

CIS 680 Homework 5 Answers

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1 Variational Auto-Encoders (VAE)

1.1 Training Curves

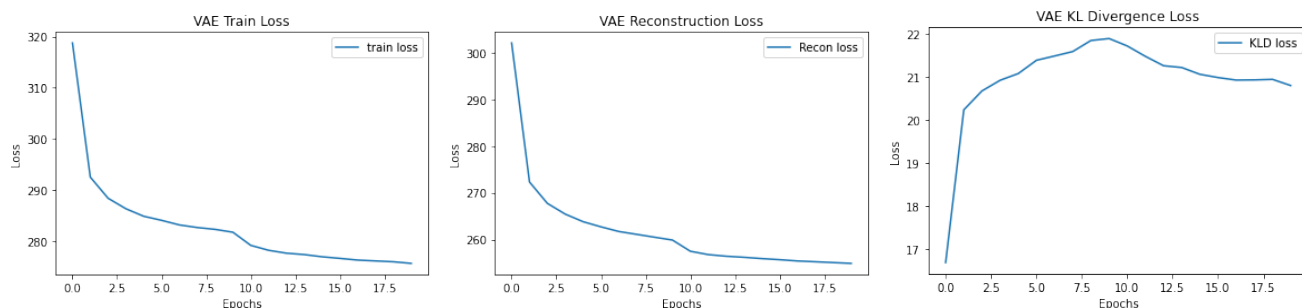


Figure 1: VAE training losses

We trained the network for 20 epochs, and set $\text{ZDIM} = 10000$. Notice that the KL divergence loss first increases, and then decreases slowly. This is because `nn.Linear` adopts Kaiming uniform initialization at the beginning which yields $\mu = 0, \sigma = 1$. Since KL divergence measures the distance between $N(\mu, \sigma^2)$ and $N(0, 1)$, the initial loss would be small. As the network parameters get updated, the learned mean and variance would first diverge from $N(0, 1)$ and further converges to $N(0, 1)$.

1.2 Qualitative Evaluations

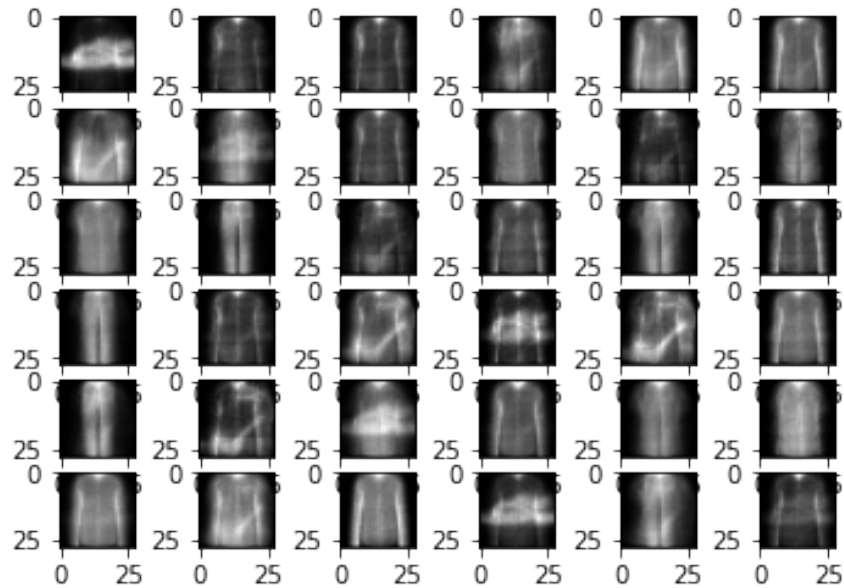


Figure 2: VAE Visualization on random latent variables.

