

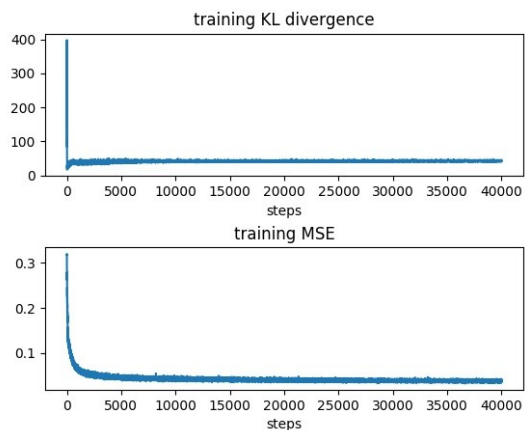
Problem1 VAE(6%)

1.

Layer (type)	Output Shape	Param #
Conv2d-1	[-1, 32, 32, 32]	1568
BatchNorm2d-2	[-1, 32, 32, 32]	64
LeakyReLU-3	[-1, 32, 32, 32]	0
Conv2d-4	[-1, 64, 16, 16]	32832
BatchNorm2d-5	[-1, 64, 16, 16]	128
LeakyReLU-6	[-1, 64, 16, 16]	0
Conv2d-7	[-1, 128, 8, 8]	131200
BatchNorm2d-8	[-1, 128, 8, 8]	256
LeakyReLU-9	[-1, 128, 8, 8]	0
Conv2d-10	[-1, 256, 4, 4]	524544
BatchNorm2d-11	[-1, 256, 4, 4]	512
LeakyReLU-12	[-1, 256, 4, 4]	0
Linear-13	[-1, 512]	2097664
Linear-14	[-1, 512]	2097664
Linear-15	[-1, 4096]	2101248
ConvTranspose2d-16	[-1, 128, 8, 8]	524288
BatchNorm2d-17	[-1, 128, 8, 8]	256
LeakyReLU-18	[-1, 128, 8, 8]	0
ConvTranspose2d-19	[-1, 64, 16, 16]	131072
BatchNorm2d-20	[-1, 64, 16, 16]	128
LeakyReLU-21	[-1, 64, 16, 16]	0
ConvTranspose2d-22	[-1, 32, 32, 32]	32768
BatchNorm2d-23	[-1, 32, 32, 32]	64
LeakyReLU-24	[-1, 32, 32, 32]	0
ConvTranspose2d-25	[-1, 3, 64, 64]	1536
Tanh-26	[-1, 3, 64, 64]	0
Total params: 7677792		
Trainable params: 7677792		
Non-trainable params: 0		

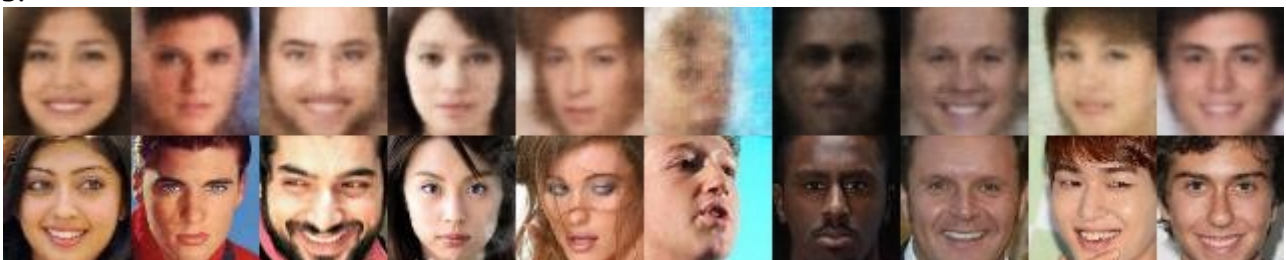
1st to 12th layer are encoding layers and 16th to 26th layer are decoding layers. I set the latent dimension as 512. I normalize the image to [-1,1] here and following cases.

2.



The scale is not clear in figure. The KL divergence is about 40 during the training process

3.

