

GAN

November 5, 2020

```
In [1]: googlecolab = True
```

```
if googlecolab:  
    from os.path import exists  
    from wheel.pep425tags import get_abbr_impl, get_impl_ver, get_abi_tag  
    platform = '{}{}-{}'.format(get_abbr_impl(), get_impl_ver(), get_abi_tag())  
    cuda_output = !ldconfig -p|grep cudart.so|sed -e 's/.*/.\.\([0-9]*\)\.\.\([0-9]*\)\$/cu'  
    accelerator = cuda_output[0] if exists('/dev/nvidia0') else 'cpu'  
  
!pip install -q http://download.pytorch.org/whl/{accelerator}/torch-1.3.1-{platform}  
!pip install Pillow==4.1.1
```

Collecting Pillow==4.1.1

```
  Downloading https://files.pythonhosted.org/packages/36/e5/88b3d60924a3f8476fa74ec086f5fbaba50  
    || 5.7MB 4.2MB/s
```

Requirement already satisfied: olefile in /usr/local/lib/python3.6/dist-packages (from Pillow==4.1.1)

ERROR: scikit-image 0.15.0 has requirement pillow>=4.3.0, but you'll have pillow 4.1.1 which is

ERROR: albumentations 0.1.12 has requirement imgaug<0.2.7,>=0.2.5, but you'll have imgaug 0.2.9

Installing collected packages: Pillow

```
  Found existing installation: Pillow 4.3.0
```

```
    Uninstalling Pillow-4.3.0:
```

```
      Successfully uninstalled Pillow-4.3.0
```

```
Successfully installed Pillow-4.1.1
```

```
In [0]: %matplotlib inline
```

```
import argparse  
import os  
import random  
import torch  
import torch.nn as nn  
import torch.nn.parallel  
import torch.backends.cudnn as cudnn  
import torch.optim as optim  
import torch.utils.data  
import torchvision.datasets as dset  
import torchvision.transforms as transforms  
import torchvision.utils as vutils
```

```

import numpy as np
import matplotlib.pyplot as plt
import matplotlib.animation as animation
from IPython.display import HTML

```

0.1 Hyperparameters

Define the hyperparameters. You can play with those later.

In [3]: *## Data loading*

```

workers = 4 # Number of workers for dataloader (/\! set to 4 when you're done debugging)

## Architecture

nz = 100 # Size of z latent vector (i.e. size of generator input)
ndf = 32 # Base size of feature maps in discriminator
ngf = 32 # Base size of feature maps in generator

## Optimization

lrD = 0.0002 # Learning rate for the discriminator
lrG = 0.0002 # Learning rate for the generator
beta1G = 0.5 # Momentum beta1 for the discriminator
beta1D = 0.5 # Momentum beta1 for the generator

## Training

batch_size = 256 # Images per batch
nb_update_D = 1 # Number of sub-steps of discriminator optim. at each step
nb_update_G = 1 # Number of sub-steps of generator optim. at each step
steps = 8000 # Number of global steps in the training loop
nb_epochs = None # Number of epochs, leave "None" if you want to set the number of "step

if nb_epochs is None:
    nb_epochs = (steps * batch_size) / (nb_update_D * 202000)
else:
    steps = int(nb_epochs * nb_update_D * 202000 / batch_size)
    print("Doing %.1f epochs in %d steps" % (nb_epochs, steps))

```

Doing 10.1 epochs in 8000 steps

1 Dataset

Download and load the dataset. Nothing to do here.

```
In [4]: %%sh
# Dataset loading

if ! [ -d "/tmp/celeba/img_align_celeba" ] ; then
    mkdir /tmp/celeba
    cd /tmp/celeba
    wget http://webia.lip6.fr/~robert/cours/rdfia/celeba.zip
    unzip celeba.zip
fi

# For 64x64 images, replace celeba with celeba64 everywhere
```

IOPub data rate exceeded.
The notebook server will temporarily stop sending output
to the client in order to avoid crashing it.
To change this limit, set the config variable
`--NotebookApp.iopub_data_rate_limit`.

Current values:

```
NotebookApp.iopub_data_rate_limit=1000000.0 (bytes/sec)
NotebookApp.rate_limit_window=3.0 (secs)
```

```
--2020-01-05 21:25:38--  http://webia.lip6.fr/~robert/cours/rdfia/celeba.zip
Resolving webia.lip6.fr (webia.lip6.fr)... 132.227.201.33
Connecting to webia.lip6.fr (webia.lip6.fr)|132.227.201.33|:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 153357646 (146M) [application/zip]
Saving to: celeba.zip
```

OK	0%	183K	13m38s
50K	0%	366K	10m13s
100K	0%	61.5M	6m49s
150K	0%	105M	5m7s
200K	0%	368K	5m27s
250K	0%	52.7M	4m33s
300K	0%	67.6M	3m54s
350K	0%	79.8M	3m25s
400K	0%	373K	3m47s
450K	0%	80.9M	3m24s
500K	0%	83.4M	3m6s
550K	0%	72.8M	2m50s
600K	0%	92.3M	2m37s
650K	0%	90.3M	2m26s
700K	0%	88.5M	2m16s
750K	0%	89.0M	2m8s
800K	0%	113M	2m0s
850K	0%	379K	2m15s
900K	0%	86.1M	2m8s

950K	0%	90.0M	2m2s
1000K	0%	72.6M	1m56s
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21550K	14%	94.4M	11s
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21950K	14%	124M	11s
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22150K	14%	113M	11s
22200K	14%	111M	11s
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22350K	14%	126M	11s
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22500K	15%	109M	11s

22550K	15%	92.6M	11s
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22750K	15%	107M	11s
22800K	15%	101M	11s
22850K	15%	117M	11s
22900K	15%	95.2M	11s
22950K	15%	104M	11s
23000K	15%	103M	11s
23050K	15%	106M	11s
23100K	15%	95.9M	11s
23150K	15%	113M	11s
23200K	15%	113M	11s
23250K	15%	104M	11s
23300K	15%	91.5M	11s
23350K	15%	441K	11s
23400K	15%	284M	11s
23450K	15%	86.7M	11s
23500K	15%	136M	11s
23550K	15%	113M	11s
23600K	15%	114M	11s
23650K	15%	108M	11s
23700K	15%	114M	11s
23750K	15%	114M	11s
23800K	15%	105M	11s
23850K	15%	121M	11s
23900K	15%	116M	11s
23950K	16%	95.2M	11s
24000K	16%	105M	11s
24050K	16%	124M	11s
24100K	16%	111M	11s
24150K	16%	101M	11s
24200K	16%	111M	11s
24250K	16%	94.2M	11s
24300K	16%	101M	11s
24350K	16%	106M	11s
24400K	16%	129M	11s
24450K	16%	109M	11s
24500K	16%	118M	11s
24550K	16%	97.0M	11s
24600K	16%	96.2M	11s
24650K	16%	113M	10s
24700K	16%	102M	10s
24750K	16%	84.2M	10s
24800K	16%	117M	10s
24850K	16%	102M	10s
24900K	16%	119M	10s

24950K	16%	110M	10s
25000K	16%	112M	10s
25050K	16%	105M	10s
25100K	16%	105M	10s
25150K	16%	115M	10s
25200K	16%	121M	10s
25250K	16%	127M	10s
25300K	16%	106M	10s
25350K	16%	99.7M	10s
25400K	16%	104M	10s
25450K	17%	103M	10s
25500K	17%	110M	10s
25550K	17%	111M	10s
25600K	17%	103M	10s
25650K	17%	93.7M	10s
25700K	17%	119M	10s
25750K	17%	116M	10s
25800K	17%	118M	10s
25850K	17%	90.0M	10s
25900K	17%	119M	10s
25950K	17%	112M	10s
26000K	17%	103M	10s
26050K	17%	103M	10s
26100K	17%	440K	10s
26150K	17%	178M	10s
26200K	17%	131M	10s
26250K	17%	111M	10s
26300K	17%	148M	10s
26350K	17%	119M	10s
26400K	17%	104M	10s
26450K	17%	131M	10s
26500K	17%	104M	10s
26550K	17%	113M	10s
26600K	17%	106M	10s
26650K	17%	102M	10s
26700K	17%	80.4M	10s
26750K	17%	89.0M	10s
26800K	17%	287M	10s
26850K	17%	98.5M	10s
26900K	17%	113M	10s
26950K	18%	98.6M	10s
27000K	18%	128M	10s
27050K	18%	92.6M	10s
27100K	18%	107M	10s
27150K	18%	113M	10s
27200K	18%	91.0M	10s
27250K	18%	112M	10s
27300K	18%	105M	10s

27350K	18%	129M	10s
27400K	18%	106M	10s
27450K	18%	62.8M	10s
27500K	18%	101M	10s
27550K	18%	94.8M	10s
27600K	18%	121M	10s
27650K	18%	109M	10s
27700K	18%	147M	10s
27750K	18%	98.6M	10s
27800K	18%	105M	10s
27850K	18%	115M	10s
27900K	18%	103M	10s
27950K	18%	104M	10s
28000K	18%	142M	10s
28050K	18%	99.9M	10s
28100K	18%	108M	10s
28150K	18%	108M	10s
28200K	18%	95.9M	10s
28250K	18%	105M	10s
28300K	18%	109M	10s
28350K	18%	111M	9s
28400K	18%	120M	9s
28450K	19%	95.5M	9s
28500K	19%	104M	9s
28550K	19%	118M	9s
28600K	19%	111M	9s
28650K	19%	92.9M	9s
28700K	19%	112M	9s
28750K	19%	129M	9s
28800K	19%	105M	9s
28850K	19%	109M	9s
28900K	19%	442K	10s
28950K	19%	104M	10s
29000K	19%	148M	10s
29050K	19%	106M	10s
29100K	19%	110M	10s
29150K	19%	119M	10s
29200K	19%	131M	10s
29250K	19%	99.3M	10s
29300K	19%	120M	10s
29350K	19%	110M	10s
29400K	19%	98.3M	10s
29450K	19%	103M	10s
29500K	19%	126M	10s
29550K	19%	117M	10s
29600K	19%	118M	9s
29650K	19%	86.6M	9s
29700K	19%	114M	9s

29750K	19%	115M	9s
29800K	19%	94.4M	9s
29850K	19%	103M	9s
29900K	19%	107M	9s
29950K	20%	116M	9s
30000K	20%	100M	9s
30050K	20%	109M	9s
30100K	20%	110M	9s
30150K	20%	102M	9s
30200K	20%	119M	9s
30250K	20%	107M	9s
30300K	20%	71.3M	9s
30350K	20%	107M	9s
30400K	20%	104M	9s
30450K	20%	131M	9s
30500K	20%	115M	9s
30550K	20%	105M	9s
30600K	20%	128M	9s
30650K	20%	85.9M	9s
30700K	20%	123M	9s
30750K	20%	112M	9s
30800K	20%	93.4M	9s
30850K	20%	96.5M	9s
30900K	20%	120M	9s
30950K	20%	114M	9s
31000K	20%	108M	9s
31050K	20%	108M	9s
31100K	20%	109M	9s
31150K	20%	100M	9s
31200K	20%	110M	9s
31250K	20%	107M	9s
31300K	20%	111M	9s
31350K	20%	110M	9s
31400K	20%	99.0M	9s
31450K	21%	101M	9s
31500K	21%	104M	9s
31550K	21%	119M	9s
31600K	21%	109M	9s
31650K	21%	441K	9s
31700K	21%	228M	9s
31750K	21%	84.6M	9s
31800K	21%	289M	9s
31850K	21%	91.9M	9s
31900K	21%	104M	9s
31950K	21%	208M	9s
32000K	21%	118M	9s
32050K	21%	88.0M	9s
32100K	21%	141M	9s

32150K	21%	67.5M	9s
32200K	21%	137M	9s
32250K	21%	37.5M	9s
32300K	21%	148M	9s
32350K	21%	102M	9s
32400K	21%	174M	9s
32450K	21%	176M	9s
32500K	21%	190M	9s
32550K	21%	191M	9s
32600K	21%	95.9M	9s
32650K	21%	105M	9s
32700K	21%	104M	9s
32750K	21%	75.6M	9s
32800K	21%	145M	9s
32850K	21%	68.4M	9s
32900K	22%	387M	9s
32950K	22%	76.6M	9s
33000K	22%	228M	9s
33050K	22%	59.0M	9s
33100K	22%	151M	9s
33150K	22%	80.8M	9s
33200K	22%	321M	9s
33250K	22%	64.6M	9s
33300K	22%	373M	9s
33350K	22%	77.2M	9s
33400K	22%	151M	9s
33450K	22%	72.6M	9s
33500K	22%	280M	9s
33550K	22%	69.1M	9s
33600K	22%	345M	9s
33650K	22%	59.7M	9s
33700K	22%	167M	9s
33750K	22%	113M	9s
33800K	22%	65.0M	9s
33850K	22%	361M	9s
33900K	22%	119M	9s
33950K	22%	54.8M	8s
34000K	22%	296M	8s
34050K	22%	174M	8s
34100K	22%	62.4M	8s
34150K	22%	156M	8s
34200K	22%	220M	8s
34250K	22%	64.2M	8s
34300K	22%	229M	8s
34350K	22%	72.8M	8s
34400K	23%	443K	9s
34450K	23%	295M	9s
34500K	23%	81.2M	9s

34550K	23%	72.2M	9s
34600K	23%	310M	9s
34650K	23%	130M	9s
34700K	23%	62.2M	9s
34750K	23%	205M	9s
34800K	23%	359M	9s
34850K	23%	52.5M	9s
34900K	23%	109M	9s
34950K	23%	201M	9s
35000K	23%	143M	9s
35050K	23%	57.1M	9s
35100K	23%	93.5M	9s
35150K	23%	176M	9s
35200K	23%	376M	9s
35250K	23%	131M	8s
35300K	23%	81.8M	8s
35350K	23%	118M	8s
35400K	23%	128M	8s
35450K	23%	97.8M	8s
35500K	23%	102M	8s
35550K	23%	112M	8s
35600K	23%	108M	8s
35650K	23%	109M	8s
35700K	23%	92.2M	8s
35750K	23%	155M	8s
35800K	23%	23.5M	8s
35850K	23%	122M	8s
35900K	24%	374M	8s
35950K	24%	325M	8s
36000K	24%	83.4M	8s
36050K	24%	91.5M	8s
36100K	24%	189M	8s
36150K	24%	112M	8s
36200K	24%	124M	8s
36250K	24%	103M	8s
36300K	24%	126M	8s
36350K	24%	95.1M	8s
36400K	24%	127M	8s
36450K	24%	85.4M	8s
36500K	24%	121M	8s
36550K	24%	108M	8s
36600K	24%	110M	8s
36650K	24%	99.5M	8s
36700K	24%	114M	8s
36750K	24%	102M	8s
36800K	24%	113M	8s
36850K	24%	108M	8s
36900K	24%	102M	8s

36950K	24%	94.5M	8s
37000K	24%	132M	8s
37050K	24%	111M	8s
37100K	24%	100M	8s
37150K	24%	105M	8s
37200K	24%	445K	8s
37250K	24%	157M	8s
37300K	24%	99.9M	8s
37350K	24%	139M	8s
37400K	25%	113M	8s
37450K	25%	94.8M	8s
37500K	25%	136M	8s
37550K	25%	118M	8s
37600K	25%	101M	8s
37650K	25%	106M	8s
37700K	25%	102M	8s
37750K	25%	103M	8s
37800K	25%	104M	8s
37850K	25%	115M	8s
37900K	25%	100M	8s
37950K	25%	116M	8s
38000K	25%	97.2M	8s
38050K	25%	124M	8s
38100K	25%	76.6M	8s
38150K	25%	134M	8s
38200K	25%	114M	8s
38250K	25%	124M	8s
38300K	25%	107M	8s
38350K	25%	110M	8s
38400K	25%	102M	8s
38450K	25%	95.7M	8s
38500K	25%	99.8M	8s
38550K	25%	109M	8s
38600K	25%	43.0M	8s
38650K	25%	100M	8s
38700K	25%	124M	8s
38750K	25%	97.1M	8s
38800K	25%	103M	8s
38850K	25%	145M	8s
38900K	26%	115M	8s
38950K	26%	108M	8s
39000K	26%	107M	8s
39050K	26%	90.1M	8s
39100K	26%	110M	8s
39150K	26%	102M	8s
39200K	26%	93.8M	8s
39250K	26%	123M	8s
39300K	26%	91.9M	8s

39350K	26%	96.8M	8s
39400K	26%	107M	8s
39450K	26%	122M	8s
39500K	26%	110M	8s
39550K	26%	106M	8s
39600K	26%	43.4M	8s
39650K	26%	257M	8s
39700K	26%	276M	8s
39750K	26%	101M	8s
39800K	26%	53.2M	8s
39850K	26%	50.6M	8s
39900K	26%	127M	8s
39950K	26%	287M	8s
40000K	26%	448K	8s
40050K	26%	85.2M	8s
40100K	26%	415M	8s
40150K	26%	191M	8s
40200K	26%	63.1M	8s
40250K	26%	188M	8s
40300K	26%	161M	8s
40350K	26%	90.9M	8s
40400K	27%	108M	8s
40450K	27%	122M	8s
40500K	27%	143M	8s
40550K	27%	93.6M	8s
40600K	27%	108M	8s
40650K	27%	100M	8s
40700K	27%	115M	8s
40750K	27%	90.0M	8s
40800K	27%	141M	8s
40850K	27%	113M	8s
40900K	27%	102M	8s
40950K	27%	93.5M	8s
41000K	27%	128M	8s
41050K	27%	98.5M	8s
41100K	27%	116M	8s
41150K	27%	105M	8s
41200K	27%	107M	8s
41250K	27%	102M	8s
41300K	27%	109M	8s
41350K	27%	48.0M	8s
41400K	27%	103M	8s
41450K	27%	121M	8s
41500K	27%	102M	8s
41550K	27%	128M	8s
41600K	27%	107M	8s
41650K	27%	106M	8s
41700K	27%	113M	8s

41750K	27%	105M	8s
41800K	27%	128M	7s
41850K	27%	77.0M	7s
41900K	28%	125M	7s
41950K	28%	124M	7s
42000K	28%	89.8M	7s
42050K	28%	121M	7s
42100K	28%	119M	7s
42150K	28%	94.5M	7s
42200K	28%	113M	7s
42250K	28%	111M	7s
42300K	28%	117M	7s
42350K	28%	93.7M	7s
42400K	28%	107M	7s
42450K	28%	101M	7s
42500K	28%	122M	7s
42550K	28%	111M	7s
42600K	28%	106M	7s
42650K	28%	96.2M	7s
42700K	28%	109M	7s
42750K	28%	444K	8s
42800K	28%	92.7M	8s
42850K	28%	111M	8s
42900K	28%	104M	8s
42950K	28%	124M	8s
43000K	28%	118M	8s
43050K	28%	109M	7s
43100K	28%	119M	7s
43150K	28%	101M	7s
43200K	28%	90.3M	7s
43250K	28%	112M	7s
43300K	28%	122M	7s
43350K	28%	105M	7s
43400K	29%	123M	7s
43450K	29%	108M	7s
43500K	29%	104M	7s
43550K	29%	108M	7s
43600K	29%	102M	7s
43650K	29%	119M	7s
43700K	29%	103M	7s
43750K	29%	94.2M	7s
43800K	29%	128M	7s
43850K	29%	99.6M	7s
43900K	29%	115M	7s
43950K	29%	93.8M	7s
44000K	29%	108M	7s
44050K	29%	101M	7s
44100K	29%	119M	7s

44150K	29%	82.6M	7s
44200K	29%	98.1M	7s
44250K	29%	127M	7s
44300K	29%	108M	7s
44350K	29%	113M	7s
44400K	29%	132M	7s
44450K	29%	99.3M	7s
44500K	29%	98.1M	7s
44550K	29%	123M	7s
44600K	29%	107M	7s
44650K	29%	91.6M	7s
44700K	29%	100M	7s
44750K	29%	127M	7s
44800K	29%	102M	7s
44850K	29%	110M	7s
44900K	30%	94.4M	7s
44950K	30%	119M	7s
45000K	30%	103M	7s
45050K	30%	116M	7s
45100K	30%	107M	7s
45150K	30%	111M	7s
45200K	30%	89.2M	7s
45250K	30%	132M	7s
45300K	30%	92.4M	7s
45350K	30%	107M	7s
45400K	30%	101M	7s
45450K	30%	102M	7s
45500K	30%	443K	7s
45550K	30%	278M	7s
45600K	30%	95.2M	7s
45650K	30%	107M	7s
45700K	30%	132M	7s
45750K	30%	103M	7s
45800K	30%	125M	7s
45850K	30%	125M	7s
45900K	30%	108M	7s
45950K	30%	101M	7s
46000K	30%	114M	7s
46050K	30%	92.2M	7s
46100K	30%	113M	7s
46150K	30%	114M	7s
46200K	30%	107M	7s
46250K	30%	107M	7s
46300K	30%	101M	7s
46350K	30%	105M	7s
46400K	31%	120M	7s
46450K	31%	92.8M	7s
46500K	31%	127M	7s

46550K	31%	106M	7s
46600K	31%	111M	7s
46650K	31%	107M	7s
46700K	31%	114M	7s
46750K	31%	99.1M	7s
46800K	31%	107M	7s
46850K	31%	78.5M	7s
46900K	31%	102M	7s
46950K	31%	114M	7s
47000K	31%	117M	7s
47050K	31%	95.8M	7s
47100K	31%	117M	7s
47150K	31%	115M	7s
47200K	31%	105M	7s
47250K	31%	121M	7s
47300K	31%	102M	7s
47350K	31%	105M	7s
47400K	31%	99.8M	7s
47450K	31%	113M	7s
47500K	31%	96.6M	7s
47550K	31%	134M	7s
47600K	31%	98.2M	7s
47650K	31%	116M	7s
47700K	31%	99.0M	7s
47750K	31%	96.5M	7s
47800K	31%	90.8M	7s
47850K	31%	139M	7s
47900K	32%	88.7M	7s
47950K	32%	84.2M	7s
48000K	32%	245M	7s
48050K	32%	50.2M	7s
48100K	32%	109M	7s
48150K	32%	287M	7s
48200K	32%	442K	7s
48250K	32%	76.7M	7s
48300K	32%	75.8M	7s
48350K	32%	133M	7s
48400K	32%	390M	7s
48450K	32%	127M	7s
48500K	32%	69.3M	7s
48550K	32%	91.6M	7s
48600K	32%	395M	7s
48650K	32%	88.2M	7s
48700K	32%	224M	7s
48750K	32%	102M	7s
48800K	32%	121M	7s
48850K	32%	96.0M	7s
48900K	32%	104M	7s