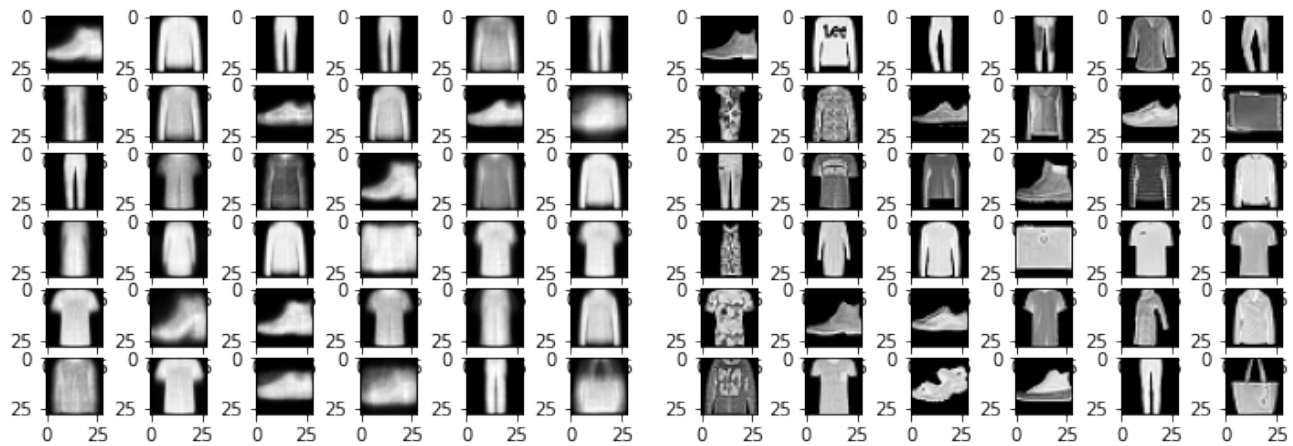


Figure 3: VAE Visualization with our reconstruction images (6x6) on the left hand side, ground truth images (6x6) on the right hand side.

1.3 Quantitative Evaluations

The final reconstruction error is 0.41.