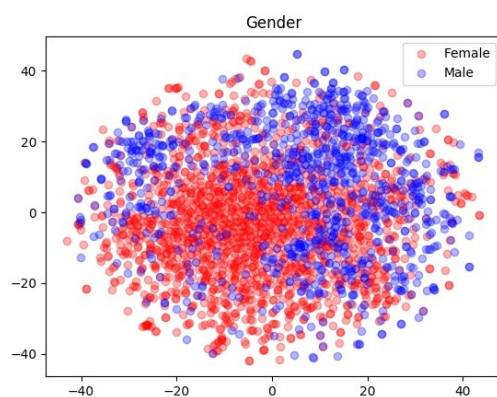


MSE on testing set: 215.99, Consider the normalization, 2.249 per pixel

4.



5.



I sampled all the images in testing set, and the result roughly shows the difference between two genders. They clustered at different location which can be discriminated.

6.

(1) The parameter lambda is important for training. If the MSE is over weighted, the reconstruction would be very similar to the original input images. However, the random generation would be very noisy. On the contrast, if the KLD is overweighted, there would be a big difference between the reconstruction images and original images.

(2) After striking a balance between reconstruction and random generation, I found out that the results are blurry compared with the result of GAN, which matches the theory.

Problem2 GAN(5%)

1.

Generator:

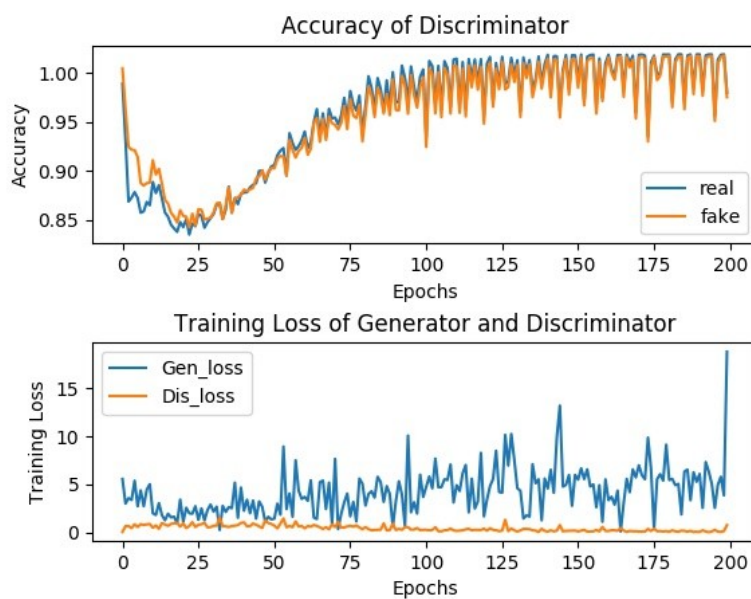
Layer (type)	Output Shape	Param #
ConvTranspose2d-1	[-1, 512, 4, 4]	819200
BatchNorm2d-2	[-1, 512, 4, 4]	1024
ReLU-3	[-1, 512, 4, 4]	0
ConvTranspose2d-4	[-1, 256, 8, 8]	2097152
BatchNorm2d-5	[-1, 256, 8, 8]	512
ReLU-6	[-1, 256, 8, 8]	0
ConvTranspose2d-7	[-1, 128, 16, 16]	524288
BatchNorm2d-8	[-1, 128, 16, 16]	256
ReLU-9	[-1, 128, 16, 16]	0
ConvTranspose2d-10	[-1, 64, 32, 32]	131072
BatchNorm2d-11	[-1, 64, 32, 32]	128
ReLU-12	[-1, 64, 32, 32]	0
ConvTranspose2d-13	[-1, 3, 64, 64]	3072
Tanh-14	[-1, 3, 64, 64]	0
Total params: 3576704		
Trainable params: 3576704		
Non-trainable params: 0		

Discriminator:

Layer (type)	Output Shape	Param #
Conv2d-1	[-1, 64, 32, 32]	3072
BatchNorm2d-2	[-1, 64, 32, 32]	128
LeakyReLU-3	[-1, 64, 32, 32]	0
Conv2d-4	[-1, 128, 16, 16]	131072
BatchNorm2d-5	[-1, 128, 16, 16]	256
LeakyReLU-6	[-1, 128, 16, 16]	0
Conv2d-7	[-1, 256, 8, 8]	524288
BatchNorm2d-8	[-1, 256, 8, 8]	512
LeakyReLU-9	[-1, 256, 8, 8]	0
Conv2d-10	[-1, 512, 4, 4]	2097152
BatchNorm2d-11	[-1, 512, 4, 4]	1024
LeakyReLU-12	[-1, 512, 4, 4]	0
Conv2d-13	[-1, 1, 1, 1]	8192
Sigmoid-14	[-1, 1, 1, 1]	0
Total params: 2765696		
Trainable params: 2765696		
Non-trainable params: 0		

I set the latent dimension as 100 and the max number of filters as 512.