48950K	32%	101M	7s
49000K	32%	102M	7s
49050K	32%	105M	7s
49100K	32%	84.2M	7s
49150K	32%	126M	7s
49200K	32%	116M	7s
49250K	32%	106M	7s
49300K	32%	115M	7s
49350K	32%	117M	7s
49400K	33%	96.5M	7s
49450K	33%	110M	7s
49500K	33%	105M	7s
49550K	33%	109M	7s
49600K	33%	129M	7s
49650K	33%	47.9M	7s
49700K	33%	101M	7s
49750K	33%	377M	7s
49800K	33%	109M	7s
49850K	33%	77.4M	7s
49900K	33%	282M	7s
49950K	33%	75.8M	7s
50000K	33%	206M	7s
50050K	33%	85.1M	7s
50100K	33%	169M	7s
50150K	33%	109M	7s
50200K	33%	107M	7s
50250K	33%	98.5M	7s
50300K	33%	111M	7s
50350K	33%	111M	7s
50400K	33%	109M	7s
50450K	33%	99.7M	7s
50500K	33%	113M	7s
50550K	33%	122M	7s
50600K	33%	105M	7s
50650K	33%	94.9M	6s
50700K	33%	105M	6s
50750K	33%	104M	6s
50800K	33%	114M	6s
50850K	33%	111M	6s
50900K	34%	99.4M	6s
50950K	34%	93.2M	6s
51000K	34%	441K	7s
51050K	34%	368M	7s
51100K	34%	112M	7s
51150K	34%	99.6M	7s
51200K	34%	132M	7s
51250K	34%	93.8M	7s
51300K	34%	158M	7s

51350K	34%	121M	7s
51400K	34%	104M	7s
51450K	34%	104M	7s
51500K	34%	109M	7s
51550K	34%	105M	7s
51600K	34%	118M	7s
51650K	34%	101M	7s
51700K	34%	98.8M	7s
51750K	34%	117M	7s
51800K	34%	105M	7s
51850K	34%	116M	6s
51900K	34%	113M	6s
51950K	34%	120M	6s
52000K	34%	106M	6s
52050K	34%	110M	6s
52100K	34%	106M	6s
52150K	34%	118M	6s
52200K	34%	102M	6s
52250K	34%	124M	6s
52300K	34%	104M	6s
52350K	34%	113M	6s
52400K	35%	79.4M	6s
52450K	35%	114M	6s
52500K	35%	131M	6s
52550K	35%	104M	6s
52600K	35%	128M	6s
52650K	35%	99.7M	6s
52700K	35%	129M	6s
52750K	35%	97.5M	6s
52800K	35%	119M	6s
52850K	35%	103M	6s
52900K	35%	123M	6s
52950K	35%	118M	6s
53000K	35%	103M	6s
53050K	35%	106M	6s
53100K	35%	102M	6s
53150K	35%	101M	6s
53200K	35%	123M	6s
53250K	35%	100M	6s
53300K	35%	101M	6s
53350K	35%	131M	6s
53400K	35%	114M	6s
53450K	35%	101M	6s
53500K	35%	130M	6s
53550K	35%	109M	6s
53600K	35%	98.6M	6s
53650K	35%	106M	6s
53700K	35%	125M	6s

53750K	35%	439K	6s
53800K	35%	161M	6s
53850K	35%	383M	6s
53900K	36%	88.2M	6s
53950K	36%	92.5M	6s
54000K	36%	226M	6s
54050K	36%	85.4M	6s
54100K	36%	180M	6s
54150K	36%	108M	6s
54200K	36%	99.5M	6s
54250K	36%	111M	6s
54300K	36%	119M	6s
54350K	36%	101M	6s
54400K	36%	121M	6s
54450K	36%	112M	6s
54500K	36%	107M	6s
54550K	36%	105M	6s
54600K	36%	105M	6s
54650K	36%	115M	6s
54700K	36%	99.9M	6s
54750K	36%	113M	6s
54800K	36%	112M	6s
54850K	36%	91.3M	6s
54900K	36%	124M	6s
54950K	36%	63.1M	6s
55000K	36%	65.5M	6s
55050K	36%	388M	6s
55100K	36%	137M	6s
55150K	36%	81.4M	6s
55200K	36%	175M	6s
55250K	36%	64.9M	6s
55300K	36%	368M	6s
55350K	36%	98.2M	6s
55400K	37%	112M	6s
55450K	37%	145M	6s
55500K	37%	126M	6s
55550K	37%	96.4M	6s
55600K	37%	116M	6s
55650K	37%	115M	6s
55700K	37%	119M	6s
55750K	37%	101M	6s
55800K	37%	120M	6s
55850K	37%	88.6M	6s
55900K	37%	112M	6s
55950K	37%	117M	6s
56000K	37%	81.8M	6s
56050K	37%	73.4M	6s
56100K	37%	78.3M	6s

56150K	37%	100M	6s
56200K	37%	111M	6s
56250K	37%	114M	6s
56300K	37%	97.7M	6s
56350K	37%	118M	6s
56400K	37%	105M	6s
56450K	37%	442K	6s
56500K	37%	263M	6s
56550K	37%	127M	6s
56600K	37%	99.4M	6s
56650K	37%	106M	6s
56700K	37%	140M	6s
56750K	37%	115M	6s
56800K	37%	106M	6s
56850K	37%	127M	6s
56900K	38%	105M	6s
56950K	38%	95.7M	6s
57000K	38%	133M	6s
57050K	38%	98.7M	6s
57100K	38%	103M	6s
57150K	38%	112M	6s
57200K	38%	112M	6s
57250K	38%	107M	6s
57300K	38%	127M	6s
57350K	38%	106M	6s
57400K	38%	100M	6s
57450K	38%	111M	6s
57500K	38%	117M	6s
57550K	38%	98.0M	6s
57600K	38%	109M	6s
57650K	38%	125M	6s
57700K	38%	110M	6s
57750K	38%	82.8M	6s
57800K	38%	169M	6s
57850K	38%	103M	6s
57900K	38%	76.9M	6s
57950K	38%	108M	6s
58000K	38%	107M	6s
58050K	38%	116M	6s
58100K	38%	110M	6s
58150K	38%	119M	6s
58200K	38%	101M	6s
58250K	38%	107M	6s
58300K	38%	122M	6s
58350K	38%	94.8M	6s
58400K	39%	113M	6s
58450K	39%	118M	6s
58500K	39%	120M	6s

58550K	39%	125M	6s
58600K	39%	99.2M	6s
58650K	39%	97.8M	6s
58700K	39%	124M	6s
58750K	39%	112M	6s
58800K	39%	133M	6s
58850K	39%	104M	6s
58900K	39%	101M	6s
58950K	39%	99.0M	6s
59000K	39%	103M	6s
59050K	39%	115M	6s
59100K	39%	100M	6s
59150K	39%	120M	6s
59200K	39%	94.1M	6s
59250K	39%	120M	6s
59300K	39%	440K	6s
59350K	39%	258M	6s
59400K	39%	80.9M	6s
59450K	39%	155M	6s
59500K	39%	115M	6s
59550K	39%	108M	6s
59600K	39%	118M	6s
59650K	39%	107M	6s
59700K	39%	122M	6s
59750K	39%	108M	6s
59800K	39%	109M	6s
59850K	39%	114M	6s
59900K	40%	112M	6s
59950K	40%	105M	6s
60000K	40%	101M	6s
60050K	40%	121M	6s
60100K	40%	108M	6s
60150K	40%	105M	6s
60200K	40%	107M	6s
60250K	40%	109M	6s
60300K	40%	115M	6s
60350K	40%	102M	6s
60400K	40%	115M	6s
60450K	40%	109M	6s
60500K	40%	105M	6s
60550K	40%	111M	6s
60600K	40%	101M	6s
60650K	40%	115M	6s
60700K	40%	89.6M	6s
60750K	40%	102M	6s
60800K	40%	117M	6s
60850K	40%	104M	6s
60900K	40%	112M	6s

60950K	40%	113M	6s
61000K	40%	105M	6s
61050K	40%	122M	6s
61100K	40%	110M	6s
61150K	40%	119M	6s
61200K	40%	70.6M	6s
61250K	40%	211M	6s
61300K	40%	93.5M	6s
61350K	40%	161M	6s
61400K	41%	96.0M	6s
61450K	41%	124M	6s
61500K	41%	122M	6s
61550K	41%	101M	6s
61600K	41%	118M	6s
61650K	41%	94.8M	6s
61700K	41%	114M	6s
61750K	41%	111M	6s
61800K	41%	125M	6s
61850K	41%	102M	5s
61900K	41%	101M	5s
61950K	41%	100M	5s
62000K	41%	106M	5s
62050K	41%	441K	6s
62100K	41%	139M	6s
62150K	41%	107M	6s
62200K	41%	127M	6s
62250K	41%	122M	6s
62300K	41%	111M	6s
62350K	41%	108M	6s
62400K	41%	114M	6s
62450K	41%	96.0M	6s
62500K	41%	92.3M	6s
62550K	41%	154M	6s
62600K	41%	117M	6s
62650K	41%	99.4M	6s
62700K	41%	114M	6s
62750K	41%	126M	6s
62800K	41%	114M	6s
62850K	41%	105M	6s
62900K	42%	108M	6s
62950K	42%	124M	6s
63000K	42%	94.4M	5s
63050K	42%	133M	5s
63100K	42%	102M	5s
63150K	42%	71.0M	5s
63200K	42%	69.7M	5s
63250K	42%	88.3M	5s
63300K	42%	115M	5s

63350K	42%	106M	5s
63400K	42%	119M	5s
63450K	42%	114M	5s
63500K	42%	95.9M	5s
63550K	42%	114M	5s
63600K	42%	114M	5s
63650K	42%	127M	5s
63700K	42%	99.0M	5s
63750K	42%	115M	5s
63800K	42%	110M	5s
63850K	42%	110M	5s
63900K	42%	125M	5s
63950K	42%	99.9M	5s
64000K	42%	123M	5s
64050K	42%	101M	5s
64100K	42%	125M	5s
64150K	42%	107M	5s
64200K	42%	99.4M	5s
64250K	42%	108M	5s
64300K	42%	133M	5s
64350K	43%	123M	5s
64400K	43%	92.1M	5s
64450K	43%	110M	5s
64500K	43%	136M	5s
64550K	43%	107M	5s
64600K	43%	118M	5s
64650K	43%	104M	5s
64700K	43%	115M	5s
64750K	43%	122M	5s
64800K	43%	440K	5s
64850K	43%	193M	5s
64900K	43%	78.1M	5s
64950K	43%	179M	5s
65000K	43%	87.8M	5s
65050K	43%	167M	5s
65100K	43%	111M	5s
65150K	43%	95.6M	5s
65200K	43%	123M	5s
65250K	43%	109M	5s
65300K	43%	108M	5s
65350K	43%	120M	5s
65400K	43%	105M	5s
65450K	43%	110M	5s
65500K	43%	119M	5s
65550K	43%	120M	5s
65600K	43%	110M	5s
65650K	43%	104M	5s
65700K	43%	109M	5s

65750K	43%	121M	5s
65800K	43%	98.7M	5s
65850K	44%	132M	5s
65900K	44%	93.6M	5s
65950K	44%	111M	5s
66000K	44%	135M	5s
66050K	44%	103M	5s
66100K	44%	103M	5s
66150K	44%	67.0M	5s
66200K	44%	114M	5s
66250K	44%	114M	5s
66300K	44%	111M	5s
66350K	44%	107M	5s
66400K	44%	116M	5s
66450K	44%	119M	5s
66500K	44%	94.7M	5s
66550K	44%	116M	5s
66600K	44%	132M	5s
66650K	44%	100M	5s
66700K	44%	111M	5s
66750K	44%	103M	5s
66800K	44%	111M	5s
66850K	44%	115M	5s
66900K	44%	117M	5s
66950K	44%	110M	5s
67000K	44%	116M	5s
67050K	44%	98.7M	5s
67100K	44%	113M	5s
67150K	44%	132M	5s
67200K	44%	106M	5s
67250K	44%	114M	5s
67300K	44%	105M	5s
67350K	45%	95.9M	5s
67400K	45%	121M	5s
67450K	45%	108M	5s
67500K	45%	441K	5s
67550K	45%	176M	5s
67600K	45%	102M	5s
67650K	45%	128M	5s
67700K	45%	115M	5s
67750K	45%	101M	5s
67800K	45%	101M	5s
67850K	45%	117M	5s
67900K	45%	130M	5s
67950K	45%	89.3M	5s
68000K	45%	104M	5s
68050K	45%	105M	5s
68100K	45%	112M	5s

68150K	45%	102M	5s
68200K	45%	117M	5s
68250K	45%	111M	5s
68300K	45%	110M	5s
68350K	45%	97.5M	5s
68400K	45%	115M	5s
68450K	45%	103M	5s
68500K	45%	126M	5s
68550K	45%	119M	5s
68600K	45%	106M	5s
68650K	45%	98.1M	5s
68700K	45%	111M	5s
68750K	45%	119M	5s
68800K	45%	100M	5s
68850K	46%	84.7M	5s
68900K	46%	134M	5s
68950K	46%	105M	5s
69000K	46%	102M	5s
69050K	46%	113M	5s
69100K	46%	116M	5s
69150K	46%	108M	5s
69200K	46%	106M	5s
69250K	46%	109M	5s
69300K	46%	120M	5s
69350K	46%	105M	5s
69400K	46%	129M	5s
69450K	46%	97.6M	5s
69500K	46%	104M	5s
69550K	46%	100M	5s
69600K	46%	108M	5s
69650K	46%	110M	5s
69700K	46%	124M	5s
69750K	46%	102M	5s
69800K	46%	109M	5s
69850K	46%	139M	5s
69900K	46%	99.3M	5s
69950K	46%	109M	5s
70000K	46%	117M	5s
70050K	46%	98.3M	5s
70100K	46%	115M	5s
70150K	46%	135M	5s
70200K	46%	441K	5s
70250K	46%	169M	5s
70300K	46%	110M	5s
70350K	47%	113M	5s
70400K	47%	109M	5s
70450K	47%	116M	5s
70500K	47%	95.6M	5s

70550K	47%	151M	5s
70600K	47%	100M	5s
70650K	47%	121M	5s
70700K	47%	89.4M	5s
70750K	47%	127M	5s
70800K	47%	120M	5s
70850K	47%	109M	5s
70900K	47%	104M	5s
70950K	47%	104M	5s
71000K	47%	112M	5s
71050K	47%	119M	5s
71100K	47%	122M	5s
71150K	47%	94.4M	5s
71200K	47%	138M	5s
71250K	47%	106M	5s
71300K	47%	123M	5s
71350K	47%	102M	5s
71400K	47%	112M	5s
71450K	47%	114M	5s
71500K	47%	112M	5s
71550K	47%	54.4M	5s
71600K	47%	123M	5s
71650K	47%	107M	5s
71700K	47%	102M	5s
71750K	47%	114M	5s
71800K	47%	112M	5s
71850K	48%	111M	5s
71900K	48%	104M	5s
71950K	48%	130M	5s
72000K	48%	106M	5s
72050K	48%	129M	5s
72100K	48%	89.1M	5s
72150K	48%	119M	5s
72200K	48%	99.2M	5s
72250K	48%	120M	5s
72300K	48%	90.1M	5s
72350K	48%	98.7M	5s
72400K	48%	85.3M	5s
72450K	48%	58.3M	5s
72500K	48%	244M	5s
72550K	48%	349M	5s
72600K	48%	130M	5s
72650K	48%	56.2M	5s
72700K	48%	228M	5s
72750K	48%	270M	5s
72800K	48%	86.8M	5s
72850K	48%	97.1M	5s
72900K	48%	147M	5s

72950K	48%	442K	5s
73000K	48%	99.0M	5s
73050K	48%	284M	5s
73100K	48%	37.3M	5s
73150K	48%	76.3M	5s
73200K	48%	337M	5s
73250K	48%	393M	5s
73300K	48%	358M	5s
73350K	49%	74.5M	5s
73400K	49%	30.4M	5s
73450K	49%	59.1M	5s
73500K	49%	304M	5s
73550K	49%	384M	5s
73600K	49%	245M	5s
73650K	49%	378M	5s
73700K	49%	355M	5s
73750K	49%	351M	5s
73800K	49%	169M	5s
73850K	49%	60.6M	5s
73900K	49%	50.8M	5s
73950K	49%	57.6M	5s
74000K	49%	58.1M	5s
74050K	49%	52.7M	5s
74100K	49%	134M	5s
74150K	49%	49.8M	5s
74200K	49%	60.1M	5s
74250K	49%	114M	5s
74300K	49%	301M	5s
74350K	49%	248M	5s
74400K	49%	362M	5s
74450K	49%	362M	5s
74500K	49%	247M	5s
74550K	49%	374M	5s
74600K	49%	331M	5s
74650K	49%	304M	5s
74700K	49%	268M	5s
74750K	49%	347M	5s
74800K	49%	58.3M	5s
74850K	50%	48.0M	5s
74900K	50%	44.0M	5s
74950K	50%	50.9M	5s
75000K	50%	51.8M	5s
75050K	50%	47.3M	5s
75100K	50%	34.5M	5s
75150K	50%	252M	5s
75200K	50%	265M	5s
75250K	50%	263M	5s
75300K	50%	320M	5s

75350K	50%	292M	4s
75400K	50%	344M	4s
75450K	50%	375M	4s
75500K	50%	444M	4s
75550K	50%	359M	4s
75600K	50%	430M	4s
75650K	50%	379M	4s
75700K	50%	445K	5s
75750K	50%	110M	5s
75800K	50%	148M	5s
75850K	50%	95.1M	5s
75900K	50%	109M	5s
75950K	50%	140M	5s
76000K	50%	91.0M	5s
76050K	50%	96.5M	5s
76100K	50%	92.2M	5s
76150K	50%	170M	5s
76200K	50%	81.0M	5s
76250K	50%	56.2M	5s
76300K	50%	168M	5s
76350K	51%	170M	4s
76400K	51%	189M	4s
76450K	51%	159M	4s
76500K	51%	41.2M	4s
76550K	51%	50.4M	4s
76600K	51%	46.7M	4s
76650K	51%	47.4M	4s
76700K	51%	56.1M	4s
76750K	51%	66.6M	4s
76800K	51%	58.2M	4s
76850K	51%	176M	4s
76900K	51%	322M	4s
76950K	51%	311M	4s
77000K	51%	339M	4s
77050K	51%	331M	4s
77100K	51%	357M	4s
77150K	51%	266M	4s
77200K	51%	335M	4s
77250K	51%	226M	4s
77300K	51%	357M	4s
77350K	51%	420M	4s
77400K	51%	78.0M	4s
77450K	51%	59.1M	4s
77500K	51%	57.3M	4s
77550K	51%	51.5M	4s
77600K	51%	35.8M	4s
77650K	51%	25.7M	4s
77700K	51%	41.3M	4s

77750K	51%	48.8M	4s
77800K	51%	148M	4s
77850K	52%	148M	4s
77900K	52%	191M	4s
77950K	52%	272M	4s
78000K	52%	235M	4s
78050K	52%	216M	4s
78100K	52%	246M	4s
78150K	52%	287M	4s
78200K	52%	235M	4s
78250K	52%	250M	4s
78300K	52%	460M	4s
78350K	52%	465M	4s
78400K	52%	287M	4s
78450K	52%	451K	4s
78500K	52%	46.2M	4s
78550K	52%	283M	4s
78600K	52%	323M	4s
78650K	52%	70.4M	4s
78700K	52%	53.0M	4s
78750K	52%	265M	4s
78800K	52%	330M	4s
78850K	52%	340M	4s
78900K	52%	53.6M	4s
78950K	52%	47.9M	4s
79000K	52%	99.0M	4s
79050K	52%	250M	4s
79100K	52%	425M	4s
79150K	52%	445M	4s
79200K	52%	201M	4s
79250K	52%	81.4M	4s
79300K	52%	83.0M	4s
79350K	53%	67.7M	4s
79400K	53%	83.9M	4s
79450K	53%	430M	4s
79500K	53%	376M	4s
79550K	53%	75.5M	4s
79600K	53%	157M	4s
79650K	53%	62.2M	4s
79700K	53%	298M	4s
79750K	53%	16.7M	4s
79800K	53%	317M	4s
79850K	53%	318M	4s
79900K	53%	240M	4s
79950K	53%	327M	4s
80000K	53%	380M	4s
80050K	53%	328M	4s
80100K	53%	188M	4s

80150K	53%	115M	4s
80200K	53%	111M	4s
80250K	53%	101M	4s
80300K	53%	118M	4s
80350K	53%	110M	4s
80400K	53%	118M	4s
80450K	53%	104M	4s
80500K	53%	79.3M	4s
80550K	53%	103M	4s
80600K	53%	116M	4s
80650K	53%	99.3M	4s
80700K	53%	115M	4s
80750K	53%	107M	4s
80800K	53%	130M	4s
80850K	54%	100M	4s
80900K	54%	110M	4s
80950K	54%	102M	4s
81000K	54%	117M	4s
81050K	54%	118M	4s
81100K	54%	443K	4s
81150K	54%	106M	4s
81200K	54%	133M	4s
81250K	54%	121M	4s
81300K	54%	124M	4s
81350K	54%	107M	4s
81400K	54%	119M	4s
81450K	54%	92.2M	4s
81500K	54%	122M	4s
81550K	54%	109M	4s
81600K	54%	103M	4s
81650K	54%	117M	4s
81700K	54%	119M	4s
81750K	54%	98.8M	4s
81800K	54%	132M	4s
81850K	54%	116M	4s
81900K	54%	100M	4s
81950K	54%	105M	4s
82000K	54%	86.5M	4s
82050K	54%	126M	4s
82100K	54%	111M	4s
82150K	54%	107M	4s
82200K	54%	119M	4s
82250K	54%	98.8M	4s
82300K	54%	117M	4s
82350K	55%	93.4M	4s
82400K	55%	96.7M	4s
82450K	55%	106M	4s
82500K	55%	117M	4s

82550K	55%	114M	4s
82600K	55%	33.0M	4s
82650K	55%	125M	4s
82700K	55%	107M	4s
82750K	55%	138M	4s
82800K	55%	105M	4s
82850K	55%	124M	4s
82900K	55%	106M	4s
82950K	55%	105M	4s
83000K	55%	105M	4s
83050K	55%	111M	4s
83100K	55%	123M	4s
83150K	55%	119M	4s
83200K	55%	112M	4s
83250K	55%	115M	4s
83300K	55%	87.5M	4s
83350K	55%	136M	4s
83400K	55%	125M	4s
83450K	55%	103M	4s
83500K	55%	114M	4s
83550K	55%	108M	4s
83600K	55%	108M	4s
83650K	55%	123M	4s
83700K	55%	105M	4s
83750K	55%	105M	4s
83800K	55%	94.1M	4s
83850K	56%	122M	4s
83900K	56%	116M	4s
83950K	56%	108M	4s
84000K	56%	444K	4s
84050K	56%	196M	4s
84100K	56%	85.8M	4s
84150K	56%	94.7M	4s
84200K	56%	405M	4s
84250K	56%	54.1M	4s
84300K	56%	226M	4s
84350K	56%	276M	4s
84400K	56%	69.1M	4s
84450K	56%	51.0M	4s
84500K	56%	68.7M	4s
84550K	56%	298M	4s
84600K	56%	228M	4s
84650K	56%	156M	4s
84700K	56%	212M	4s
84750K	56%	222M	4s
84800K	56%	79.6M	4s
84850K	56%	254M	4s
84900K	56%	62.8M	4s