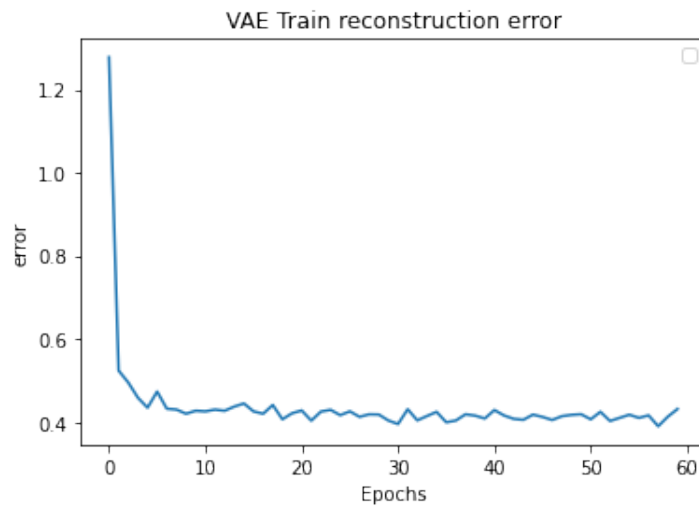


Figure 4: VAE training reconstruction errors

Image Set	IS VAE
Real image set	4.35
Generated image set	2.09

Table 1: IS score table of VAE

2 Generative Adversarial Networks (GAN, DC-GAN)

2.1 Training Curves

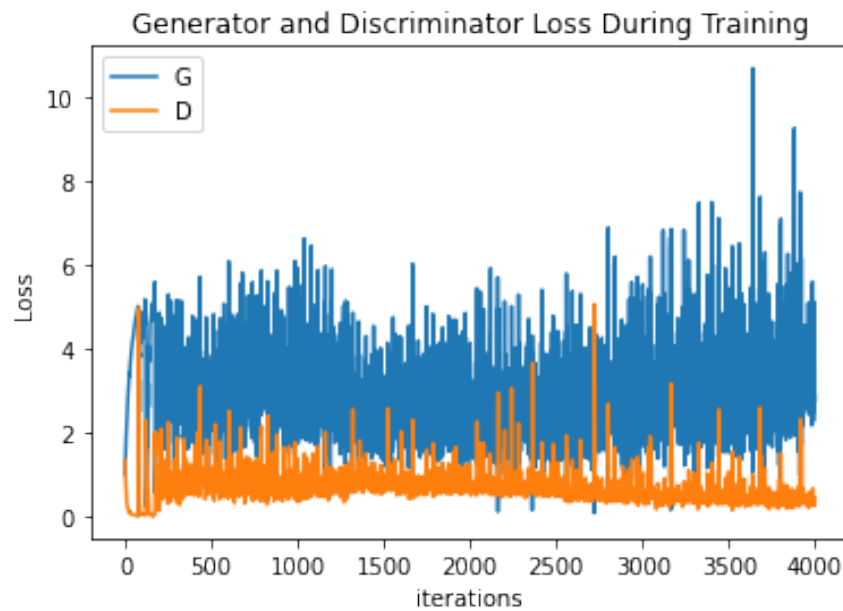
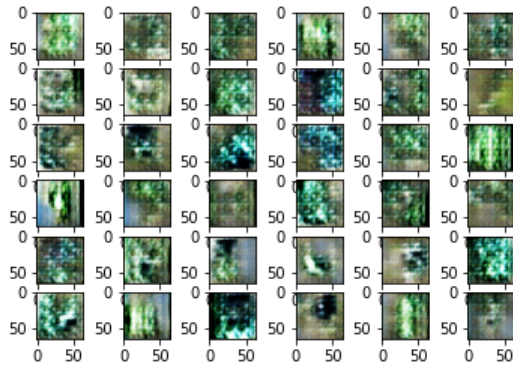


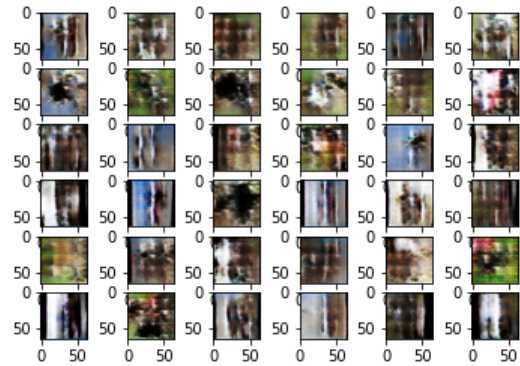
Figure 5: DC-GAN training losses

2.2 Qualitative Evaluations

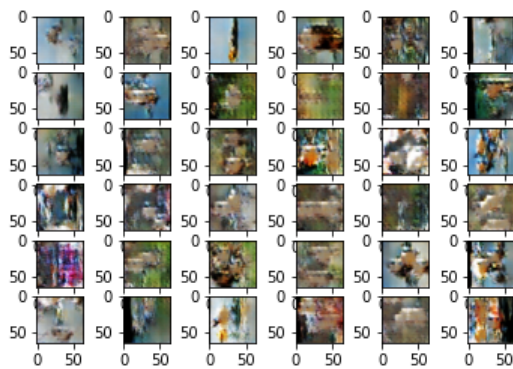
We visualized the output of generator during training using fixed random noise as follows.



