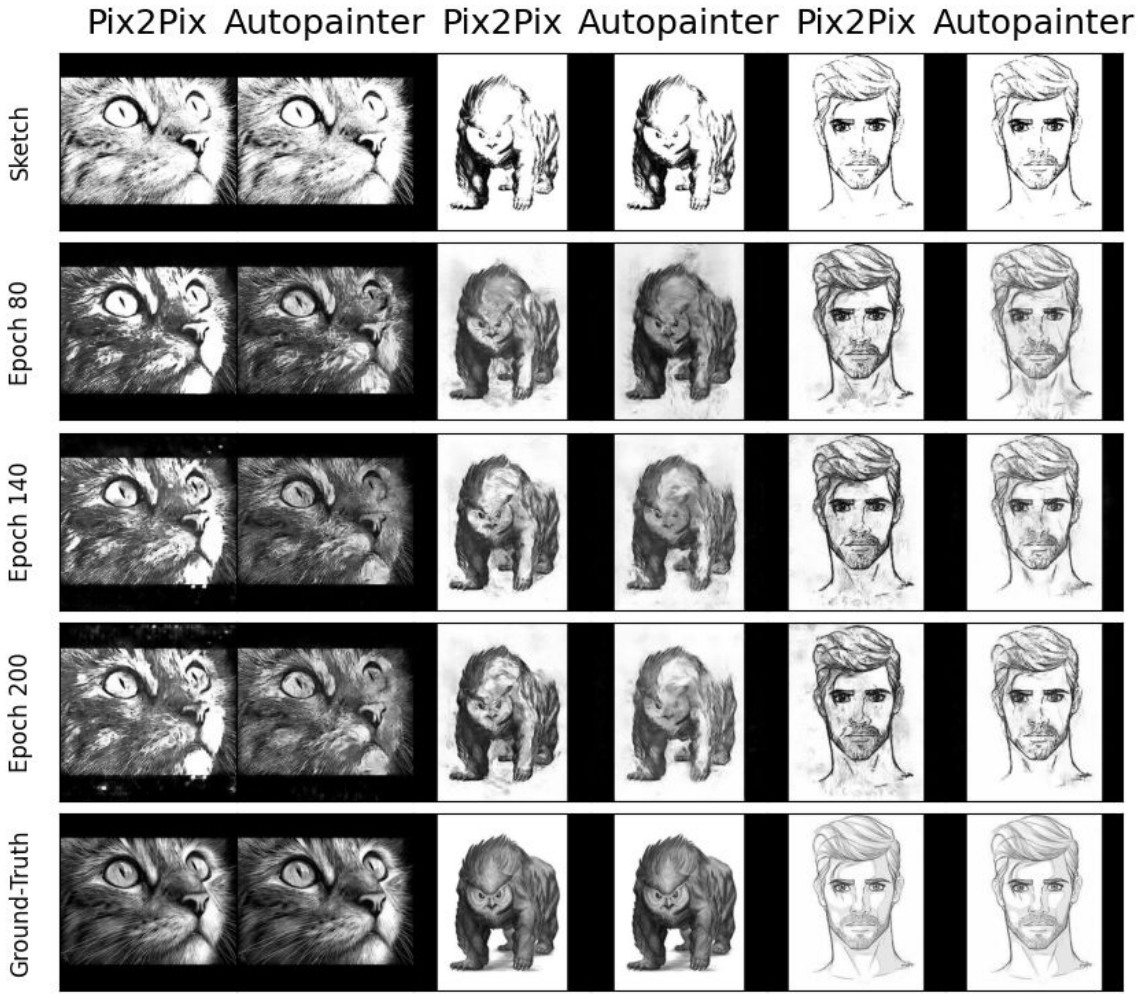
Pix2Pix
Autopainter
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Autopainter
Sketch
Epoch 80
Epoch 140
Epoch 200
Ground-Truth

Things to Test in the Future

- Use more data, and further normalize data
- Test different batch sizes (used batch size of 1)
- Tune roughly a dozen hyperparameters

Thank you for listening!

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