84950K	56%	66.6M	4s
85000K	56%	355M	4s
85050K	56%	322M	4s
85100K	56%	70.0M	4s
85150K	56%	54.4M	4s
85200K	56%	305M	4s
85250K	56%	324M	4s
85300K	56%	194M	4s
85350K	57%	24.0M	4s
85400K	57%	53.9M	4s
85450K	57%	227M	4s
85500K	57%	337M	4s
85550K	57%	98.6M	4s
85600K	57%	60.4M	4s
85650K	57%	177M	4s
85700K	57%	386M	4s
85750K	57%	87.0M	4s
85800K	57%	61.7M	4s
85850K	57%	198M	4s
85900K	57%	331M	4s
85950K	57%	54.7M	4s
86000K	57%	72.7M	4s
86050K	57%	399M	4s
86100K	57%	320M	4s
86150K	57%	67.9M	4s
86200K	57%	69.8M	4s
86250K	57%	325M	4s
86300K	57%	168M	4s
86350K	57%	61.4M	4s
86400K	57%	123M	4s
86450K	57%	309M	4s
86500K	57%	105M	4s
86550K	57%	60.1M	4s
86600K	57%	101M	4s
86650K	57%	351M	4s
86700K	57%	445K	4s
86750K	57%	59.6M	4s
86800K	57%	85.2M	4s
86850K	58%	287M	4s
86900K	58%	359M	4s
86950K	58%	390M	4s
87000K	58%	116M	4s
87050K	58%	61.5M	4s
87100K	58%	52.4M	4s
87150K	58%	321M	4s
87200K	58%	362M	4s
87250K	58%	389M	4s
87300K	58%	112M	4s

87350K	58%	52.6M	4s
87400K	58%	62.4M	4s
87450K	58%	254M	4s
87500K	58%	355M	4s
87550K	58%	304M	4s
87600K	58%	76.0M	4s
87650K	58%	59.2M	4s
87700K	58%	87.0M	4s
87750K	58%	342M	4s
87800K	58%	315M	4s
87850K	58%	110M	4s
87900K	58%	53.6M	4s
87950K	58%	183M	4s
88000K	58%	328M	4s
88050K	58%	24.8M	4s
88100K	58%	61.7M	4s
88150K	58%	314M	4s
88200K	58%	327M	4s
88250K	58%	69.9M	4s
88300K	58%	56.0M	4s
88350K	59%	378M	4s
88400K	59%	333M	4s
88450K	59%	96.5M	4s
88500K	59%	54.8M	4s
88550K	59%	101M	4s
88600K	59%	296M	4s
88650K	59%	323M	4s
88700K	59%	87.4M	4s
88750K	59%	61.5M	4s
88800K	59%	68.0M	4s
88850K	59%	308M	4s
88900K	59%	313M	4s
88950K	59%	199M	4s
89000K	59%	60.3M	4s
89050K	59%	60.9M	4s
89100K	59%	350M	4s
89150K	59%	389M	4s
89200K	59%	79.7M	4s
89250K	59%	60.9M	4s
89300K	59%	90.4M	4s
89350K	59%	325M	4s
89400K	59%	446K	4s
89450K	59%	66.4M	4s
89500K	59%	368M	4s
89550K	59%	343M	4s
89600K	59%	194M	4s
89650K	59%	51.2M	4s
89700K	59%	58.4M	4s

89750K	59%	195M	4s
89800K	59%	395M	4s
89850K	60%	289M	4s
89900K	60%	108M	4s
89950K	60%	52.7M	4s
90000K	60%	105M	4s
90050K	60%	176M	4s
90100K	60%	151M	4s
90150K	60%	171M	4s
90200K	60%	135M	4s
90250K	60%	167M	4s
90300K	60%	119M	4s
90350K	60%	108M	4s
90400K	60%	134M	4s
90450K	60%	105M	4s
90500K	60%	103M	4s
90550K	60%	125M	4s
90600K	60%	102M	4s
90650K	60%	119M	3s
90700K	60%	110M	3s
90750K	60%	21.8M	3s
90800K	60%	116M	3s
90850K	60%	122M	3s
90900K	60%	114M	3s
90950K	60%	96.3M	3s
91000K	60%	114M	3s
91050K	60%	128M	3s
91100K	60%	108M	3s
91150K	60%	105M	3s
91200K	60%	117M	3s
91250K	60%	109M	3s
91300K	60%	108M	3s
91350K	61%	112M	3s
91400K	61%	119M	3s
91450K	61%	110M	3s
91500K	61%	106M	3s
91550K	61%	113M	3s
91600K	61%	117M	3s
91650K	61%	102M	3s
91700K	61%	120M	3s
91750K	61%	111M	3s
91800K	61%	101M	3s
91850K	61%	111M	3s
91900K	61%	108M	3s
91950K	61%	107M	3s
92000K	61%	107M	3s
92050K	61%	109M	3s
92100K	61%	95.7M	3s

92150K	61%	445K	3s
92200K	61%	101M	3s
92250K	61%	124M	3s
92300K	61%	106M	3s
92350K	61%	67.0M	3s
92400K	61%	149M	3s
92450K	61%	171M	3s
92500K	61%	129M	3s
92550K	61%	109M	3s
92600K	61%	120M	3s
92650K	61%	102M	3s
92700K	61%	91.2M	3s
92750K	61%	144M	3s
92800K	61%	112M	3s
92850K	62%	107M	3s
92900K	62%	126M	3s
92950K	62%	69.6M	3s
93000K	62%	132M	3s
93050K	62%	123M	3s
93100K	62%	146M	3s
93150K	62%	108M	3s
93200K	62%	86.8M	3s
93250K	62%	152M	3s
93300K	62%	111M	3s
93350K	62%	120M	3s
93400K	62%	22.6M	3s
93450K	62%	169M	3s
93500K	62%	126M	3s
93550K	62%	226M	3s
93600K	62%	133M	3s
93650K	62%	125M	3s
93700K	62%	113M	3s
93750K	62%	35.3M	3s
93800K	62%	120M	3s
93850K	62%	128M	3s
93900K	62%	143M	3s
93950K	62%	141M	3s
94000K	62%	150M	3s
94050K	62%	117M	3s
94100K	62%	121M	3s
94150K	62%	213M	3s
94200K	62%	169M	3s
94250K	62%	162M	3s
94300K	62%	108M	3s
94350K	63%	123M	3s
94400K	63%	106M	3s
94450K	63%	109M	3s
94500K	63%	124M	3s

94550K	63%	103M	3s
94600K	63%	116M	3s
94650K	63%	107M	3s
94700K	63%	94.1M	3s
94750K	63%	120M	3s
94800K	63%	108M	3s
94850K	63%	444K	3s
94900K	63%	151M	3s
94950K	63%	141M	3s
95000K	63%	127M	3s
95050K	63%	113M	3s
95100K	63%	111M	3s
95150K	63%	115M	3s
95200K	63%	98.0M	3s
95250K	63%	119M	3s
95300K	63%	118M	3s
95350K	63%	110M	3s
95400K	63%	109M	3s
95450K	63%	99.4M	3s
95500K	63%	123M	3s
95550K	63%	114M	3s
95600K	63%	107M	3s
95650K	63%	108M	3s
95700K	63%	109M	3s
95750K	63%	121M	3s
95800K	64%	97.7M	3s
95850K	64%	130M	3s
95900K	64%	107M	3s
95950K	64%	102M	3s
96000K	64%	121M	3s
96050K	64%	116M	3s
96100K	64%	100M	3s
96150K	64%	118M	3s
96200K	64%	30.2M	3s
96250K	64%	121M	3s
96300K	64%	108M	3s
96350K	64%	105M	3s
96400K	64%	113M	3s
96450K	64%	102M	3s
96500K	64%	128M	3s
96550K	64%	101M	3s
96600K	64%	134M	3s
96650K	64%	90.9M	3s
96700K	64%	121M	3s
96750K	64%	106M	3s
96800K	64%	99.4M	3s
96850K	64%	96.6M	3s
96900K	64%	119M	3s

96950K	64%	98.2M	3s
97000K	64%	120M	3s
97050K	64%	110M	3s
97100K	64%	105M	3s
97150K	64%	104M	3s
97200K	64%	109M	3s
97250K	64%	106M	3s
97300K	65%	116M	3s
97350K	65%	112M	3s
97400K	65%	102M	3s
97450K	65%	93.8M	3s
97500K	65%	102M	3s
97550K	65%	445K	3s
97600K	65%	194M	3s
97650K	65%	112M	3s
97700K	65%	119M	3s
97750K	65%	106M	3s
97800K	65%	107M	3s
97850K	65%	125M	3s
97900K	65%	105M	3s
97950K	65%	108M	3s
98000K	65%	119M	3s
98050K	65%	107M	3s
98100K	65%	97.6M	3s
98150K	65%	118M	3s
98200K	65%	88.9M	3s
98250K	65%	110M	3s
98300K	65%	88.3M	3s
98350K	65%	140M	3s
98400K	65%	98.3M	3s
98450K	65%	114M	3s
98500K	65%	107M	3s
98550K	65%	110M	3s
98600K	65%	108M	3s
98650K	65%	103M	3s
98700K	65%	101M	3s
98750K	65%	107M	3s
98800K	66%	107M	3s
98850K	66%	124M	3s
98900K	66%	39.6M	3s
98950K	66%	121M	3s
99000K	66%	118M	3s
99050K	66%	96.7M	3s
99100K	66%	122M	3s
99150K	66%	107M	3s
99200K	66%	109M	3s
99250K	66%	121M	3s
99300K	66%	110M	3s

99350K	66%	107M	3s
99400K	66%	115M	3s
99450K	66%	99.4M	3s
99500K	66%	104M	3s
99550K	66%	109M	3s
99600K	66%	121M	3s
99650K	66%	93.1M	3s
99700K	66%	115M	3s
99750K	66%	107M	3s
99800K	66%	109M	3s
99850K	66%	94.1M	3s
99900K	66%	129M	3s
99950K	66%	109M	3s
100000K	66%	106M	3s
100050K	66%	105M	3s
100100K	66%	103M	3s
100150K	66%	119M	3s
100200K	66%	125M	3s
100250K	66%	96.5M	3s
100300K	67%	444K	3s
100350K	67%	140M	3s
100400K	67%	129M	3s
100450K	67%	110M	3s
100500K	67%	106M	3s
100550K	67%	130M	3s
100600K	67%	109M	3s
100650K	67%	103M	3s
100700K	67%	112M	3s
100750K	67%	91.9M	3s
100800K	67%	101M	3s
100850K	67%	103M	3s
100900K	67%	104M	3s
100950K	67%	107M	3s
101000K	67%	108M	3s
101050K	67%	104M	3s
101100K	67%	101M	3s
101150K	67%	109M	3s
101200K	67%	112M	3s
101250K	67%	105M	3s
101300K	67%	117M	3s
101350K	67%	88.2M	3s
101400K	67%	108M	3s
101450K	67%	110M	3s
101500K	67%	97.7M	3s
101550K	67%	89.7M	3s
101600K	67%	93.2M	3s
101650K	67%	25.3M	3s
101700K	67%	147M	3s

101750K	67%	272M	3s
101800K	68%	87.2M	3s
101850K	68%	103M	3s
101900K	68%	158M	3s
101950K	68%	111M	3s
102000K	68%	121M	3s
102050K	68%	97.6M	3s
102100K	68%	116M	3s
102150K	68%	118M	3s
102200K	68%	99.9M	3s
102250K	68%	115M	3s
102300K	68%	98.8M	3s
102350K	68%	100M	3s
102400K	68%	102M	3s
102450K	68%	117M	3s
102500K	68%	105M	3s
102550K	68%	113M	3s
102600K	68%	99.0M	3s
102650K	68%	129M	3s
102700K	68%	98.7M	3s
102750K	68%	111M	3s
102800K	68%	103M	3s
102850K	68%	97.1M	3s
102900K	68%	121M	3s
102950K	68%	108M	3s
103000K	68%	447K	3s
103050K	68%	184M	3s
103100K	68%	95.2M	3s
103150K	68%	142M	3s
103200K	68%	124M	3s
103250K	68%	97.0M	3s
103300K	69%	69.1M	3s
103350K	69%	274M	3s
103400K	69%	102M	3s
103450K	69%	122M	3s
103500K	69%	123M	3s
103550K	69%	97.6M	3s
103600K	69%	117M	3s
103650K	69%	117M	3s
103700K	69%	92.5M	3s
103750K	69%	103M	3s
103800K	69%	119M	3s
103850K	69%	114M	3s
103900K	69%	104M	3s
103950K	69%	89.4M	3s
104000K	69%	122M	3s
104050K	69%	120M	3s
104100K	69%	106M	3s

104150K	69%	92.7M	3s
104200K	69%	135M	3s
104250K	69%	94.8M	3s
104300K	69%	129M	3s
104350K	69%	82.0M	3s
104400K	69%	32.0M	3s
104450K	69%	108M	3s
104500K	69%	58.3M	3s
104550K	69%	386M	3s
104600K	69%	158M	3s
104650K	69%	97.3M	3s
104700K	69%	109M	3s
104750K	69%	102M	3s
104800K	70%	113M	3s
104850K	70%	124M	3s
104900K	70%	104M	3s
104950K	70%	102M	3s
105000K	70%	105M	3s
105050K	70%	110M	3s
105100K	70%	93.0M	3s
105150K	70%	132M	3s
105200K	70%	115M	3s
105250K	70%	110M	3s
105300K	70%	110M	3s
105350K	70%	99.2M	3s
105400K	70%	102M	3s
105450K	70%	107M	3s
105500K	70%	119M	3s
105550K	70%	105M	3s
105600K	70%	125M	3s
105650K	70%	108M	3s
105700K	70%	99.2M	3s
105750K	70%	432K	3s
105800K	70%	284M	3s
105850K	70%	113M	3s
105900K	70%	129M	3s
105950K	70%	99.1M	3s
106000K	70%	114M	3s
106050K	70%	106M	3s
106100K	70%	99.7M	3s
106150K	70%	110M	3s
106200K	70%	145M	3s
106250K	70%	105M	3s
106300K	71%	106M	3s
106350K	71%	112M	3s
106400K	71%	109M	3s
106450K	71%	99.3M	3s
106500K	71%	86.0M	3s

106550K	71%	116M	3s
106600K	71%	111M	3s
106650K	71%	104M	3s
106700K	71%	112M	2s
106750K	71%	131M	2s
106800K	71%	118M	2s
106850K	71%	91.6M	2s
106900K	71%	135M	2s
106950K	71%	90.1M	2s
107000K	71%	96.1M	2s
107050K	71%	143M	2s
107100K	71%	76.2M	2s
107150K	71%	115M	2s
107200K	71%	105M	2s
107250K	71%	124M	2s
107300K	71%	86.8M	2s
107350K	71%	145M	2s
107400K	71%	120M	2s
107450K	71%	108M	2s
107500K	71%	97.1M	2s
107550K	71%	106M	2s
107600K	71%	131M	2s
107650K	71%	97.6M	2s
107700K	71%	100M	2s
107750K	71%	119M	2s
107800K	72%	98.9M	2s
107850K	72%	120M	2s
107900K	72%	108M	2s
107950K	72%	111M	2s
108000K	72%	105M	2s
108050K	72%	97.1M	2s
108100K	72%	116M	2s
108150K	72%	108M	2s
108200K	72%	103M	2s
108250K	72%	121M	2s
108300K	72%	108M	2s
108350K	72%	103M	2s
108400K	72%	114M	2s
108450K	72%	108M	2s
108500K	72%	441K	2s
108550K	72%	203M	2s
108600K	72%	85.6M	2s
108650K	72%	157M	2s
108700K	72%	113M	2s
108750K	72%	125M	2s
108800K	72%	105M	2s
108850K	72%	99.9M	2s
108900K	72%	122M	2s

108950K	72%	94.4M	2s
109000K	72%	107M	2s
109050K	72%	111M	2s
109100K	72%	117M	2s
109150K	72%	107M	2s
109200K	72%	94.7M	2s
109250K	72%	99.2M	2s
109300K	73%	119M	2s
109350K	73%	105M	2s
109400K	73%	113M	2s
109450K	73%	122M	2s
109500K	73%	115M	2s
109550K	73%	93.5M	2s
109600K	73%	97.5M	2s
109650K	73%	113M	2s
109700K	73%	112M	2s
109750K	73%	98.0M	2s
109800K	73%	117M	2s
109850K	73%	102M	2s
109900K	73%	79.3M	2s
109950K	73%	113M	2s
110000K	73%	119M	2s
110050K	73%	85.7M	2s
110100K	73%	135M	2s
110150K	73%	108M	2s
110200K	73%	127M	2s
110250K	73%	103M	2s
110300K	73%	108M	2s
110350K	73%	137M	2s
110400K	73%	116M	2s
110450K	73%	96.9M	2s
110500K	73%	96.6M	2s
110550K	73%	120M	2s
110600K	73%	105M	2s
110650K	73%	111M	2s
110700K	73%	101M	2s
110750K	73%	117M	2s
110800K	74%	98.4M	2s
110850K	74%	118M	2s
110900K	74%	104M	2s
110950K	74%	98.5M	2s
111000K	74%	117M	2s
111050K	74%	110M	2s
111100K	74%	99.0M	2s
111150K	74%	117M	2s
111200K	74%	108M	2s
111250K	74%	442K	2s
111300K	74%	102M	2s

111350K	74%	165M	2s
111400K	74%	103M	2s
111450K	74%	134M	2s
111500K	74%	92.1M	2s
111550K	74%	140M	2s
111600K	74%	109M	2s
111650K	74%	99.9M	2s
111700K	74%	109M	2s
111750K	74%	114M	2s
111800K	74%	111M	2s
111850K	74%	97.3M	2s
111900K	74%	114M	2s
111950K	74%	109M	2s
112000K	74%	109M	2s
112050K	74%	110M	2s
112100K	74%	94.9M	2s
112150K	74%	118M	2s
112200K	74%	101M	2s
112250K	74%	107M	2s
112300K	75%	104M	2s
112350K	75%	104M	2s
112400K	75%	112M	2s
112450K	75%	108M	2s
112500K	75%	114M	2s
112550K	75%	99.7M	2s
112600K	75%	40.4M	2s
112650K	75%	111M	2s
112700K	75%	107M	2s
112750K	75%	106M	2s
112800K	75%	121M	2s
112850K	75%	121M	2s
112900K	75%	116M	2s
112950K	75%	102M	2s
113000K	75%	109M	2s
113050K	75%	111M	2s
113100K	75%	127M	2s
113150K	75%	93.2M	2s
113200K	75%	121M	2s
113250K	75%	90.9M	2s
113300K	75%	111M	2s
113350K	75%	121M	2s
113400K	75%	103M	2s
113450K	75%	120M	2s
113500K	75%	92.4M	2s
113550K	75%	108M	2s
113600K	75%	117M	2s
113650K	75%	88.6M	2s
113700K	75%	128M	2s

113750K	75%	102M	2s
113800K	76%	116M	2s
113850K	76%	91.5M	2s
113900K	76%	111M	2s
113950K	76%	112M	2s
114000K	76%	443K	2s
114050K	76%	153M	2s
114100K	76%	97.6M	2s
114150K	76%	147M	2s
114200K	76%	119M	2s
114250K	76%	117M	2s
114300K	76%	92.5M	2s
114350K	76%	107M	2s
114400K	76%	122M	2s
114450K	76%	130M	2s
114500K	76%	111M	2s
114550K	76%	112M	2s
114600K	76%	102M	2s
114650K	76%	103M	2s
114700K	76%	106M	2s
114750K	76%	102M	2s
114800K	76%	105M	2s
114850K	76%	111M	2s
114900K	76%	105M	2s
114950K	76%	122M	2s
115000K	76%	92.8M	2s
115050K	76%	93.7M	2s
115100K	76%	122M	2s
115150K	76%	98.5M	2s
115200K	76%	109M	2s
115250K	76%	109M	2s
115300K	77%	88.8M	2s
115350K	77%	105M	2s
115400K	77%	51.0M	2s
115450K	77%	97.0M	2s
115500K	77%	117M	2s
115550K	77%	102M	2s
115600K	77%	99.0M	2s
115650K	77%	110M	2s
115700K	77%	113M	2s
115750K	77%	86.2M	2s
115800K	77%	99.1M	2s
115850K	77%	94.1M	2s
115900K	77%	103M	2s
115950K	77%	101M	2s
116000K	77%	101M	2s
116050K	77%	116M	2s
116100K	77%	132M	2s

116150K	77%	103M	2s
116200K	77%	92.1M	2s
116250K	77%	97.0M	2s
116300K	77%	124M	2s
116350K	77%	116M	2s
116400K	77%	97.4M	2s
116450K	77%	107M	2s
116500K	77%	106M	2s
116550K	77%	117M	2s
116600K	77%	93.5M	2s
116650K	77%	128M	2s
116700K	77%	89.6M	2s
116750K	77%	447K	2s
116800K	78%	134M	2s
116850K	78%	116M	2s
116900K	78%	125M	2s
116950K	78%	104M	2s
117000K	78%	84.1M	2s
117050K	78%	146M	2s
117100K	78%	122M	2s
117150K	78%	100M	2s
117200K	78%	127M	2s
117250K	78%	91.9M	2s
117300K	78%	127M	2s
117350K	78%	98.9M	2s
117400K	78%	105M	2s
117450K	78%	94.8M	2s
117500K	78%	137M	2s
117550K	78%	112M	2s
117600K	78%	102M	2s
117650K	78%	113M	2s
117700K	78%	98.0M	2s
117750K	78%	128M	2s
117800K	78%	95.3M	2s
117850K	78%	106M	2s
117900K	78%	119M	2s
117950K	78%	100M	2s
118000K	78%	101M	2s
118050K	78%	106M	2s
118100K	78%	34.4M	2s
118150K	78%	128M	2s
118200K	78%	100M	2s
118250K	78%	117M	2s
118300K	79%	111M	2s
118350K	79%	118M	2s
118400K	79%	93.4M	2s
118450K	79%	100M	2s
118500K	79%	142M	2s