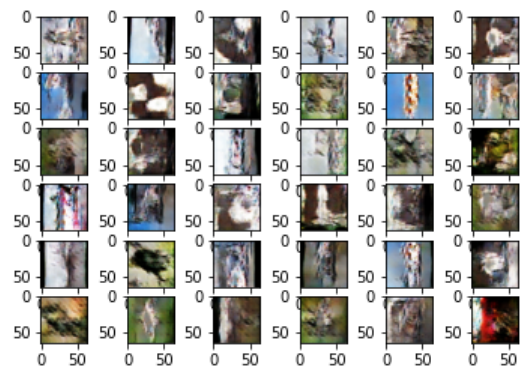
(a) Epoch 29



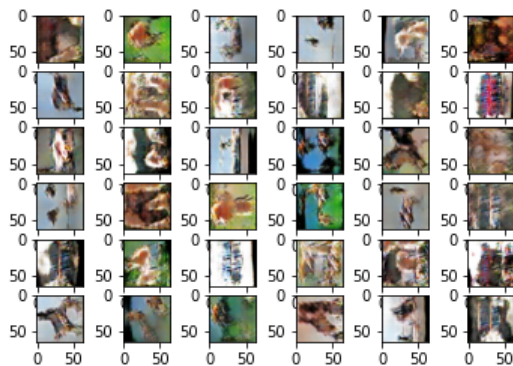
(b) Epoch 39



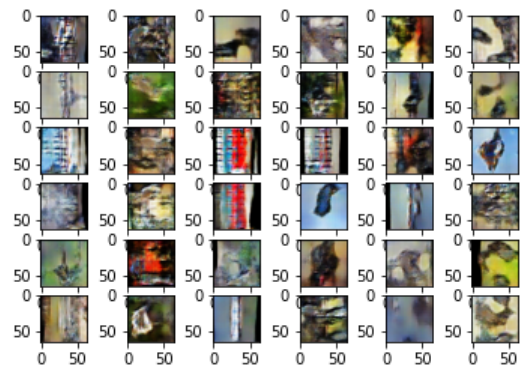
(c) Epoch 59



(d) Epoch 69



(e) Epoch 79



(f) Epoch 89

Figure 6: DC-GAN qualitative evaluation during training.

Finally we visualized the generator output after the network is trained, using random latent variables from Gaussian distribution.

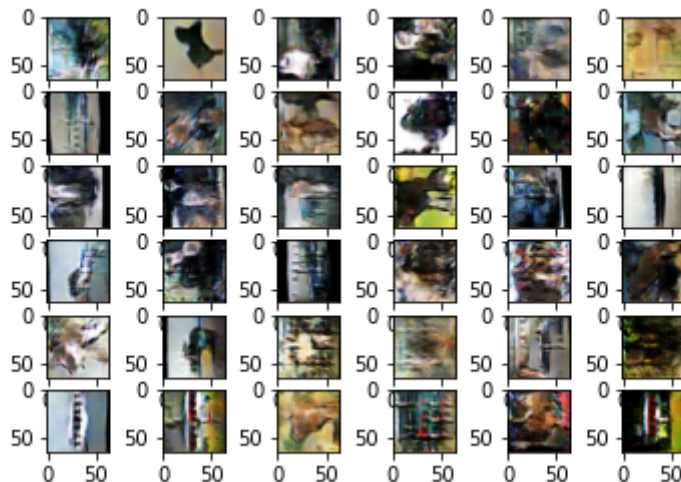


Figure 7: DC-GAN Final epoch visualization on random noise.

2.3 Quantitative Evaluations

Image Set Pair	FID GAN	Image Set	IS GAN
STL-10 real set 1 vs. STL-10 real set 1	-2.19e-05	STL-10 real set 1	14.62
STL-10 real set 1 vs. STL-10 real set 2	37.67	STL-10 real set 2	15.91
STL-10 real set 1 vs. STL-10 generated set	206.89	STL-10 generated set	2.31