2.



The accuracy of real and fake images for discriminator are close. Moreover, compared to the loss of discriminator, the loss of generator is unstable.

3.



4.

(1) Sometimes it came out that all the images looked same, which may due to mode collapse. I thus adjust some of parameters (ex: for the optimizer) to avoid this problem in the model I submit

(2) Some tips like adding dropout and using soft labels do help in the beginning steps. However, after enough many epochs, the results are similar.

(3) After about 10 epochs, it showed primary results. However, it still takes tens of epochs to learn the detail information of faces. Moreover, the difference is little between the results from after 100 epochs.

5.

Compared with the random generated images in VAE, those in GAN has higher image quality. Moreover, when changing the random seed, I also found out that GAN has higher diversity than VAE does. In case that image is distorted, that in GAN is also more serious than in VAE.

Problem3 ACGAN(4%)

1.

Generator:

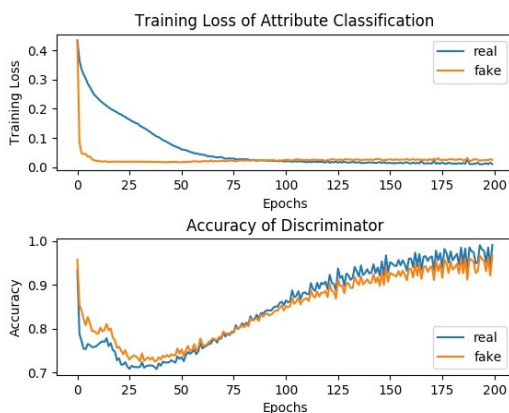
Layer (type)	Output Shape	Param #
ConvTranspose2d-1	[-1, 512, 4, 4]	819200
BatchNorm2d-2	[-1, 512, 4, 4]	1024
ReLU-3	[-1, 512, 4, 4]	0
ConvTranspose2d-4	[-1, 256, 8, 8]	2097152
BatchNorm2d-5	[-1, 256, 8, 8]	512
ReLU-6	[-1, 256, 8, 8]	0
ConvTranspose2d-7	[-1, 128, 16, 16]	524288
BatchNorm2d-8	[-1, 128, 16, 16]	256
ReLU-9	[-1, 128, 16, 16]	0
ConvTranspose2d-10	[-1, 64, 32, 32]	131072
BatchNorm2d-11	[-1, 64, 32, 32]	128
ReLU-12	[-1, 64, 32, 32]	0
ConvTranspose2d-13	[-1, 3, 64, 64]	3072
Tanh-14	[-1, 3, 64, 64]	0
Total params: 3576704		
Trainable params: 3576704		
Non-trainable params: 0		

Discriminator:

Layer (type)	Output Shape	Param #
Conv2d-1	[-1, 64, 32, 32]	3072
BatchNorm2d-2	[-1, 64, 32, 32]	128
LeakyReLU-3	[-1, 64, 32, 32]	0
Conv2d-4	[-1, 128, 16, 16]	131072
BatchNorm2d-5	[-1, 128, 16, 16]	256
LeakyReLU-6	[-1, 128, 16, 16]	0
Conv2d-7	[-1, 256, 8, 8]	524288
BatchNorm2d-8	[-1, 256, 8, 8]	512
LeakyReLU-9	[-1, 256, 8, 8]	0
Conv2d-10	[-1, 512, 4, 4]	2097152
LeakyReLU-11	[-1, 512, 4, 4]	0
Conv2d-12	[-1, 1, 1, 1]	8192
Conv2d-13	[-1, 1, 1, 1]	8192
Total params: 2772864		
Trainable params: 2772864		
Non-trainable params: 0		

The architectures is similar to that in GAN, only adding a discriminator in 13th layer to discriminate the class.

2.



The loss of classification in fake images decays much faster than that in real images. Moreover, the accuracy of discriminating the image is close between real and fake images during the training process.

3.



There's an obvious difference between the images of two rows. The second row is the smiling version of the first row. Some features like the shape of mouth, teeth, eyesight are quite obvious to show that how ACGAN works.