118550K	79%	97.1M	2s
118600K	79%	134M	2s
118650K	79%	92.1M	2s
118700K	79%	107M	2s
118750K	79%	113M	2s
118800K	79%	92.2M	2s
118850K	79%	122M	2s
118900K	79%	110M	2s
118950K	79%	131M	2s
119000K	79%	102M	2s
119050K	79%	90.4M	2s
119100K	79%	111M	2s
119150K	79%	102M	2s
119200K	79%	134M	2s
119250K	79%	99.3M	2s
119300K	79%	105M	2s
119350K	79%	110M	2s
119400K	79%	105M	2s
119450K	79%	446K	2s
119500K	79%	122M	2s
119550K	79%	89.8M	2s
119600K	79%	128M	2s
119650K	79%	124M	2s
119700K	79%	103M	2s
119750K	79%	100M	2s
119800K	80%	170M	2s
119850K	80%	108M	2s
119900K	80%	104M	2s
119950K	80%	98.8M	2s
120000K	80%	105M	2s
120050K	80%	92.8M	2s
120100K	80%	119M	2s
120150K	80%	112M	2s
120200K	80%	118M	2s
120250K	80%	117M	2s
120300K	80%	92.8M	2s
120350K	80%	109M	2s
120400K	80%	107M	2s
120450K	80%	98.3M	2s
120500K	80%	118M	2s
120550K	80%	108M	2s
120600K	80%	110M	2s
120650K	80%	109M	2s
120700K	80%	100M	2s
120750K	80%	113M	2s
120800K	80%	96.1M	2s
120850K	80%	32.5M	2s
120900K	80%	195M	2s

120950K	80%	128M	2s
121000K	80%	118M	2s
121050K	80%	116M	2s
121100K	80%	111M	2s
121150K	80%	108M	2s
121200K	80%	113M	2s
121250K	80%	123M	2s
121300K	81%	102M	2s
121350K	81%	110M	2s
121400K	81%	93.5M	2s
121450K	81%	99.9M	2s
121500K	81%	121M	2s
121550K	81%	118M	2s
121600K	81%	105M	2s
121650K	81%	107M	2s
121700K	81%	109M	2s
121750K	81%	109M	2s
121800K	81%	106M	2s
121850K	81%	89.6M	2s
121900K	81%	115M	2s
121950K	81%	105M	2s
122000K	81%	115M	2s
122050K	81%	103M	2s
122100K	81%	91.9M	2s
122150K	81%	119M	2s
122200K	81%	445K	2s
122250K	81%	312M	2s
122300K	81%	79.0M	2s
122350K	81%	162M	2s
122400K	81%	107M	2s
122450K	81%	109M	2s
122500K	81%	100M	2s
122550K	81%	120M	2s
122600K	81%	123M	2s
122650K	81%	110M	2s
122700K	81%	110M	2s
122750K	81%	87.7M	2s
122800K	82%	126M	2s
122850K	82%	99.2M	2s
122900K	82%	99.6M	2s
122950K	82%	127M	2s
123000K	82%	97.3M	2s
123050K	82%	114M	2s
123100K	82%	51.1M	2s
123150K	82%	98.1M	2s
123200K	82%	89.6M	2s
123250K	82%	96.9M	2s
123300K	82%	120M	2s

123350K	82%	110M	2s
123400K	82%	106M	1s
123450K	82%	108M	1s
123500K	82%	111M	1s
123550K	82%	113M	1s
123600K	82%	71.1M	1s
123650K	82%	130M	1s
123700K	82%	111M	1s
123750K	82%	111M	1s
123800K	82%	119M	1s
123850K	82%	100M	1s
123900K	82%	107M	1s
123950K	82%	115M	1s
124000K	82%	110M	1s
124050K	82%	115M	1s
124100K	82%	102M	1s
124150K	82%	111M	1s
124200K	82%	98.3M	1s
124250K	82%	115M	1s
124300K	83%	110M	1s
124350K	83%	108M	1s
124400K	83%	108M	1s
124450K	83%	102M	1s
124500K	83%	109M	1s
124550K	83%	68.8M	1s
124600K	83%	150M	1s
124650K	83%	154M	1s
124700K	83%	93.3M	1s
124750K	83%	126M	1s
124800K	83%	110M	1s
124850K	83%	102M	1s
124900K	83%	103M	1s
124950K	83%	436K	1s
125000K	83%	408M	1s
125050K	83%	453M	1s
125100K	83%	95.1M	1s
125150K	83%	88.3M	1s
125200K	83%	88.1M	1s
125250K	83%	391M	1s
125300K	83%	93.5M	1s
125350K	83%	125M	1s
125400K	83%	122M	1s
125450K	83%	106M	1s
125500K	83%	111M	1s
125550K	83%	108M	1s
125600K	83%	115M	1s
125650K	83%	93.3M	1s
125700K	83%	99.1M	1s

125750K	83%	130M	1s
125800K	84%	104M	1s
125850K	84%	109M	1s
125900K	84%	94.3M	1s
125950K	84%	71.3M	1s
126000K	84%	96.5M	1s
126050K	84%	125M	1s
126100K	84%	84.8M	1s
126150K	84%	175M	1s
126200K	84%	105M	1s
126250K	84%	100M	1s
126300K	84%	104M	1s
126350K	84%	65.2M	1s
126400K	84%	127M	1s
126450K	84%	108M	1s
126500K	84%	106M	1s
126550K	84%	110M	1s
126600K	84%	128M	1s
126650K	84%	102M	1s
126700K	84%	111M	1s
126750K	84%	128M	1s
126800K	84%	101M	1s
126850K	84%	117M	1s
126900K	84%	105M	1s
126950K	84%	108M	1s
127000K	84%	124M	1s
127050K	84%	100M	1s
127100K	84%	113M	1s
127150K	84%	91.8M	1s
127200K	84%	103M	1s
127250K	85%	106M	1s
127300K	85%	116M	1s
127350K	85%	106M	1s
127400K	85%	103M	1s
127450K	85%	122M	1s
127500K	85%	104M	1s
127550K	85%	109M	1s
127600K	85%	98.2M	1s
127650K	85%	97.6M	1s
127700K	85%	121M	1s
127750K	85%	106M	1s
127800K	85%	442K	1s
127850K	85%	180M	1s
127900K	85%	129M	1s
127950K	85%	110M	1s
128000K	85%	109M	1s
128050K	85%	126M	1s
128100K	85%	125M	1s

128150K	85%	106M	1s
128200K	85%	99.9M	1s
128250K	85%	105M	1s
128300K	85%	132M	1s
128350K	85%	101M	1s
128400K	85%	107M	1s
128450K	85%	70.1M	1s
128500K	85%	262M	1s
128550K	85%	112M	1s
128600K	85%	92.9M	1s
128650K	85%	112M	1s
128700K	85%	108M	1s
128750K	86%	114M	1s
128800K	86%	102M	1s
128850K	86%	115M	1s
128900K	86%	116M	1s
128950K	86%	95.7M	1s
129000K	86%	107M	1s
129050K	86%	102M	1s
129100K	86%	101M	1s
129150K	86%	111M	1s
129200K	86%	57.8M	1s
129250K	86%	103M	1s
129300K	86%	132M	1s
129350K	86%	103M	1s
129400K	86%	118M	1s
129450K	86%	109M	1s
129500K	86%	96.2M	1s
129550K	86%	122M	1s
129600K	86%	129M	1s
129650K	86%	99.0M	1s
129700K	86%	108M	1s
129750K	86%	111M	1s
129800K	86%	101M	1s
129850K	86%	91.3M	1s
129900K	86%	122M	1s
129950K	86%	119M	1s
130000K	86%	105M	1s
130050K	86%	110M	1s
130100K	86%	96.6M	1s
130150K	86%	109M	1s
130200K	86%	107M	1s
130250K	87%	82.2M	1s
130300K	87%	178M	1s
130350K	87%	119M	1s
130400K	87%	86.5M	1s
130450K	87%	101M	1s
130500K	87%	115M	1s

130550K	87%	442K	1s
130600K	87%	391M	1s
130650K	87%	96.5M	1s
130700K	87%	96.0M	1s
130750K	87%	143M	1s
130800K	87%	116M	1s
130850K	87%	97.0M	1s
130900K	87%	125M	1s
130950K	87%	120M	1s
131000K	87%	95.9M	1s
131050K	87%	129M	1s
131100K	87%	97.5M	1s
131150K	87%	96.0M	1s
131200K	87%	126M	1s
131250K	87%	103M	1s
131300K	87%	115M	1s
131350K	87%	100M	1s
131400K	87%	118M	1s
131450K	87%	93.9M	1s
131500K	87%	97.2M	1s
131550K	87%	133M	1s
131600K	87%	111M	1s
131650K	87%	102M	1s
131700K	87%	103M	1s
131750K	88%	92.5M	1s
131800K	88%	118M	1s
131850K	88%	97.8M	1s
131900K	88%	128M	1s
131950K	88%	76.6M	1s
132000K	88%	118M	1s
132050K	88%	106M	1s
132100K	88%	107M	1s
132150K	88%	103M	1s
132200K	88%	105M	1s
132250K	88%	114M	1s
132300K	88%	134M	1s
132350K	88%	102M	1s
132400K	88%	101M	1s
132450K	88%	114M	1s
132500K	88%	94.1M	1s
132550K	88%	124M	1s
132600K	88%	107M	1s
132650K	88%	109M	1s
132700K	88%	126M	1s
132750K	88%	94.8M	1s
132800K	88%	107M	1s
132850K	88%	109M	1s
132900K	88%	101M	1s

132950K	88%	108M	1s
133000K	88%	109M	1s
133050K	88%	107M	1s
133100K	88%	95.7M	1s
133150K	88%	112M	1s
133200K	88%	123M	1s
133250K	89%	106M	1s
133300K	89%	441K	1s
133350K	89%	129M	1s
133400K	89%	101M	1s
133450K	89%	150M	1s
133500K	89%	105M	1s
133550K	89%	114M	1s
133600K	89%	124M	1s
133650K	89%	106M	1s
133700K	89%	107M	1s
133750K	89%	102M	1s
133800K	89%	116M	1s
133850K	89%	115M	1s
133900K	89%	89.0M	1s
133950K	89%	105M	1s
134000K	89%	138M	1s
134050K	89%	90.0M	1s
134100K	89%	125M	1s
134150K	89%	99.1M	1s
134200K	89%	114M	1s
134250K	89%	94.3M	1s
134300K	89%	110M	1s
134350K	89%	102M	1s
134400K	89%	125M	1s
134450K	89%	106M	1s
134500K	89%	104M	1s
134550K	89%	96.6M	1s
134600K	89%	105M	1s
134650K	89%	125M	1s
134700K	89%	82.3M	1s
134750K	90%	108M	1s
134800K	90%	116M	1s
134850K	90%	116M	1s
134900K	90%	90.5M	1s
134950K	90%	114M	1s
135000K	90%	117M	1s
135050K	90%	93.5M	1s
135100K	90%	116M	1s
135150K	90%	127M	1s
135200K	90%	118M	1s
135250K	90%	86.8M	1s
135300K	90%	124M	1s

135350K	90%	100M	1s
135400K	90%	102M	1s
135450K	90%	125M	1s
135500K	90%	105M	1s
135550K	90%	117M	1s
135600K	90%	105M	1s
135650K	90%	110M	1s
135700K	90%	97.5M	1s
135750K	90%	110M	1s
135800K	90%	104M	1s
135850K	90%	102M	1s
135900K	90%	109M	1s
135950K	90%	113M	1s
136000K	90%	88.8M	1s
136050K	90%	442K	1s
136100K	90%	380M	1s
136150K	90%	119M	1s
136200K	90%	96.1M	1s
136250K	91%	135M	1s
136300K	91%	96.0M	1s
136350K	91%	147M	1s
136400K	91%	98.8M	1s
136450K	91%	121M	1s
136500K	91%	95.1M	1s
136550K	91%	133M	1s
136600K	91%	116M	1s
136650K	91%	105M	1s
136700K	91%	107M	1s
136750K	91%	113M	1s
136800K	91%	86.7M	1s
136850K	91%	113M	1s
136900K	91%	112M	1s
136950K	91%	103M	1s
137000K	91%	109M	1s
137050K	91%	122M	1s
137100K	91%	92.5M	1s
137150K	91%	111M	1s
137200K	91%	113M	1s
137250K	91%	97.7M	1s
137300K	91%	129M	1s
137350K	91%	96.3M	1s
137400K	91%	116M	1s
137450K	91%	78.9M	1s
137500K	91%	98.1M	1s
137550K	91%	136M	1s
137600K	91%	102M	1s
137650K	91%	122M	1s
137700K	91%	107M	1s

137750K	92%	117M	1s
137800K	92%	95.4M	1s
137850K	92%	134M	1s
137900K	92%	104M	1s
137950K	92%	111M	1s
138000K	92%	115M	1s
138050K	92%	87.0M	1s
138100K	92%	116M	1s
138150K	92%	108M	1s
138200K	92%	106M	1s
138250K	92%	126M	1s
138300K	92%	97.4M	1s
138350K	92%	111M	1s
138400K	92%	107M	1s
138450K	92%	106M	1s
138500K	92%	106M	1s
138550K	92%	101M	1s
138600K	92%	110M	1s
138650K	92%	99.8M	1s
138700K	92%	116M	1s
138750K	92%	96.3M	1s
138800K	92%	441K	1s
138850K	92%	374M	1s
138900K	92%	87.2M	1s
138950K	92%	93.0M	1s
139000K	92%	229M	1s
139050K	92%	110M	1s
139100K	92%	115M	1s
139150K	92%	110M	1s
139200K	92%	122M	1s
139250K	93%	107M	1s
139300K	93%	108M	1s
139350K	93%	91.3M	1s
139400K	93%	126M	1s
139450K	93%	103M	1s
139500K	93%	115M	1s
139550K	93%	104M	1s
139600K	93%	103M	1s
139650K	93%	111M	1s
139700K	93%	104M	1s
139750K	93%	108M	1s
139800K	93%	105M	1s
139850K	93%	110M	1s
139900K	93%	98.7M	1s
139950K	93%	117M	1s
140000K	93%	107M	1s
140050K	93%	101M	1s
140100K	93%	125M	1s

140150K	93%	89.8M	1s
140200K	93%	95.1M	1s
140250K	93%	93.6M	1s
140300K	93%	125M	1s
140350K	93%	102M	1s
140400K	93%	113M	1s
140450K	93%	105M	1s
140500K	93%	122M	1s
140550K	93%	121M	1s
140600K	93%	110M	1s
140650K	93%	86.9M	1s
140700K	93%	158M	1s
140750K	94%	95.1M	1s
140800K	94%	106M	0s
140850K	94%	106M	0s
140900K	94%	107M	0s
140950K	94%	104M	0s
141000K	94%	107M	0s
141050K	94%	101M	0s
141100K	94%	108M	0s
141150K	94%	111M	0s
141200K	94%	99.5M	0s
141250K	94%	129M	0s
141300K	94%	102M	0s
141350K	94%	111M	0s
141400K	94%	107M	0s
141450K	94%	105M	0s
141500K	94%	116M	0s
141550K	94%	428K	0s
141600K	94%	180M	0s
141650K	94%	172M	0s
141700K	94%	163M	0s
141750K	94%	201M	0s
141800K	94%	199M	0s
141850K	94%	69.0M	0s
141900K	94%	30.7M	0s
141950K	94%	37.2M	0s
142000K	94%	41.1M	0s
142050K	94%	42.5M	0s
142100K	94%	114M	0s
142150K	94%	240M	0s
142200K	94%	198M	0s
142250K	95%	215M	0s
142300K	95%	210M	0s
142350K	95%	290M	0s
142400K	95%	273M	0s
142450K	95%	261M	0s
142500K	95%	213M	0s

142550K	95%	231M	0s
142600K	95%	240M	0s
142650K	95%	257M	0s
142700K	95%	230M	0s
142750K	95%	283M	0s
142800K	95%	230M	0s
142850K	95%	253M	0s
142900K	95%	213M	0s
142950K	95%	237M	0s
143000K	95%	228M	0s
143050K	95%	218M	0s
143100K	95%	42.5M	0s
143150K	95%	48.9M	0s
143200K	95%	49.2M	0s
143250K	95%	48.8M	0s
143300K	95%	45.3M	0s
143350K	95%	49.7M	0s
143400K	95%	50.3M	0s
143450K	95%	49.8M	0s
143500K	95%	43.2M	0s
143550K	95%	125M	0s
143600K	95%	229M	0s
143650K	95%	466M	0s
143700K	95%	368M	0s
143750K	96%	508M	0s
143800K	96%	512M	0s
143850K	96%	495M	0s
143900K	96%	418M	0s
143950K	96%	508M	0s
144000K	96%	505M	0s
144050K	96%	503M	0s
144100K	96%	363M	0s
144150K	96%	489M	0s
144200K	96%	458M	0s
144250K	96%	493M	0s
144300K	96%	443K	0s
144350K	96%	70.4M	0s
144400K	96%	69.0M	0s
144450K	96%	69.7M	0s
144500K	96%	61.7M	0s
144550K	96%	69.4M	0s
144600K	96%	70.4M	0s
144650K	96%	68.8M	0s
144700K	96%	60.5M	0s
144750K	96%	72.3M	0s
144800K	96%	72.1M	0s
144850K	96%	114M	0s
144900K	96%	331M	0s

144950K	96%	282M	0s
145000K	96%	357M	0s
145050K	96%	349M	0s
145100K	96%	337M	0s
145150K	96%	539M	0s
145200K	96%	418M	0s
145250K	97%	342M	0s
145300K	97%	257M	0s
145350K	97%	83.2M	0s
145400K	97%	69.7M	0s
145450K	97%	71.6M	0s
145500K	97%	71.9M	0s
145550K	97%	61.3M	0s
145600K	97%	71.2M	0s
145650K	97%	70.7M	0s
145700K	97%	71.2M	0s
145750K	97%	161M	0s
145800K	97%	326M	0s
145850K	97%	361M	0s
145900K	97%	361M	0s
145950K	97%	314M	0s
146000K	97%	369M	0s
146050K	97%	378M	0s
146100K	97%	73.2M	0s
146150K	97%	72.7M	0s
146200K	97%	71.7M	0s
146250K	97%	62.6M	0s
146300K	97%	71.6M	0s
146350K	97%	86.1M	0s
146400K	97%	343M	0s
146450K	97%	257M	0s
146500K	97%	352M	0s
146550K	97%	331M	0s
146600K	97%	83.2M	0s
146650K	97%	72.2M	0s
146700K	97%	70.2M	0s
146750K	98%	88.7M	0s
146800K	98%	216M	0s
146850K	98%	439K	0s
146900K	98%	272M	0s
146950K	98%	99.6M	0s
147000K	98%	83.7M	0s
147050K	98%	324M	0s
147100K	98%	77.9M	0s
147150K	98%	157M	0s
147200K	98%	72.0M	0s
147250K	98%	208M	0s
147300K	98%	78.2M	0s

147350K	98%	113M	0s
147400K	98%	108M	0s
147450K	98%	80.7M	0s
147500K	98%	300M	0s
147550K	98%	91.6M	0s
147600K	98%	73.1M	0s
147650K	98%	148M	0s
147700K	98%	206M	0s
147750K	98%	65.1M	0s
147800K	98%	70.9M	0s
147850K	98%	135M	0s
147900K	98%	356M	0s
147950K	98%	88.8M	0s
148000K	98%	70.0M	0s
148050K	98%	118M	0s
148100K	98%	289M	0s
148150K	98%	100M	0s
148200K	98%	71.0M	0s
148250K	99%	244M	0s
148300K	99%	155M	0s
148350K	99%	68.5M	0s
148400K	99%	199M	0s
148450K	99%	111M	0s
148500K	99%	71.1M	0s
148550K	99%	231M	0s
148600K	99%	75.5M	0s
148650K	99%	184M	0s
148700K	99%	83.6M	0s
148750K	99%	114M	0s
148800K	99%	130M	0s
148850K	99%	88.3M	0s
148900K	99%	138M	0s
148950K	99%	80.5M	0s
149000K	99%	134M	0s
149050K	99%	141M	0s
149100K	99%	80.8M	0s
149150K	99%	152M	0s
149200K	99%	96.0M	0s
149250K	99%	86.3M	0s
149300K	99%	172M	0s
149350K	99%	59.3M	0s
149400K	99%	217M	0s
149450K	99%	112M	0s
149500K	99%	74.7M	0s
149550K	99%	294M	0s
149600K	99%	81.1M	0s
149650K	99%	81.8M	0s
149700K	99%	358M	0s

```
149750K ... ... 100% 249M=8.3s
```

```
2020-01-05 21:25:46 (17.7 MB/s) - celeba.zip saved [153357646/153357646]
```

```
In [5]: %%sh
```

```
ls
```

```
sample_data
```

```
In [7]: # We can use an image folder dataset the way we have it setup.
```

```
# Create the dataset
```

```
dataset = dset.ImageFolder(root="/tmp/celeba",
```

```
transform=transforms.Compose([
```

```
transforms.ToTensor(),
```

```
transforms.Normalize((0.5, 0.5, 0.5), (0.5, 0.5, 0.5)),
```

```
]))
```

```
# Create the dataloader
```

```
dataloader = torch.utils.data.DataLoader(dataset, batch_size=batch_size,
```

```
shuffle=True, num_workers=workers)
```

```
# Decide which device we want to run on
```

```
device = torch.device("cuda:0" if torch.cuda.is_available() else "cpu")
```

```
# Plot some training images
```

```
real_batch = next(iter(dataloader))
```

```
plt.figure(figsize=(8,8))
```

```
plt.axis("off")
```

```
plt.title("Training Images")
```

```
plt.imshow(np.transpose(vutils.make_grid(real_batch[0].to(device))[:64], padding=2, norm
```

Training Images



In [8]: `nn.ConvTranspose2d(nz, 4*ngf, 4, 1, 0, bias=False)(torch.zeros(10, nz, 1, 1)).shape`

Out [8]: `torch.Size([10, 128, 4, 4])`

2 Model architectures

2.1 Discriminator

Input: Image $x \in \mathbb{R}^{32 \times 32 \times 3}$

Output: "Real" image probability $\in [0, 1]$

- Convolution (1*ndf filters, kernel 4, stride 2, padding 1, no bias)

- Batch Norm 2D
- LeakyReLU ($\alpha = 0.2$)
- Convolution (2*ndf filters, kernel 4, stride 2, padding 1, no bias)
- Batch Norm 2D
- LeakyReLU ($\alpha = 0.2$)
- Convolution (4*ndf filters, kernel 4, stride 2, padding 1, no bias)
- Batch Norm 2D
- LeakyReLU ($\alpha = 0.2$)
- Convolution (1 filter, kernel 4, stride 1, padding 0, no bias)
- Sigmoid activation