Table 2: FID/IS score table of DC-GAN

3 CycleGAN

3.1 Training Curves

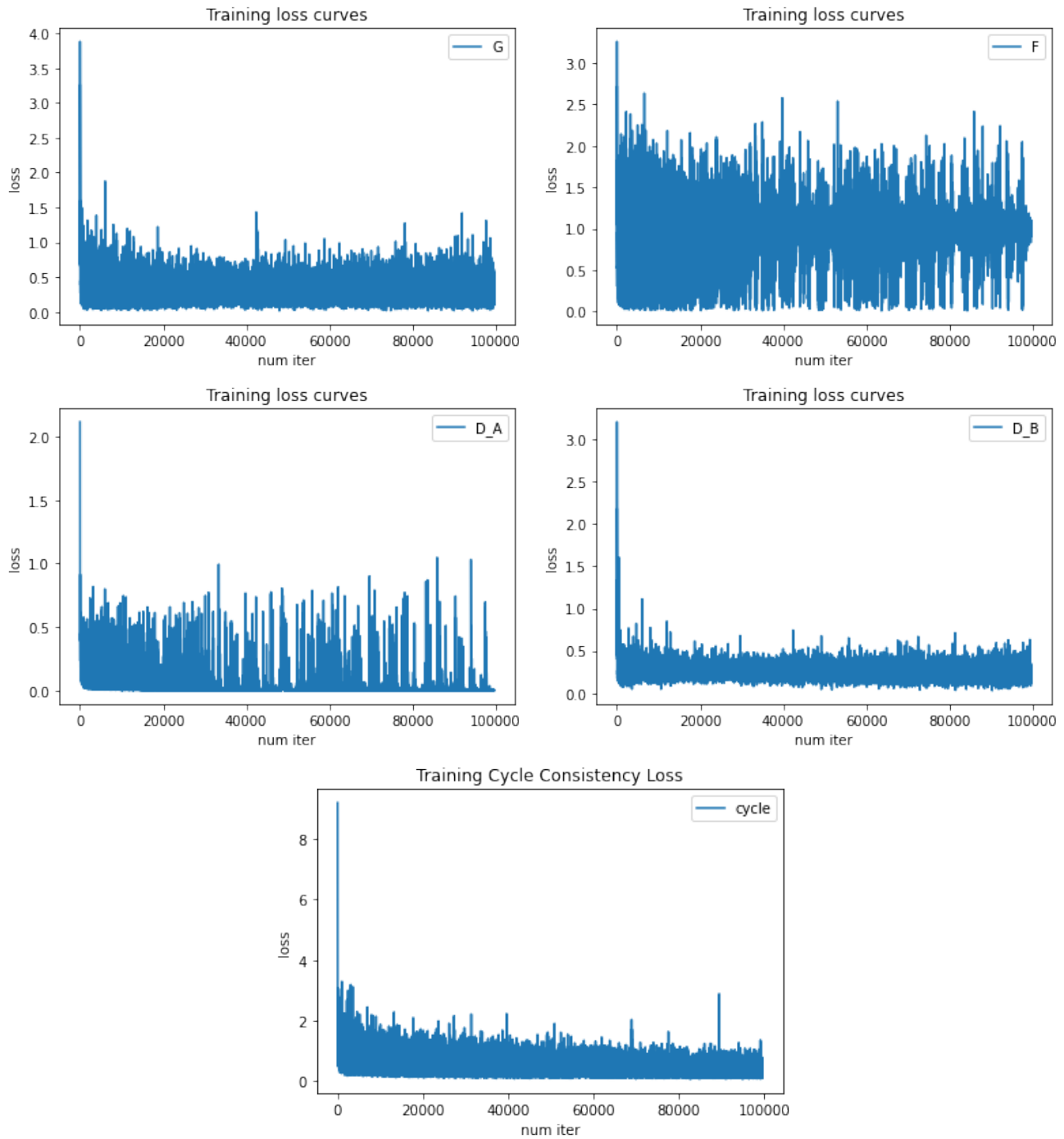


Figure 8: CycleGAN training curves.