2.2 Generator

Input: Random "noise" $z \in \mathbb{R}^{nz}$
 Output: Generated image $\tilde{x} \in \mathbb{R}^{32 \times 32 \times 3}$

- Convolution Transpose (4*ngf filters, kernel 4, stride 1, padding 0, no bias)
- Batch Norm 2D
- ReLU
- Convolution Transpose (2*ngf filters, kernel 4, stride 2, padding 1, no bias)
- Batch Norm 2D
- ReLU
- Convolution Transpose (1*ngf filters, kernel 4, stride 2, padding 1, no bias)
- Batch Norm 2D
- ReLU
- Convolution Transpose (3 filters, kernel 4, stride 2, padding 1, no bias)
- Tanh activation

```
In [0]: class Discriminator(nn.Module):
    def __init__(self):
        super(Discriminator, self).__init__()
        self.model = nn.Sequential(
            # TODO
            nn.Conv2d(3, 1*ndf, 4, 2, 1, bias=False),
            nn.BatchNorm2d(1*ndf),
            nn.LeakyReLU(0.2),

            nn.Conv2d(1*ndf, 2*ndf, 4, 2, 1, bias=False),
            nn.BatchNorm2d(2*ndf),
            nn.LeakyReLU(0.2),

            nn.Conv2d(2*ndf, 4*ndf, 4, 2, 1, bias=False),
            nn.BatchNorm2d(4*ndf),
            nn.LeakyReLU(0.2),

            nn.Conv2d(4*ndf, 1, 4, 1, 0, bias=False),
            nn.Sigmoid()
        )
```

```

def forward(self, input):
    return self.model(input)

class Generator(nn.Module):
    def __init__(self):
        super(Generator, self).__init__()
        self.model = nn.Sequential(
            # TODO
            nn.ConvTranspose2d(nz, 4*ngf, 4, 1, 0, bias=False),
            nn.BatchNorm2d(4*ngf),
            nn.ReLU(),
            nn.ConvTranspose2d(4*ngf, 2*ngf, 4, 2, 1, bias=False),
            nn.BatchNorm2d(2*ngf),
            nn.ReLU(),
            nn.ConvTranspose2d(2*ngf, 1*ngf, 4, 2, 1, bias=False),
            nn.BatchNorm2d(1*ngf),
            nn.ReLU(),
            nn.ConvTranspose2d(1*ngf, 3, 4, 2, 1, bias=False),
            nn.Tanh()
        )

        def forward(self, input):
            return self.model(input)

```

```

In [10]: # Create the models
netG = Generator().to(device)
netD = Discriminator().to(device)

# Apply the weights_init function to randomly initialize all weights to mean=0, std=0.02
def weights_init(m):
    classname = m.__class__.__name__
    if classname.find('Conv') != -1:
        nn.init.normal_(m.weight.data, 0.0, 0.02)
    elif classname.find('BatchNorm') != -1:
        nn.init.normal_(m.weight.data, 1.0, 0.02)
        nn.init.constant_(m.bias.data, 0)
    netG.apply(weights_init)
    netD.apply(weights_init)

# Print the models
print(netG)
print(netD)

```

Generator(

```

(model): Sequential(
(0): ConvTranspose2d(100, 128, kernel_size=(4, 4), stride=(1, 1), bias=False)
(1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
(2): ReLU()
(3): ConvTranspose2d(128, 64, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
(4): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
(5): ReLU()
(6): ConvTranspose2d(64, 32, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
(7): BatchNorm2d(32, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
(8): ReLU()
(9): ConvTranspose2d(32, 3, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
(10): Tanh()
)
)
Discriminator(
(model): Sequential(
(0): Conv2d(3, 32, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
(1): BatchNorm2d(32, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
(2): LeakyReLU(negative_slope=0.2)
(3): Conv2d(32, 64, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
(4): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
(5): LeakyReLU(negative_slope=0.2)
(6): Conv2d(64, 128, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
(7): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
(8): LeakyReLU(negative_slope=0.2)
(9): Conv2d(128, 1, kernel_size=(4, 4), stride=(1, 1), bias=False)
(10): Sigmoid()
)
)
)

```

```

In [11]: # TODO test your models to check if they have the right shape
z = torch.zeros(10, nz, 1, 1).to(device)
x = torch.zeros(10, 3, 32, 32).to(device)
print(netG(z).shape) # expected: [10, 3, 32, 32]
print(netD(x).shape) # expected: [10, 1, 1, 1]

torch.Size([10, 3, 32, 32])
torch.Size([10, 1, 1, 1])

```

3 Optimization and training

Here we will define:

- * Our prior $P(z)$ that we use to sample random "noise". We will use a Gaussian distribution.
- * The criterion that will be used to train the discriminator, and indirectly the generator. We will use the binary cross-entropy.
- * The optimizers of both models. We will use the Adam optimizer.

```
In [12]: torch.randn(10,3)
```

```
Out[12]: tensor([[-1.6846, -0.7719, -0.5859],  
                 [-0.1103, -0.5935, -0.6123],  
                 [-0.1166,  0.9689, -1.0035],  
                 [-0.2652,  0.7599,  0.1412],  
                 [-0.1111, -0.4078,  0.4928],  
                 [-0.8294, -1.2563, -0.6515],  
                 [-0.6763,  1.5879, -0.0102],  
                 [ 2.3493, -0.5826, -0.0108],  
                 [ 1.7394,  1.0543, -0.3020],  
                 [-0.4914,  0.7659, -0.7993]])
```

```
In [0]: # Prior P(z). Returns a Gaussian random tensor of shape (batch_size, nz, 1, 1)
```

```
def get_noise(batch_size):  
    noise = torch.randn(batch_size, nz, 1, 1)  
    return noise.to(device)
```

```
# Create the criterion function that will take (y_hat, y) as input  
criterion = nn.BCELoss() # TODO
```

```
# Setup Adam optimizers for D and G
```

```
optimizerD = optim.Adam(netD.parameters(), lr=lrD, betas=(beta1D, 0.999)) # TODO, take note  
optimizerG = optim.Adam(netG.parameters(), lr=lrG, betas=(beta1G, 0.999)) # TODO, same for G  
# Note that adam's betas is a tuple, set the second element of the tuple to 0.999 for G
```

3.0.1 Data format / batch creation functions

```
In [0]: # Data format / batch creation functions
```

```
fixed_noise = get_noise(196) # Create a fixed random vector sampled from a Gaussian, we will use this every time we want to generate fake images  
real_label = 1  
fake_label = 0  
iterator = iter(dataloader)  
  
# returns a batch of real images from the dataset (iterates infinitely on the dataset)  
def get_batch_real():  
    global iterator  
    try:  
        x_real = next(iterator)[0].to(device)  
    except:  
        iterator = iter(dataloader)  
        x_real = next(iterator)[0].to(device)  
    y_real = torch.full((x_real.size(0),), real_label, device=device)  
    return x_real, y_real  
  
# TODO
```

```

# returns a batch of generated images and training targets y_fake
# Note that the targets y_fake will be different if train_G is True or False
def get_batch_fake(train_G=False):
    z = get_noise(batch_size)
    x_fake = netG(z) # TODO generate images from z
    if train_G:
        y_fake = torch.ones(batch_size)*real_label
    else:
        y_fake = torch.ones(batch_size)*fake_label # TODO create targets, depends on train_G
    return x_fake.to(device), y_fake.to(device)

```

3.0.2 Training Loop

Reminder: when your training loop starts to work, change the workers variable to 4 and rerun your notebook

```
In [0]: img_list = []
G_losses = []
D_losses = []
```

```
In [16]: for i in range(steps):
```

```

#####
# Update D network: maximize log(D(x)) + log(1 - D(G(z)))
for _ in range(nb_update_D):
    netD.zero_grad()

    # Create batches
    x_real, y_real = get_batch_real()
    x_fake, y_fake = get_batch_fake(train_G=False)

    # Forward
    y_hat_real = netD(x_real) # TODO
    y_hat_fake = netD(x_fake) # TODO
    errD = criterion(y_hat_real, y_real) + criterion(y_hat_fake, y_fake) # TODO

    # Backward
    # TODO backward & optimization step on D
    errD.backward()
    optimizerD.step()

    # Compute / save metrics
    avg_output_for_real = y_hat_real.mean().item()
    avg_output_for_fake = y_hat_fake.mean().item()
    D_losses.append(errD.item())

```

```

#####
# Update G network: maximize log(D(G(z)))
for _ in range(nb_update_G):
    netG.zero_grad()

    # TODO: forward + backward
    # NOTE: use errG as name for your loss variable, like errD above
    x_real, y_real = get_batch_real()
    x_fake, y_fake = get_batch_fake(train_G=True)

    y_hat_G = netD(x_fake)
    errG = criterion( y_hat_G, y_fake)

    errG.backward()
    optimizerG.step()

    # Compute / save metrics
    G_losses.append(errG.item())

#####

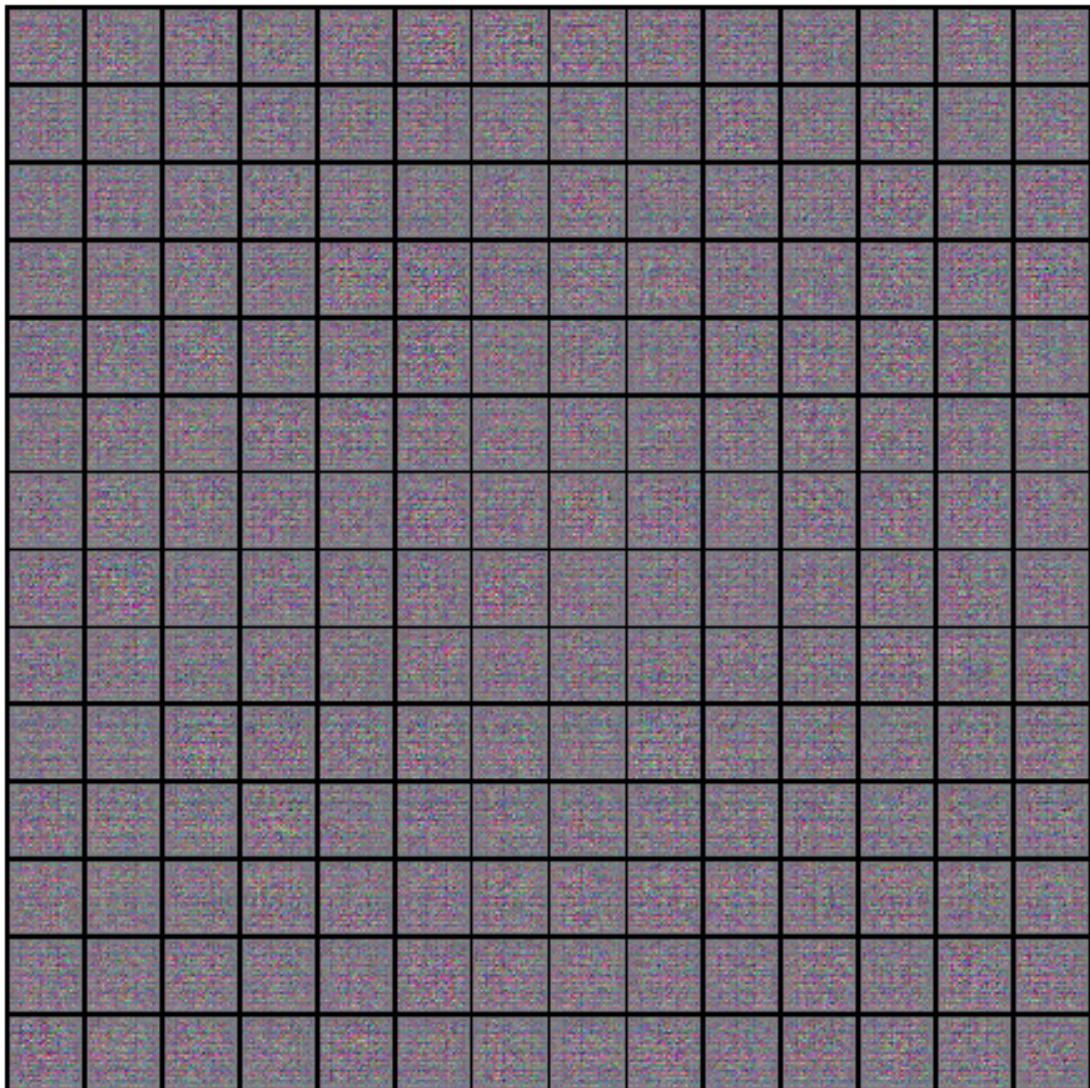
# Logs
if i % 25 == 0:
    print(' [%d/%d]\tLoss_D: %.4f\tLoss_G: %.4f\tD(x): %.4f\tD(G(z)): %.4f'
          % (i, steps, errD.item(), errG.item(), avg_output_for_real, avg_output_))

if i % 100 == 0:
    with torch.no_grad():
        x_fake = netG(fixed_noise).detach().cpu()
    img_list.append(vutils.make_grid(x_fake, padding=2, normalize=True, nrow=14))
    plt.figure(figsize=(8,8))
    plt.imshow(np.transpose(img_list[-1],(1,2,0)))
    plt.axis("off")
    plt.show()

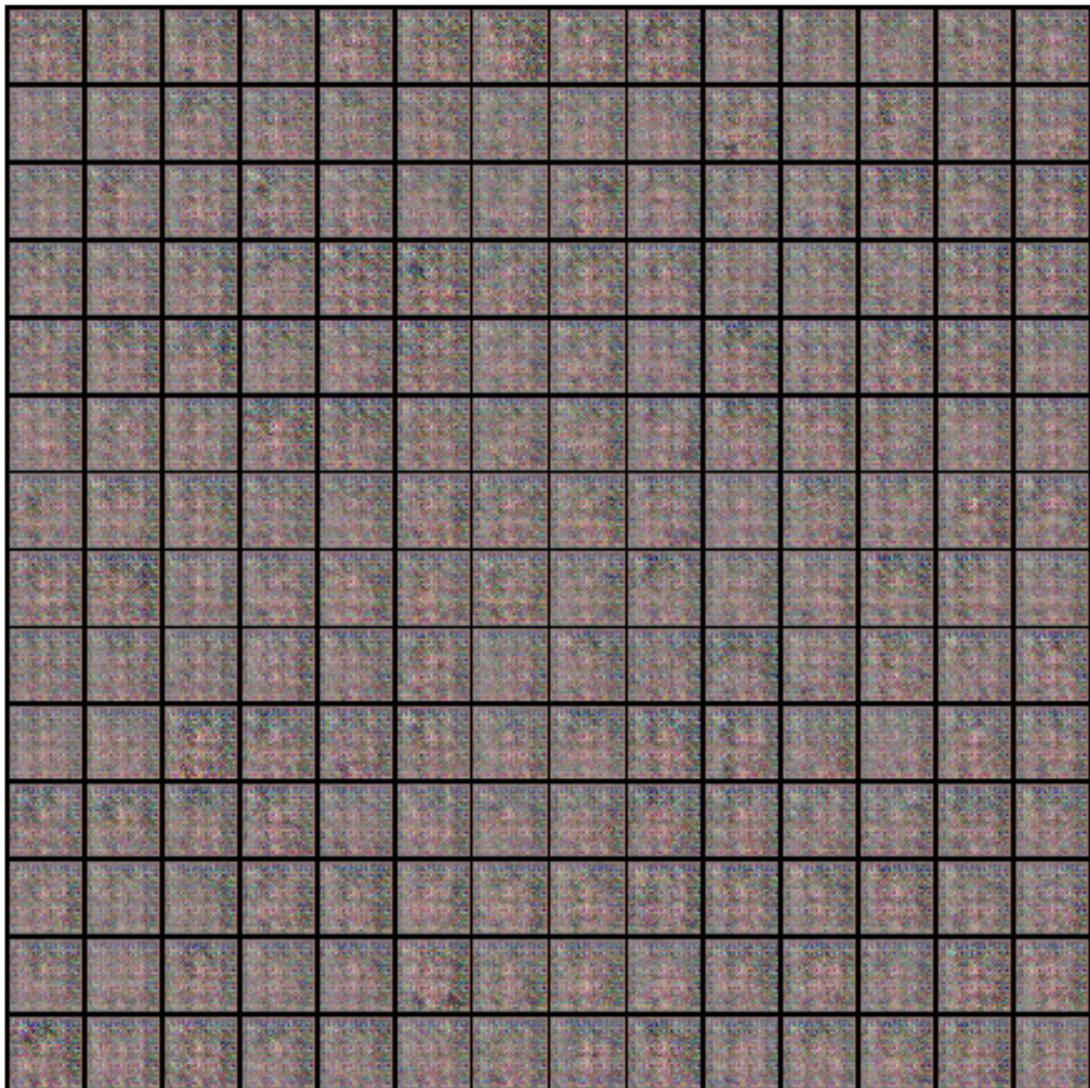
/usr/local/lib/python3.6/dist-packages/torch/nn/modules/loss.py:498: UserWarning: Using a target
      return F.binary_cross_entropy(input, target, weight=self.weight, reduction=self.reduction)

```

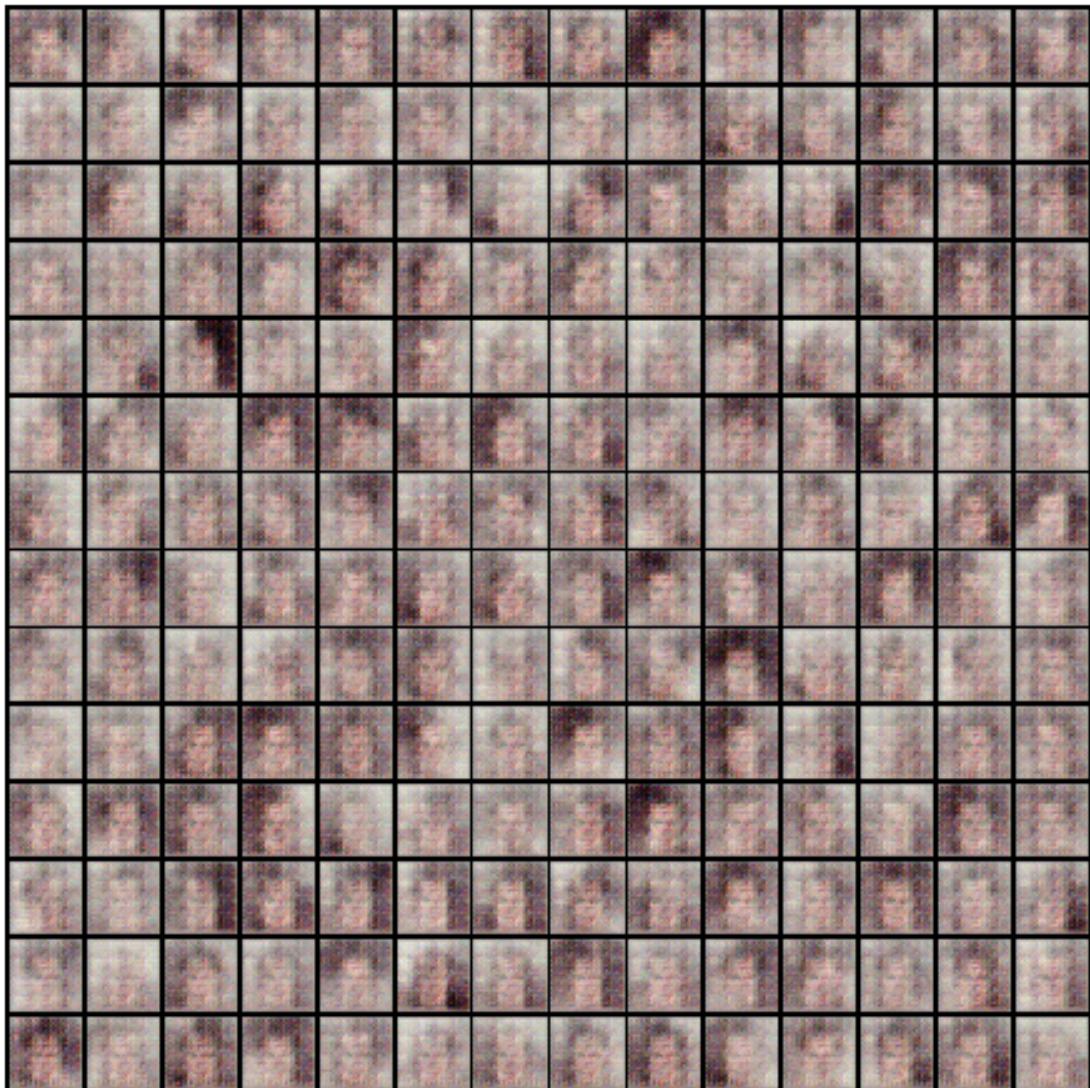
[0/ 8000]	Loss_D: 1.3048	Loss_G: 1.0331	D(x): 0.6409	D(G(z)): 0.0000
------------	----------------	----------------	--------------	-----------------



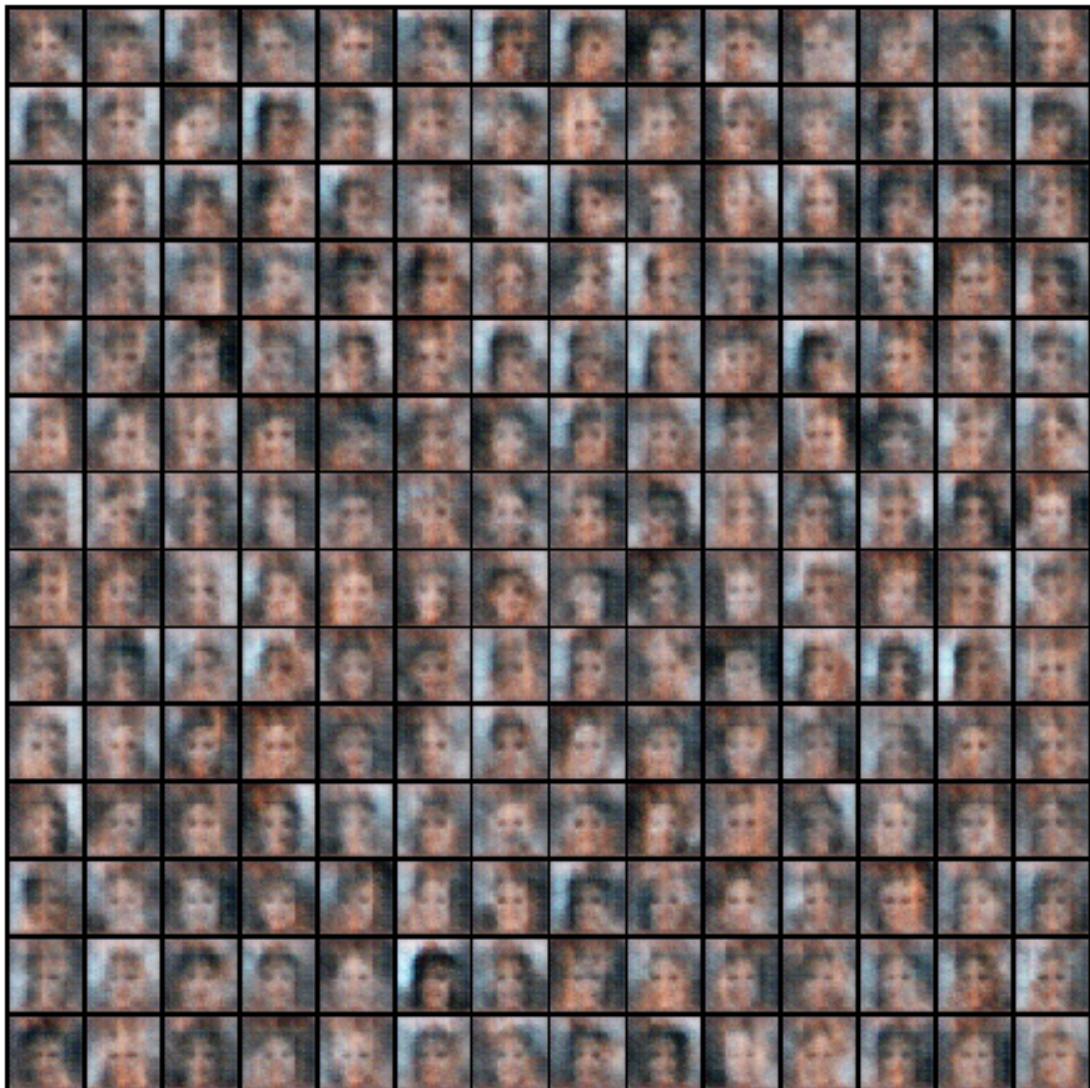
[25/ 8000]	Loss_D: 0.3585	Loss_G: 2.7936	D(x): 0.8699	D(G(z)): 0
[50/ 8000]	Loss_D: 0.3021	Loss_G: 3.4789	D(x): 0.8852	D(G(z)): 0
[75/ 8000]	Loss_D: 0.1697	Loss_G: 4.2323	D(x): 0.9314	D(G(z)): 0
[100/ 8000]	Loss_D: 0.1472	Loss_G: 4.7239	D(x): 0.9379	D(G(z)): 0



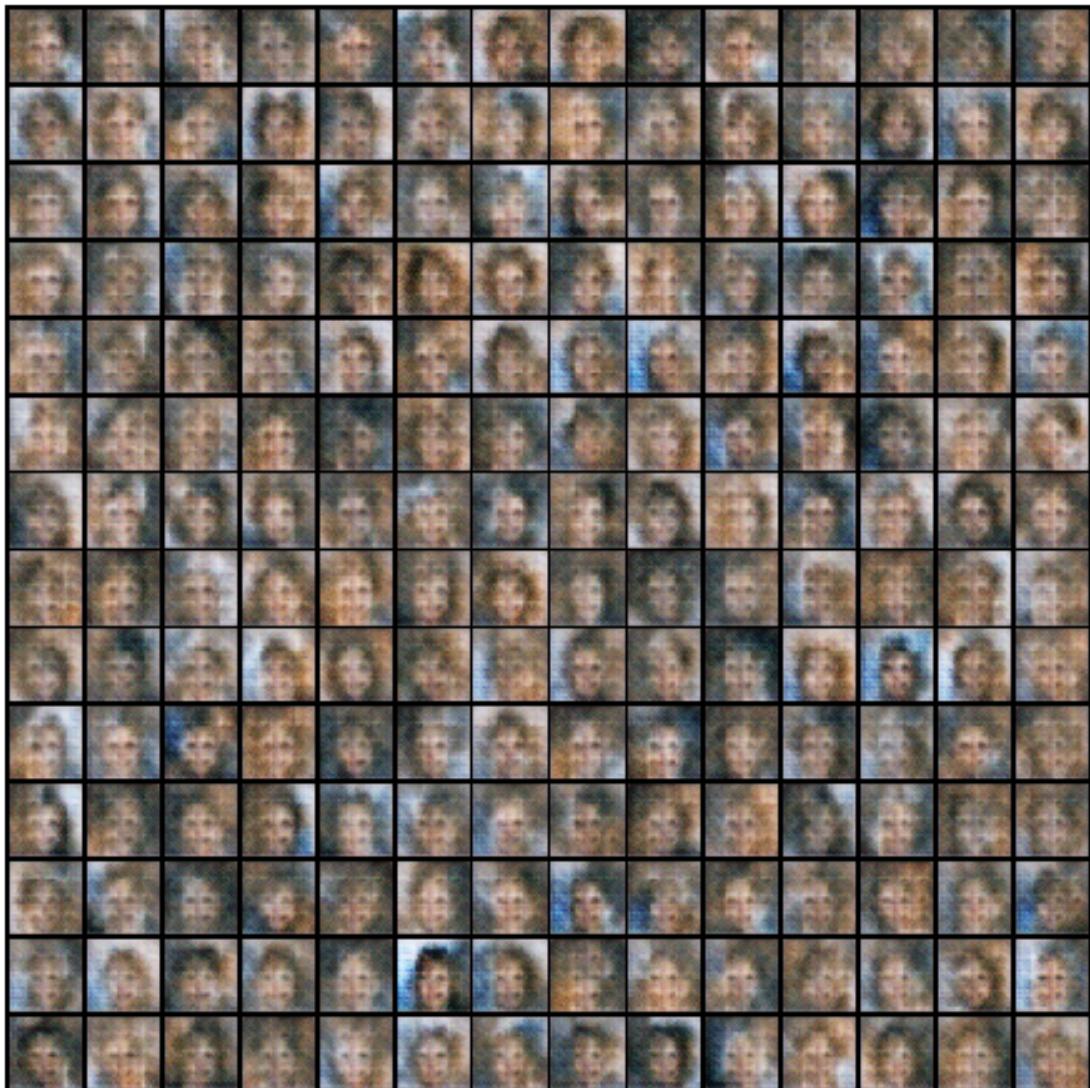
[125/ 8000]	Loss_D: 0.1105	Loss_G: 4.9524	D(x): 0.9513	D(G(z)): 0
[150/ 8000]	Loss_D: 0.1248	Loss_G: 5.7021	D(x): 0.9545	D(G(z)): 0
[175/ 8000]	Loss_D: 0.0963	Loss_G: 4.4247	D(x): 0.9665	D(G(z)): 0
[200/ 8000]	Loss_D: 0.3465	Loss_G: 5.2198	D(x): 0.9210	D(G(z)): 0



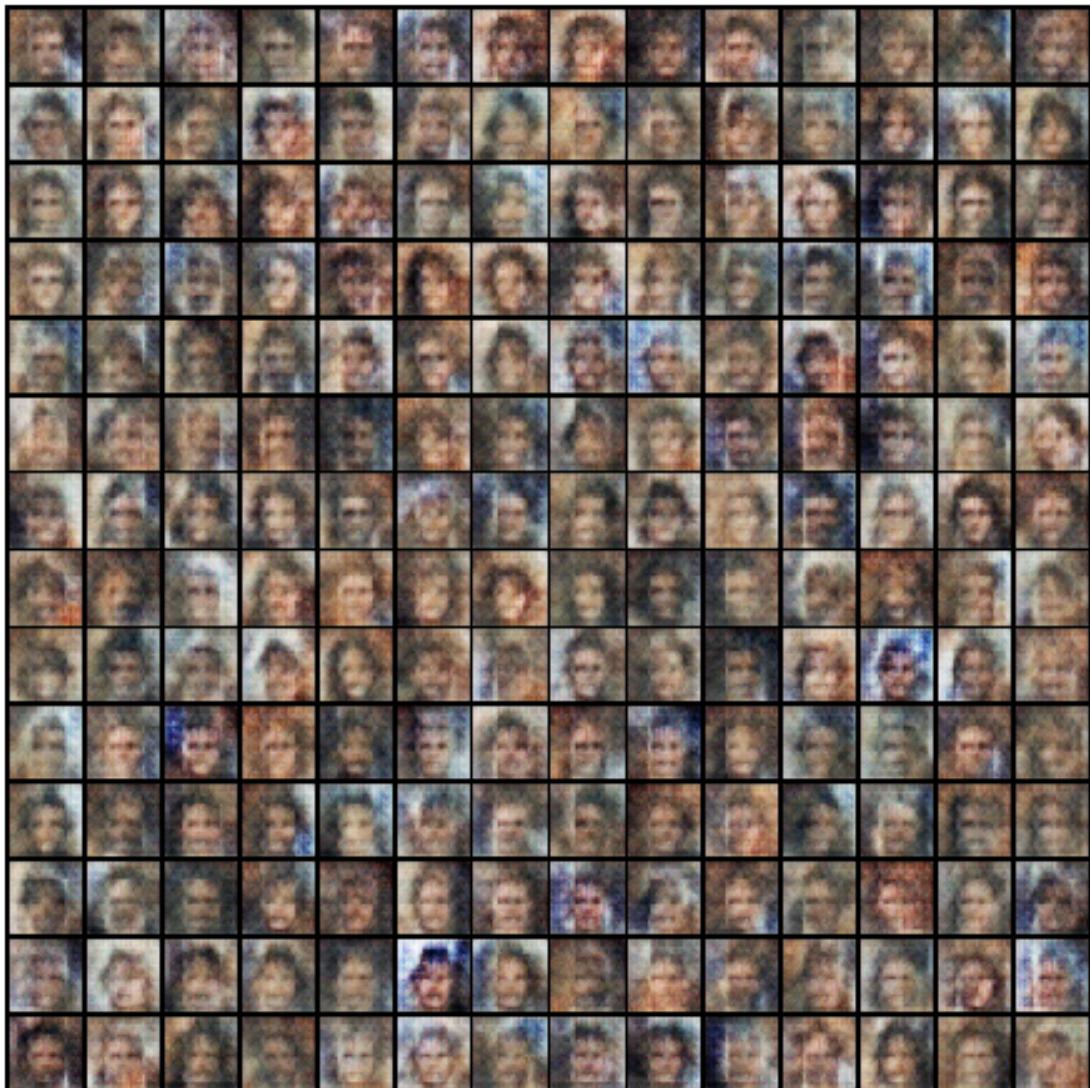
[225/ 8000]	Loss_D: 2.5372	Loss_G: 6.9996	D(x): 0.2218	D(G(z)): 0
[250/ 8000]	Loss_D: 0.5451	Loss_G: 5.3602	D(x): 0.8969	D(G(z)): 0
[275/ 8000]	Loss_D: 0.2555	Loss_G: 4.0920	D(x): 0.8777	D(G(z)): 0
[300/ 8000]	Loss_D: 0.6373	Loss_G: 3.6557	D(x): 0.8679	D(G(z)): 0



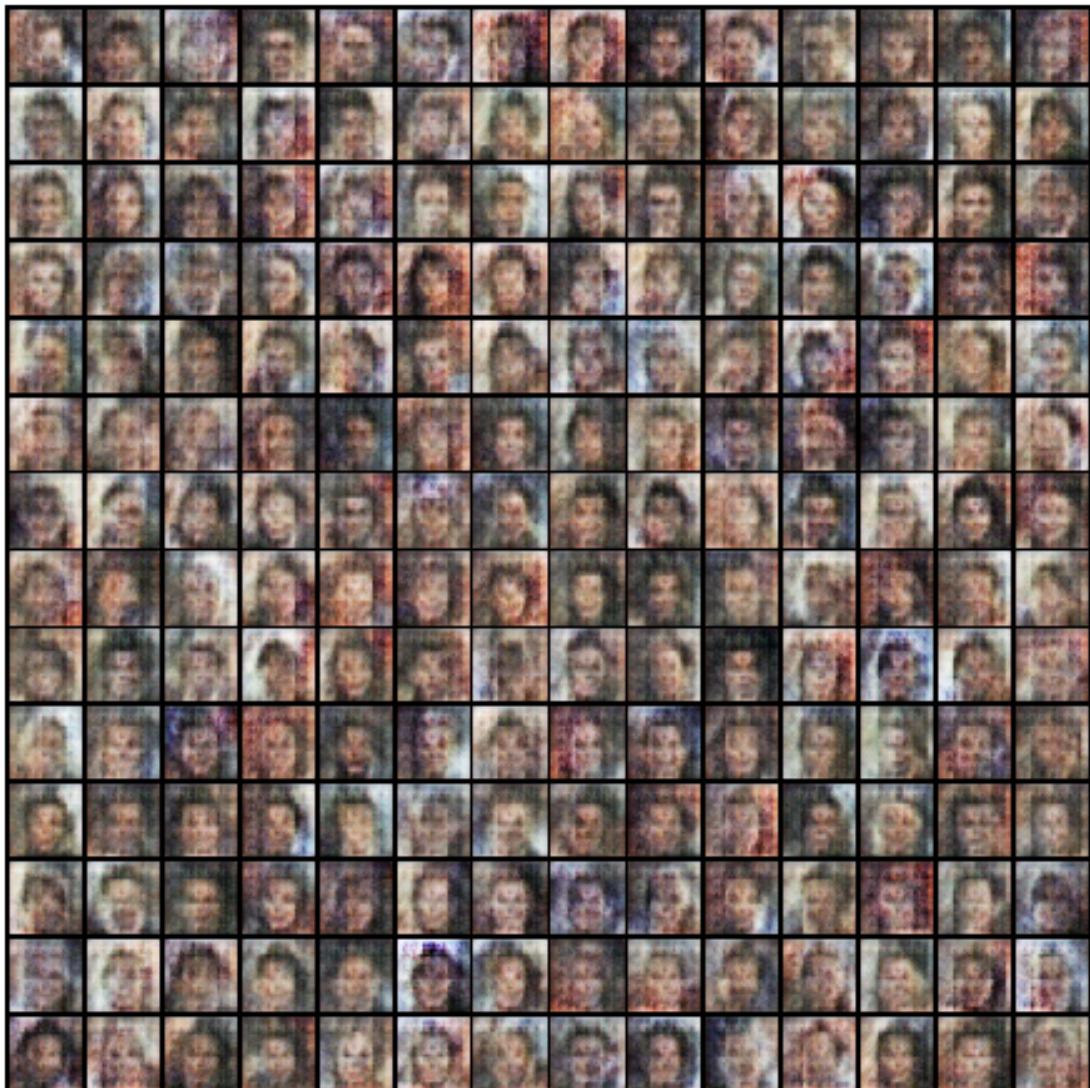
[325/ 8000]	Loss_D: 0.5007	Loss_G: 3.5809	D(x): 0.8669	D(G(z)): 0
[350/ 8000]	Loss_D: 0.7128	Loss_G: 2.6758	D(x): 0.6261	D(G(z)): 0
[375/ 8000]	Loss_D: 0.4874	Loss_G: 3.3885	D(x): 0.8035	D(G(z)): 0
[400/ 8000]	Loss_D: 0.8979	Loss_G: 1.8963	D(x): 0.5350	D(G(z)): 0



[425/ 8000]	Loss_D: 0.5489	Loss_G: 2.3363	D(x): 0.7278	D(G(z)): 0
[450/ 8000]	Loss_D: 0.5403	Loss_G: 3.0151	D(x): 0.8216	D(G(z)): 0
[475/ 8000]	Loss_D: 0.6437	Loss_G: 3.8305	D(x): 0.9085	D(G(z)): 0
[500/ 8000]	Loss_D: 0.8578	Loss_G: 2.4521	D(x): 0.5172	D(G(z)): 0



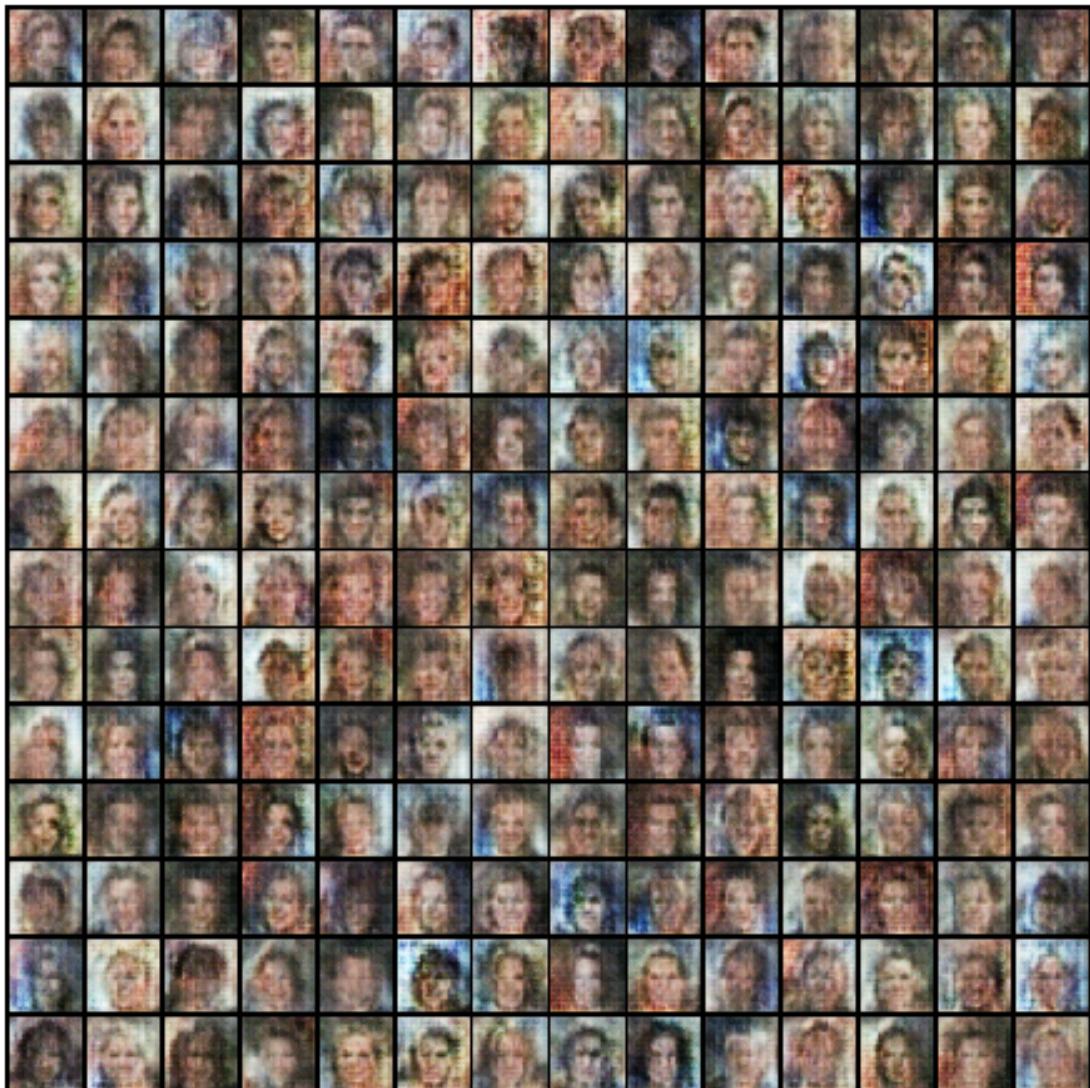
[525/ 8000]	Loss_D: 0.5463	Loss_G: 2.9733	D(x): 0.7741	D(G(z)): 0
[550/ 8000]	Loss_D: 0.6169	Loss_G: 2.5311	D(x): 0.7553	D(G(z)): 0
[575/ 8000]	Loss_D: 0.7850	Loss_G: 2.8653	D(x): 0.7194	D(G(z)): 0
[600/ 8000]	Loss_D: 0.7048	Loss_G: 1.9634	D(x): 0.6151	D(G(z)): 0



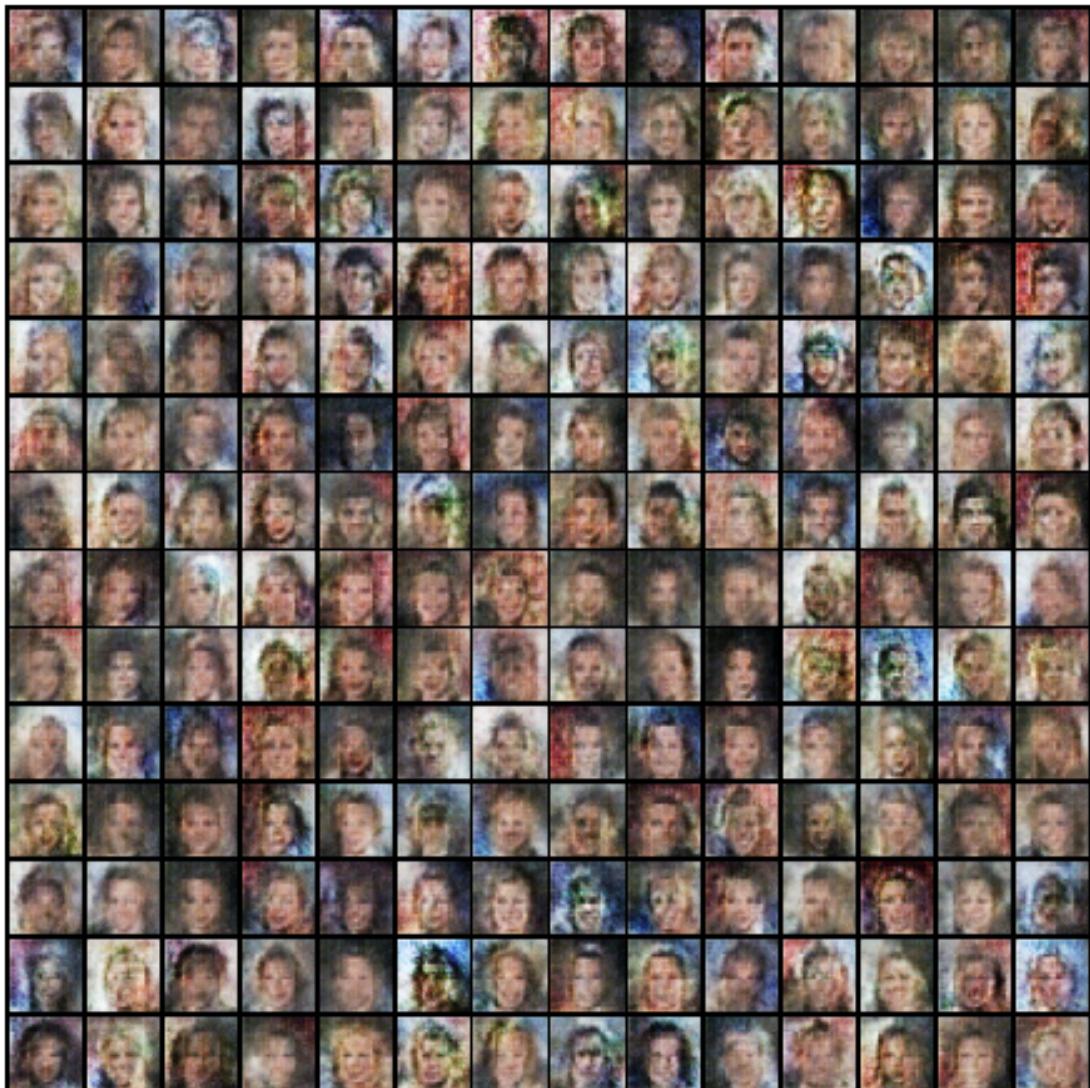
[625/ 8000]	Loss_D: 0.8249	Loss_G: 3.0161	D(x): 0.7519	D(G(z)): 0
[650/ 8000]	Loss_D: 0.6846	Loss_G: 2.5836	D(x): 0.7623	D(G(z)): 0
[675/ 8000]	Loss_D: 0.5934	Loss_G: 2.6378	D(x): 0.8113	D(G(z)): 0
[700/ 8000]	Loss_D: 0.5934	Loss_G: 2.7995	D(x): 0.8157	D(G(z)): 0