3.2 Qualitative Evaluations

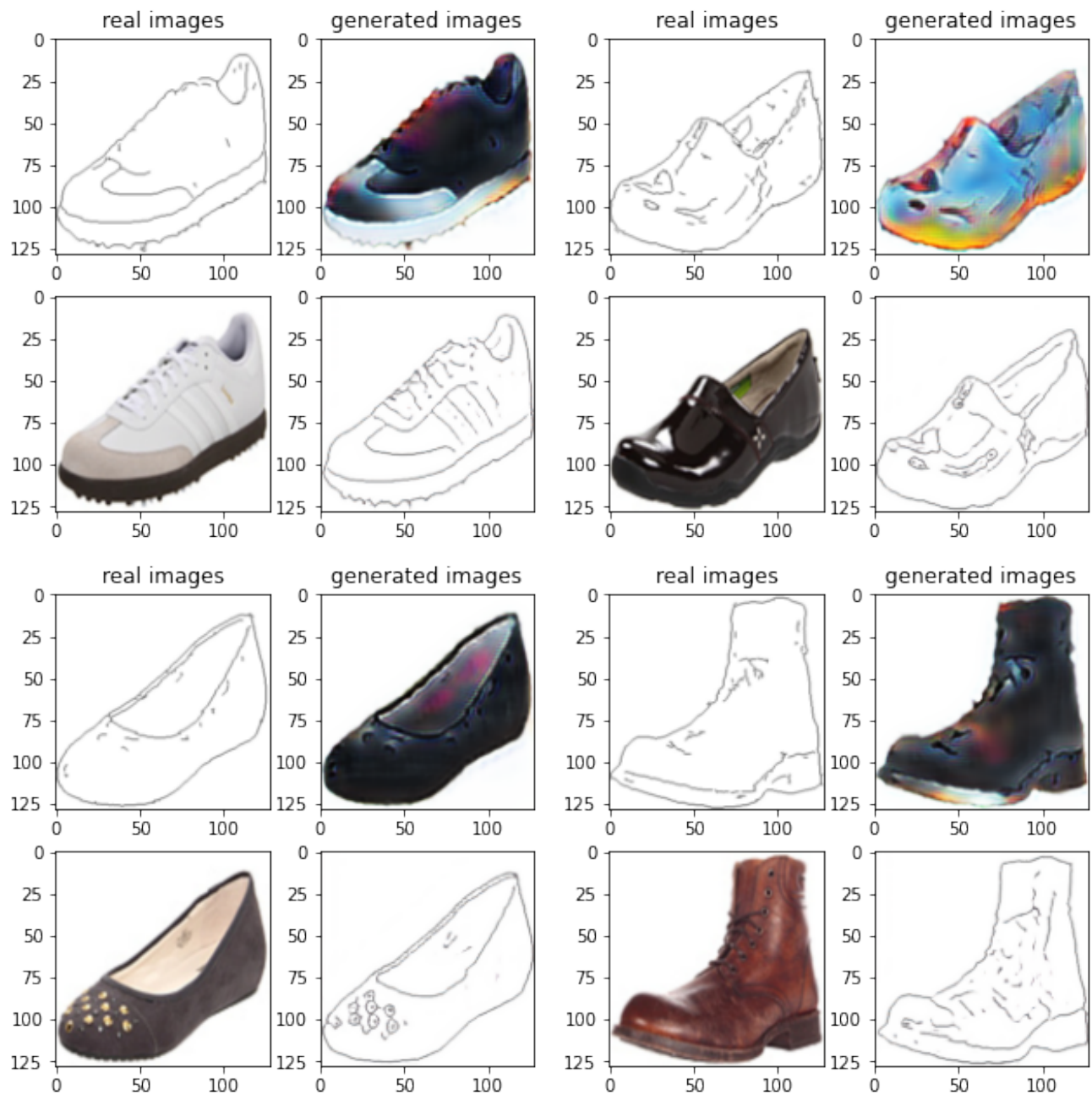


Figure 9: CycleGAN qualitative evaluation.

3.3 Quantitative Evaluations

Image Set Pair	FID CycleGAN	Image Set	IS CycleGAN
real_edge 1 vs. real_edge 2	50.26312505943679	real_edge 1	1.0017497525510533
real_edge 1 vs. generated_edge	70.86880520062158	generated_edge	1.0001618207918306
real_shoe 1 vs. real_shoe 2	59.43155002323226	real_shoe 1	3.5049714594649286
real_shoe 1 vs. generated_shoe	129.608313215207	generated_shoe	2.7210041782808028

Table 3: FID/IS score table of CycleGAN