[725/ 8000]	Loss_D: 0.5787	Loss_G: 2.0107	D(x): 0.7058	D(G(z)): 0
[750/ 8000]	Loss_D: 0.7284	Loss_G: 2.5459	D(x): 0.7523	D(G(z)): 0
[775/ 8000]	Loss_D: 0.6362	Loss_G: 2.6160	D(x): 0.7965	D(G(z)): 0
[800/ 8000]	Loss_D: 0.7337	Loss_G: 1.6271	D(x): 0.5887	D(G(z)): 0



[825/ 8000]	Loss_D: 0.5475	Loss_G: 2.4075	D(x): 0.7649	D(G(z)): 0
[850/ 8000]	Loss_D: 0.5838	Loss_G: 1.8577	D(x): 0.7265	D(G(z)): 0
[875/ 8000]	Loss_D: 0.5042	Loss_G: 2.2419	D(x): 0.7997	D(G(z)): 0
[900/ 8000]	Loss_D: 0.8566	Loss_G: 2.0719	D(x): 0.7425	D(G(z)): 0



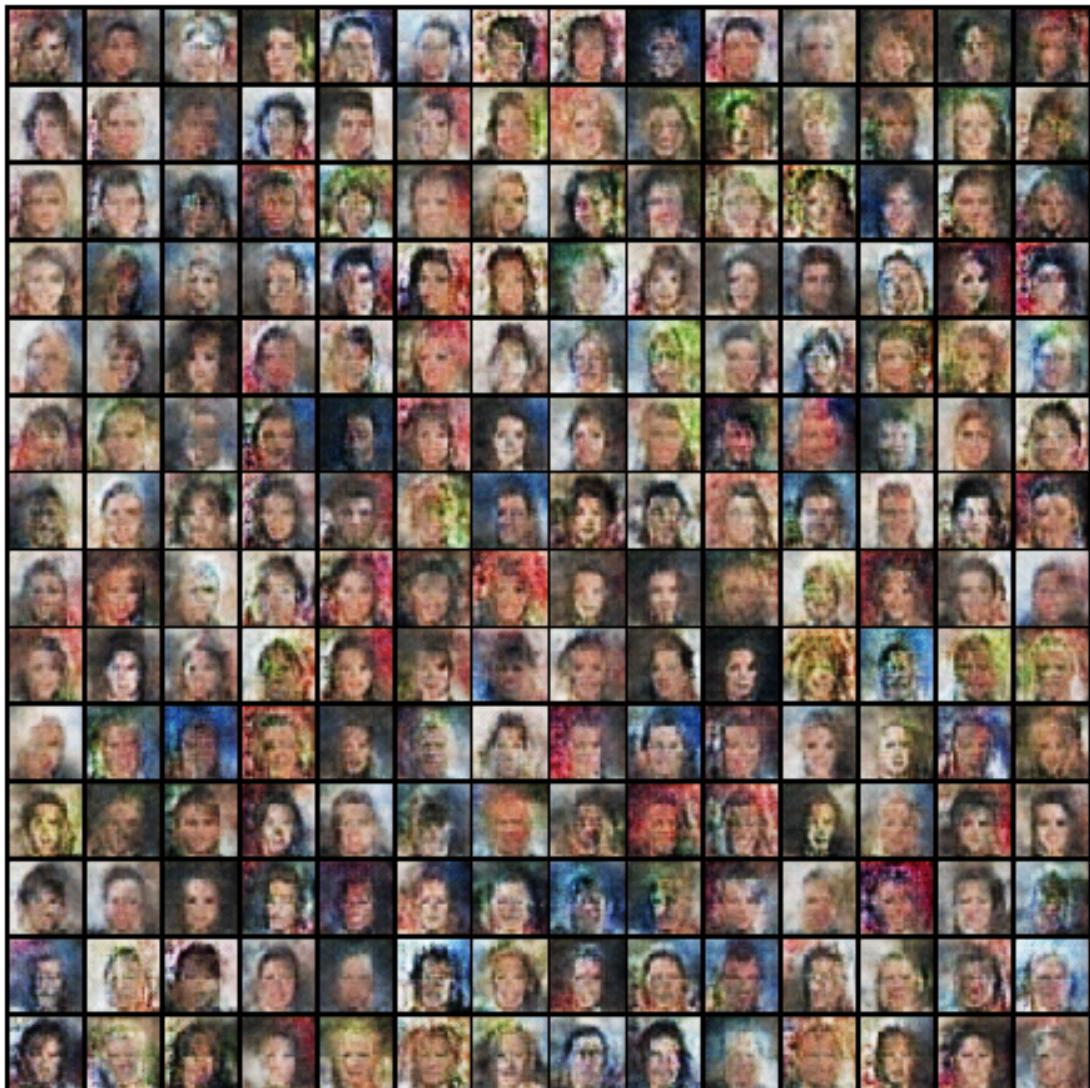
[925/ 8000]	Loss_D: 0.6844	Loss_G: 2.2688	D(x): 0.7331	D(G(z)): 0
[950/ 8000]	Loss_D: 1.6391	Loss_G: 1.0479	D(x): 0.3019	D(G(z)): 0
[975/ 8000]	Loss_D: 0.5602	Loss_G: 2.5559	D(x): 0.8426	D(G(z)): 0
[1000/ 8000]	Loss_D: 0.7185	Loss_G: 2.8013	D(x): 0.8466	D(G(z)): 0



[1025/ 8000]	Loss_D: 0.6196	Loss_G: 2.3017	D(x): 0.8261	D(G(z)): 0
[1050/ 8000]	Loss_D: 0.7231	Loss_G: 3.0330	D(x): 0.8903	D(G(z)): 0
[1075/ 8000]	Loss_D: 0.7199	Loss_G: 2.0836	D(x): 0.6093	D(G(z)): 0
[1100/ 8000]	Loss_D: 0.5003	Loss_G: 2.4942	D(x): 0.8459	D(G(z)): 0



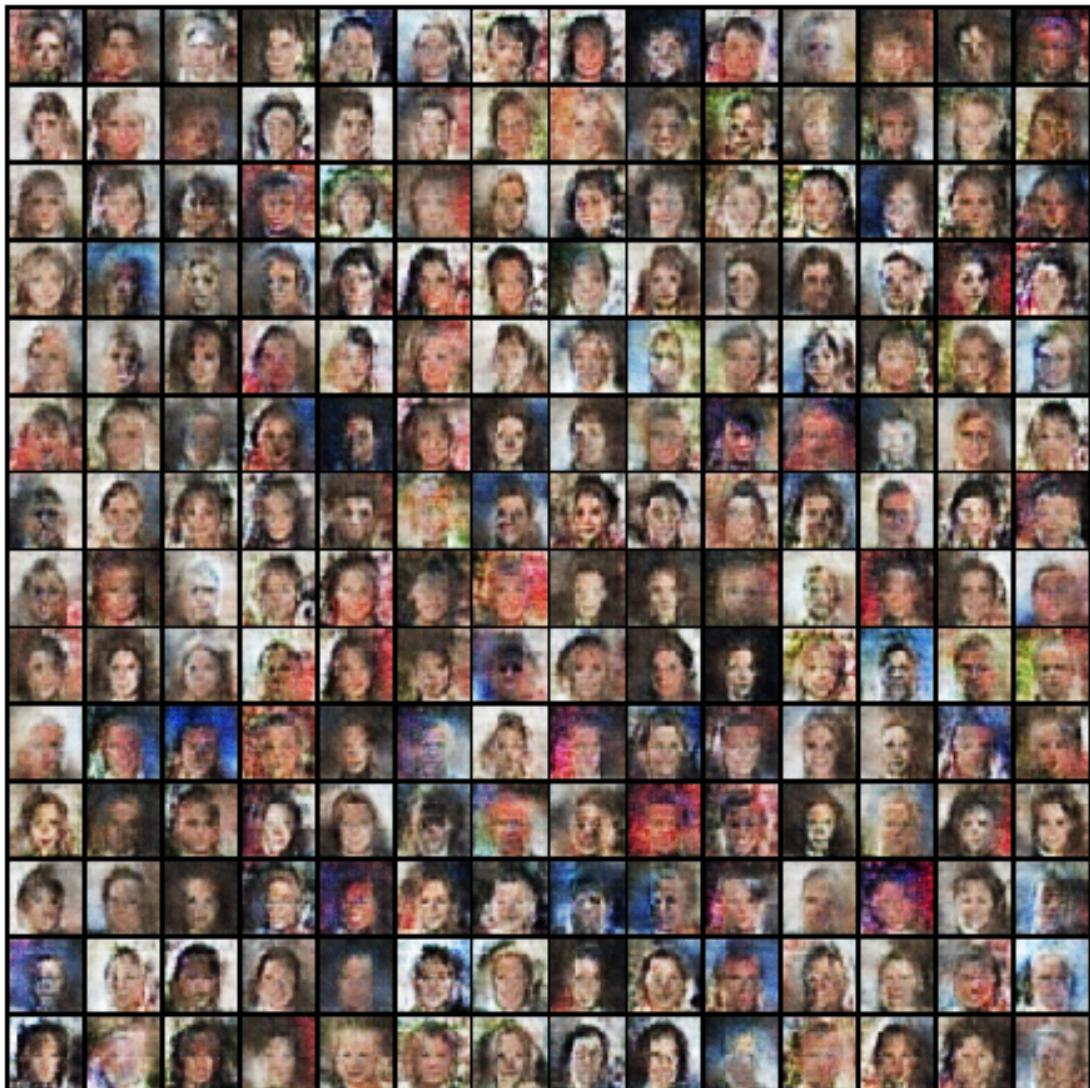
[1125/ 8000]	Loss_D: 0.5335	Loss_G: 1.7399	D(x): 0.7852	D(G(z)): 0
[1150/ 8000]	Loss_D: 0.4788	Loss_G: 1.7277	D(x): 0.7840	D(G(z)): 0
[1175/ 8000]	Loss_D: 1.0214	Loss_G: 4.7066	D(x): 0.8483	D(G(z)): 0
[1200/ 8000]	Loss_D: 0.7102	Loss_G: 1.7257	D(x): 0.7223	D(G(z)): 0



[1225/ 8000]	Loss_D: 0.6184	Loss_G: 1.4920	D(x): 0.7374	D(G(z)): 0
[1250/ 8000]	Loss_D: 0.5368	Loss_G: 1.9667	D(x): 0.7580	D(G(z)): 0
[1275/ 8000]	Loss_D: 0.5887	Loss_G: 2.1340	D(x): 0.7345	D(G(z)): 0
[1300/ 8000]	Loss_D: 0.5851	Loss_G: 2.0339	D(x): 0.7118	D(G(z)): 0



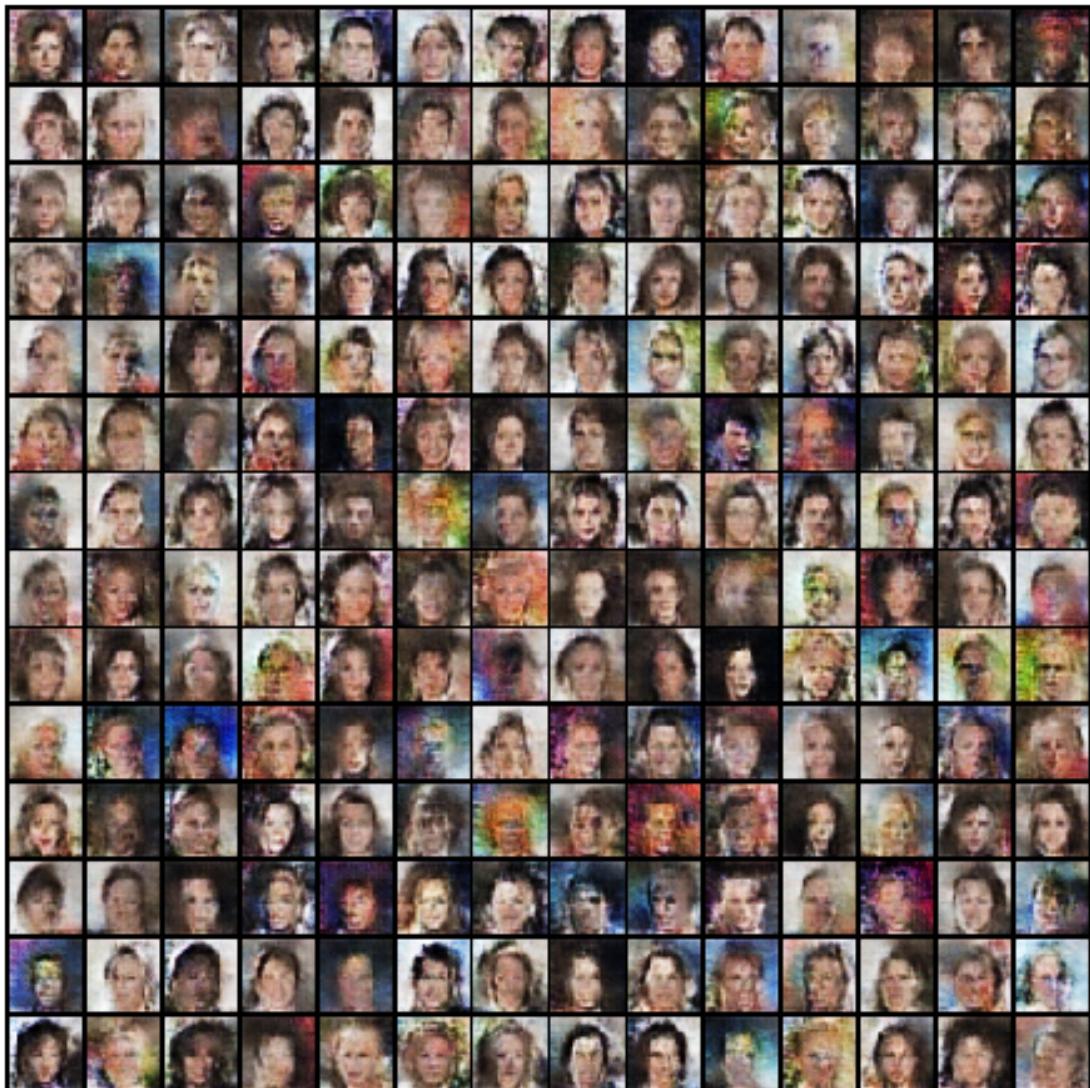
[1325/ 8000]	Loss_D: 0.6198	Loss_G: 1.8404	D(x): 0.6856	D(G(z)): 0
[1350/ 8000]	Loss_D: 0.7829	Loss_G: 1.4175	D(x): 0.6060	D(G(z)): 0
[1375/ 8000]	Loss_D: 0.7127	Loss_G: 1.9861	D(x): 0.7167	D(G(z)): 0
[1400/ 8000]	Loss_D: 0.5979	Loss_G: 2.3533	D(x): 0.8069	D(G(z)): 0



[1425/ 8000]	Loss_D: 1.3071	Loss_G: 2.7622	D(x): 0.9324	D(G(z)): 0
[1450/ 8000]	Loss_D: 0.7288	Loss_G: 2.3461	D(x): 0.7897	D(G(z)): 0
[1475/ 8000]	Loss_D: 0.7071	Loss_G: 1.9472	D(x): 0.6299	D(G(z)): 0
[1500/ 8000]	Loss_D: 0.6697	Loss_G: 1.6040	D(x): 0.7059	D(G(z)): 0



[1525/ 8000]	Loss_D: 0.7363	Loss_G: 2.2732	D(x): 0.8486	D(G(z)): 0
[1550/ 8000]	Loss_D: 1.2605	Loss_G: 0.6373	D(x): 0.3578	D(G(z)): 0
[1575/ 8000]	Loss_D: 0.6650	Loss_G: 1.5670	D(x): 0.6579	D(G(z)): 0
[1600/ 8000]	Loss_D: 0.7287	Loss_G: 0.9738	D(x): 0.6009	D(G(z)): 0



[1625/ 8000]	Loss_D: 0.7152	Loss_G: 2.2273	D(x): 0.8348	D(G(z)): 0
[1650/ 8000]	Loss_D: 0.6846	Loss_G: 2.0330	D(x): 0.7408	D(G(z)): 0
[1675/ 8000]	Loss_D: 0.6080	Loss_G: 1.6431	D(x): 0.6756	D(G(z)): 0
[1700/ 8000]	Loss_D: 0.7395	Loss_G: 1.5312	D(x): 0.7126	D(G(z)): 0



[1725/ 8000]	Loss_D: 0.6270	Loss_G: 2.0973	D(x): 0.7765	D(G(z)): 0
[1750/ 8000]	Loss_D: 0.6425	Loss_G: 1.5234	D(x): 0.6252	D(G(z)): 0
[1775/ 8000]	Loss_D: 1.1778	Loss_G: 3.3169	D(x): 0.8748	D(G(z)): 0
[1800/ 8000]	Loss_D: 0.6211	Loss_G: 2.0249	D(x): 0.7503	D(G(z)): 0



[1825/ 8000]	Loss_D: 0.6750	Loss_G: 1.8436	D(x): 0.7563	D(G(z)): 0
[1850/ 8000]	Loss_D: 0.6452	Loss_G: 2.1398	D(x): 0.7688	D(G(z)): 0
[1875/ 8000]	Loss_D: 0.8990	Loss_G: 1.5287	D(x): 0.6937	D(G(z)): 0
[1900/ 8000]	Loss_D: 0.6471	Loss_G: 1.7523	D(x): 0.7193	D(G(z)): 0



[1925/ 8000]	Loss_D: 0.7311	Loss_G: 1.9845	D(x): 0.8175	D(G(z)): 0
[1950/ 8000]	Loss_D: 0.9761	Loss_G: 0.7257	D(x): 0.4689	D(G(z)): 0
[1975/ 8000]	Loss_D: 0.6017	Loss_G: 2.5370	D(x): 0.8326	D(G(z)): 0
[2000/ 8000]	Loss_D: 0.8357	Loss_G: 1.7697	D(x): 0.6695	D(G(z)): 0



[2025/ 8000]	Loss_D: 0.6868	Loss_G: 1.2829	D(x): 0.6364	D(G(z)): 0
[2050/ 8000]	Loss_D: 0.6492	Loss_G: 1.1649	D(x): 0.6494	D(G(z)): 0
[2075/ 8000]	Loss_D: 0.6391	Loss_G: 1.9420	D(x): 0.7944	D(G(z)): 0
[2100/ 8000]	Loss_D: 0.6167	Loss_G: 1.9442	D(x): 0.8225	D(G(z)): 0



[2125/ 8000]	Loss_D: 1.2437	Loss_G: 0.5580	D(x): 0.3625	D(G(z)): 0
[2150/ 8000]	Loss_D: 0.6099	Loss_G: 2.1613	D(x): 0.7648	D(G(z)): 0
[2175/ 8000]	Loss_D: 0.6747	Loss_G: 2.0531	D(x): 0.7675	D(G(z)): 0
[2200/ 8000]	Loss_D: 0.5680	Loss_G: 1.5666	D(x): 0.7374	D(G(z)): 0



[2225/ 8000]	Loss_D: 0.6309	Loss_G: 1.9342	D(x): 0.7754	D(G(z)): 0
[2250/ 8000]	Loss_D: 0.8036	Loss_G: 1.3863	D(x): 0.6405	D(G(z)): 0
[2275/ 8000]	Loss_D: 0.6494	Loss_G: 1.9301	D(x): 0.7621	D(G(z)): 0
[2300/ 8000]	Loss_D: 1.1167	Loss_G: 2.8172	D(x): 0.9039	D(G(z)): 0



[2325/ 8000]	Loss_D: 0.6114	Loss_G: 1.7778	D(x): 0.7142	D(G(z)): 0
[2350/ 8000]	Loss_D: 0.7363	Loss_G: 1.7047	D(x): 0.7043	D(G(z)): 0
[2375/ 8000]	Loss_D: 0.6670	Loss_G: 1.7264	D(x): 0.7607	D(G(z)): 0
[2400/ 8000]	Loss_D: 1.2435	Loss_G: 3.0645	D(x): 0.9343	D(G(z)): 0



[2425/ 8000]	Loss_D: 0.5375	Loss_G: 1.6910	D(x): 0.7584	D(G(z)): 0
[2450/ 8000]	Loss_D: 0.6260	Loss_G: 1.2756	D(x): 0.6803	D(G(z)): 0
[2475/ 8000]	Loss_D: 1.0683	Loss_G: 0.9902	D(x): 0.4183	D(G(z)): 0
[2500/ 8000]	Loss_D: 0.6973	Loss_G: 1.0952	D(x): 0.6125	D(G(z)): 0



[2525/ 8000]	Loss_D: 0.5397	Loss_G: 2.0194	D(x): 0.8196	D(G(z)): 0
[2550/ 8000]	Loss_D: 0.7744	Loss_G: 1.5995	D(x): 0.6500	D(G(z)): 0
[2575/ 8000]	Loss_D: 0.5374	Loss_G: 1.5413	D(x): 0.7636	D(G(z)): 0
[2600/ 8000]	Loss_D: 1.1306	Loss_G: 1.5785	D(x): 0.6826	D(G(z)): 0



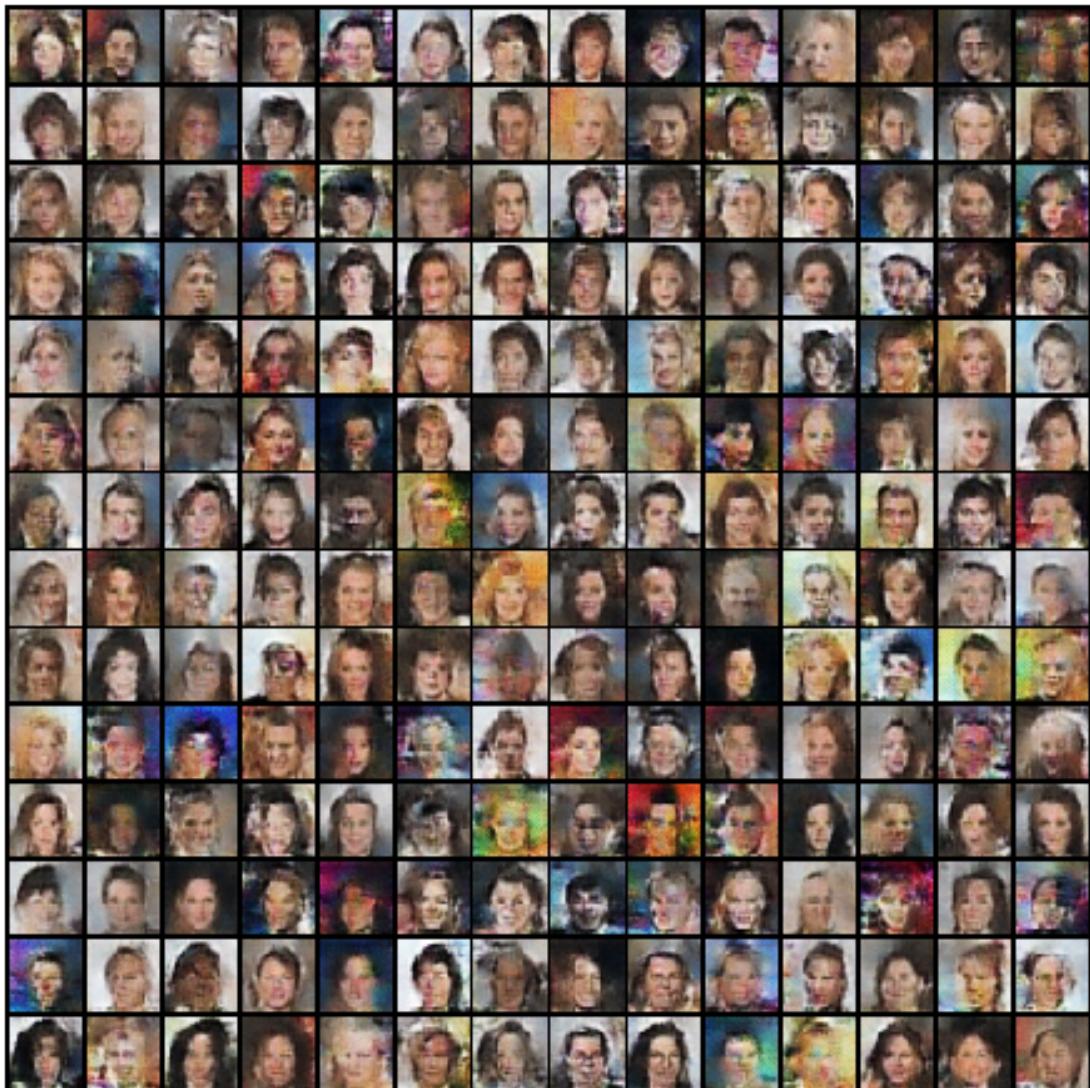
[2625/ 8000]	Loss_D: 0.5556	Loss_G: 1.8694	D(x): 0.8093	D(G(z)): 0
[2650/ 8000]	Loss_D: 1.0304	Loss_G: 1.3954	D(x): 0.4679	D(G(z)): 0
[2675/ 8000]	Loss_D: 0.5469	Loss_G: 2.1391	D(x): 0.8348	D(G(z)): 0
[2700/ 8000]	Loss_D: 0.9082	Loss_G: 1.3009	D(x): 0.6345	D(G(z)): 0



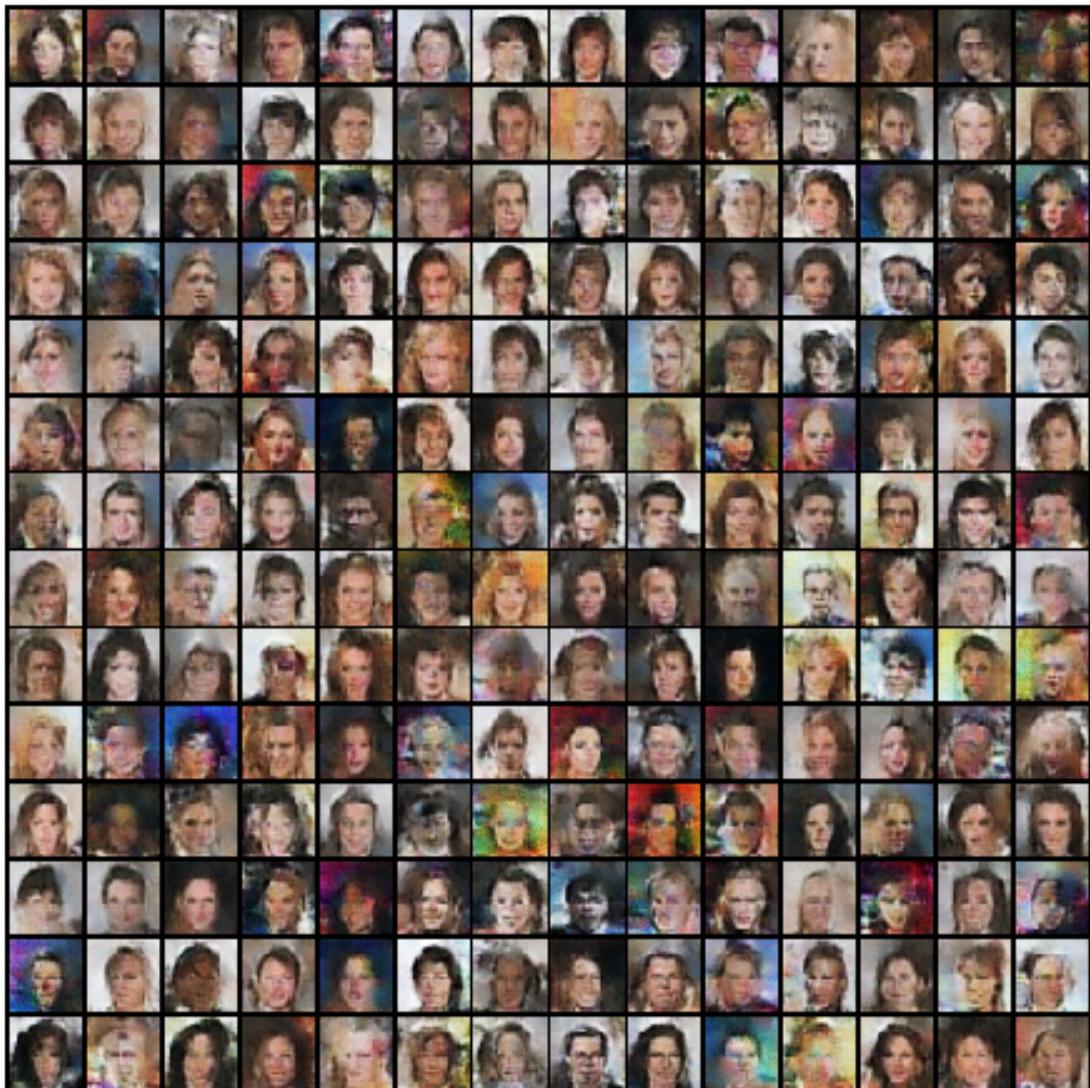
[2725/ 8000]	Loss_D: 0.8345	Loss_G: 0.8725	D(x): 0.5979	D(G(z)): 0
[2750/ 8000]	Loss_D: 0.9506	Loss_G: 2.9387	D(x): 0.9166	D(G(z)): 0
[2775/ 8000]	Loss_D: 0.7904	Loss_G: 1.3160	D(x): 0.5379	D(G(z)): 0
[2800/ 8000]	Loss_D: 0.8579	Loss_G: 2.0602	D(x): 0.7606	D(G(z)): 0



[2825/ 8000]	Loss_D: 0.5012	Loss_G: 1.7276	D(x): 0.7903	D(G(z)): 0
[2850/ 8000]	Loss_D: 0.6603	Loss_G: 2.2142	D(x): 0.8449	D(G(z)): 0
[2875/ 8000]	Loss_D: 0.7558	Loss_G: 1.5907	D(x): 0.6945	D(G(z)): 0
[2900/ 8000]	Loss_D: 0.5957	Loss_G: 1.4829	D(x): 0.7197	D(G(z)): 0



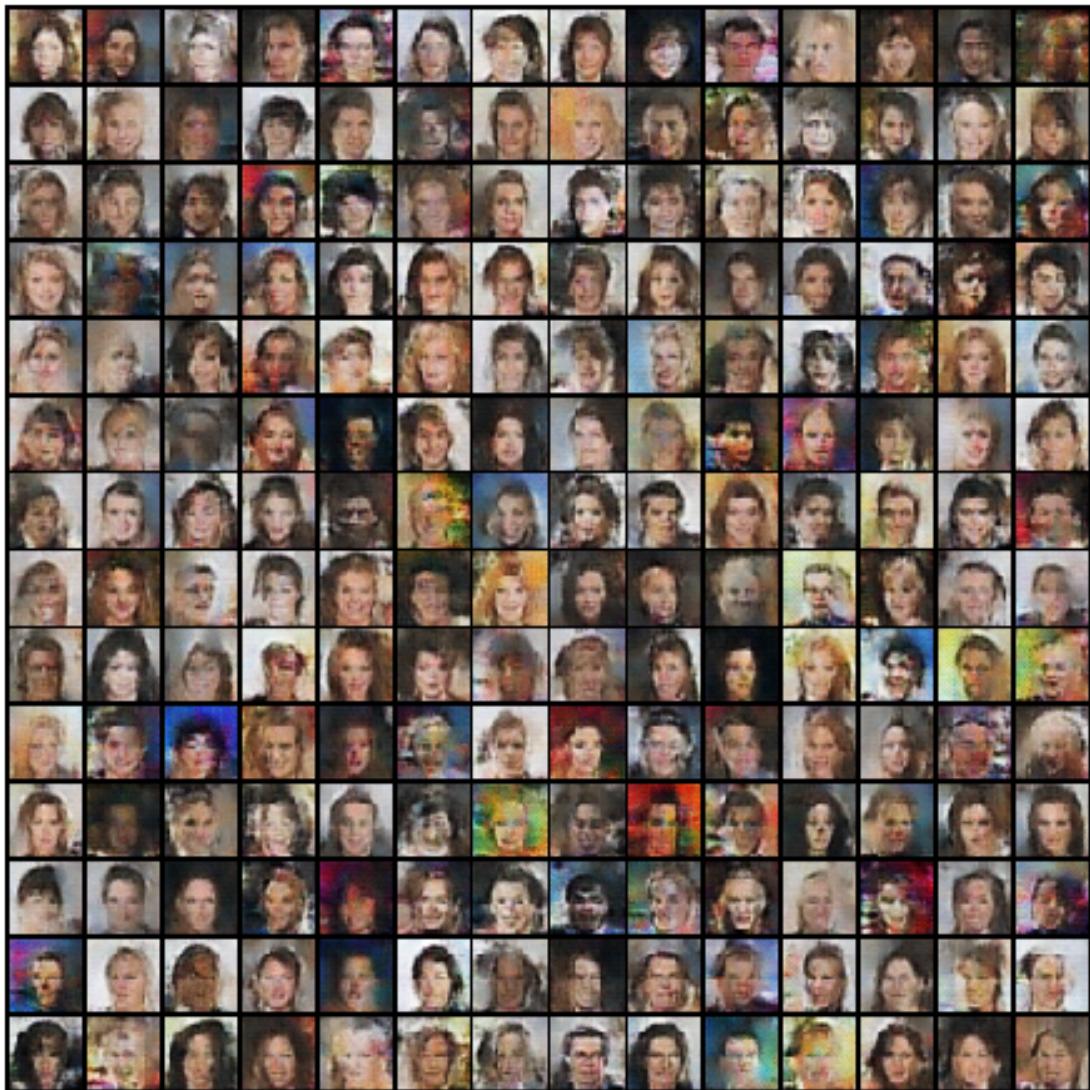
[2925/ 8000]	Loss_D: 0.5182	Loss_G: 1.6051	D(x): 0.7227	D(G(z)): 0
[2950/ 8000]	Loss_D: 0.6318	Loss_G: 1.8746	D(x): 0.7312	D(G(z)): 0
[2975/ 8000]	Loss_D: 0.6710	Loss_G: 2.0126	D(x): 0.8521	D(G(z)): 0
[3000/ 8000]	Loss_D: 0.5851	Loss_G: 2.0912	D(x): 0.8420	D(G(z)): 0



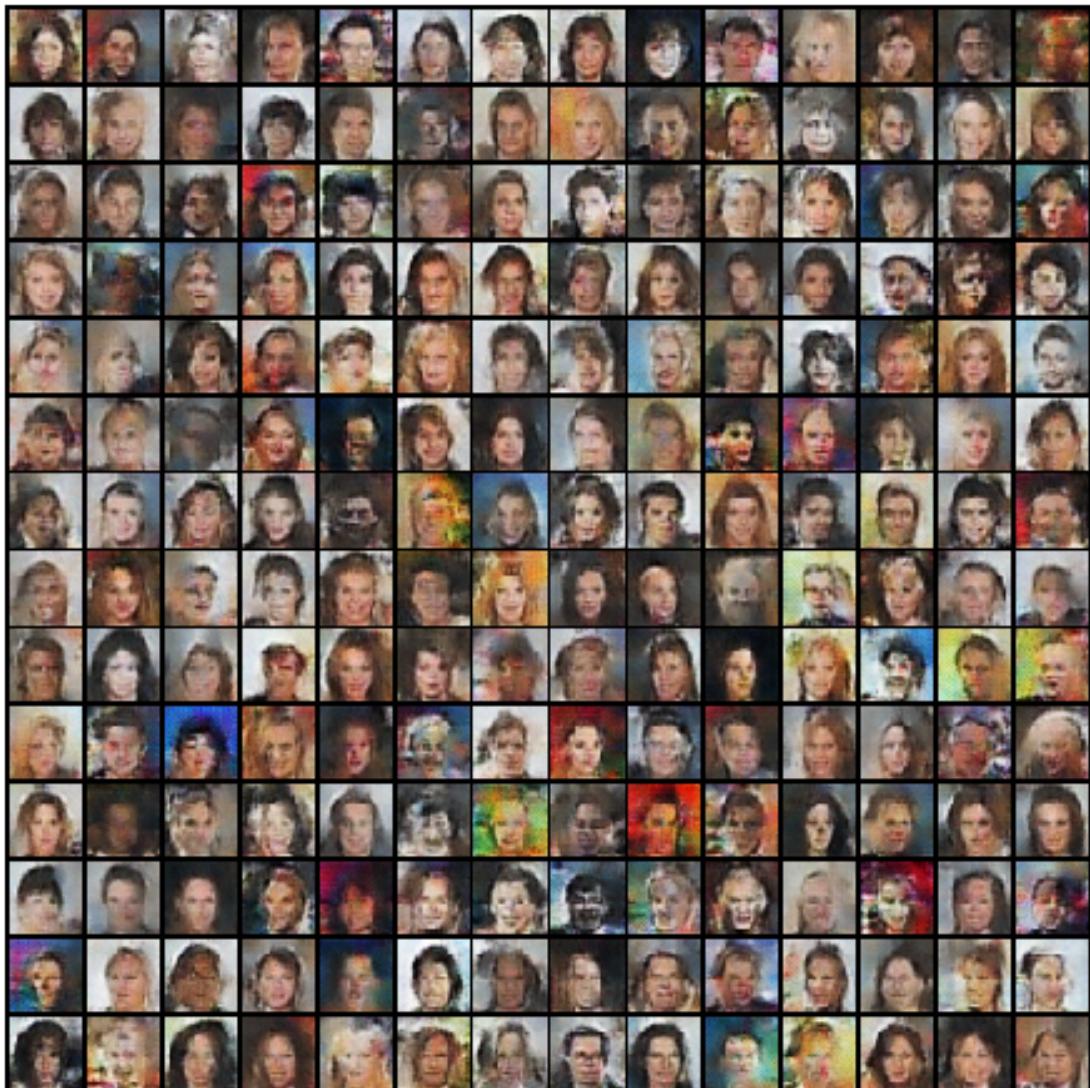
[3025/ 8000]	Loss_D: 0.6697	Loss_G: 2.5617	D(x): 0.8607	D(G(z)): 0
[3050/ 8000]	Loss_D: 0.9988	Loss_G: 2.6839	D(x): 0.9279	D(G(z)): 0
[3075/ 8000]	Loss_D: 0.5421	Loss_G: 1.8015	D(x): 0.7631	D(G(z)): 0
[3100/ 8000]	Loss_D: 0.6212	Loss_G: 1.6710	D(x): 0.7536	D(G(z)): 0



[3125/ 8000]	Loss_D: 0.7758	Loss_G: 1.1624	D(x): 0.5927	D(G(z)): 0
[3150/ 8000]	Loss_D: 0.9095	Loss_G: 0.9893	D(x): 0.4750	D(G(z)): 0
[3175/ 8000]	Loss_D: 0.4850	Loss_G: 2.0079	D(x): 0.8481	D(G(z)): 0
[3200/ 8000]	Loss_D: 0.7763	Loss_G: 1.1219	D(x): 0.5877	D(G(z)): 0



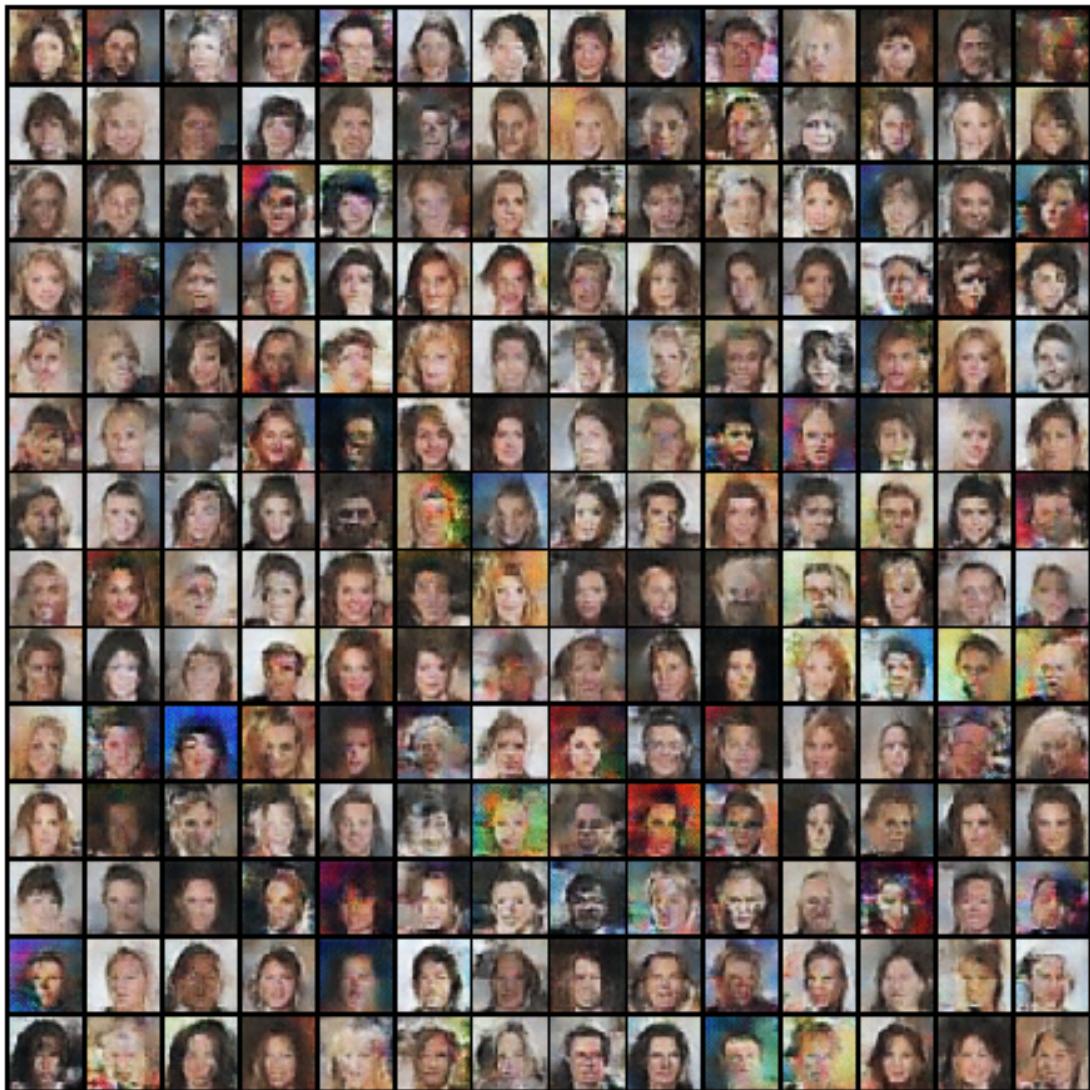
[3225/ 8000]	Loss_D: 0.7406	Loss_G: 1.3307	D(x): 0.6239	D(G(z)): 0
[3250/ 8000]	Loss_D: 0.5933	Loss_G: 2.0344	D(x): 0.7708	D(G(z)): 0
[3275/ 8000]	Loss_D: 1.1117	Loss_G: 0.4582	D(x): 0.4027	D(G(z)): 0
[3300/ 8000]	Loss_D: 0.8945	Loss_G: 2.6134	D(x): 0.9103	D(G(z)): 0



[3325/ 8000]	Loss_D: 0.5479	Loss_G: 2.5096	D(x): 0.8834	D(G(z)): 0
[3350/ 8000]	Loss_D: 0.4763	Loss_G: 1.5812	D(x): 0.7275	D(G(z)): 0
[3375/ 8000]	Loss_D: 0.6404	Loss_G: 1.5512	D(x): 0.6675	D(G(z)): 0
[3400/ 8000]	Loss_D: 0.6910	Loss_G: 2.9591	D(x): 0.8648	D(G(z)): 0



[3425/ 8000]	Loss_D: 0.5003	Loss_G: 2.1373	D(x): 0.8209	D(G(z)): 0
[3450/ 8000]	Loss_D: 1.0723	Loss_G: 0.8892	D(x): 0.4559	D(G(z)): 0
[3475/ 8000]	Loss_D: 0.5873	Loss_G: 2.1621	D(x): 0.8153	D(G(z)): 0
[3500/ 8000]	Loss_D: 0.5426	Loss_G: 1.5940	D(x): 0.7992	D(G(z)): 0



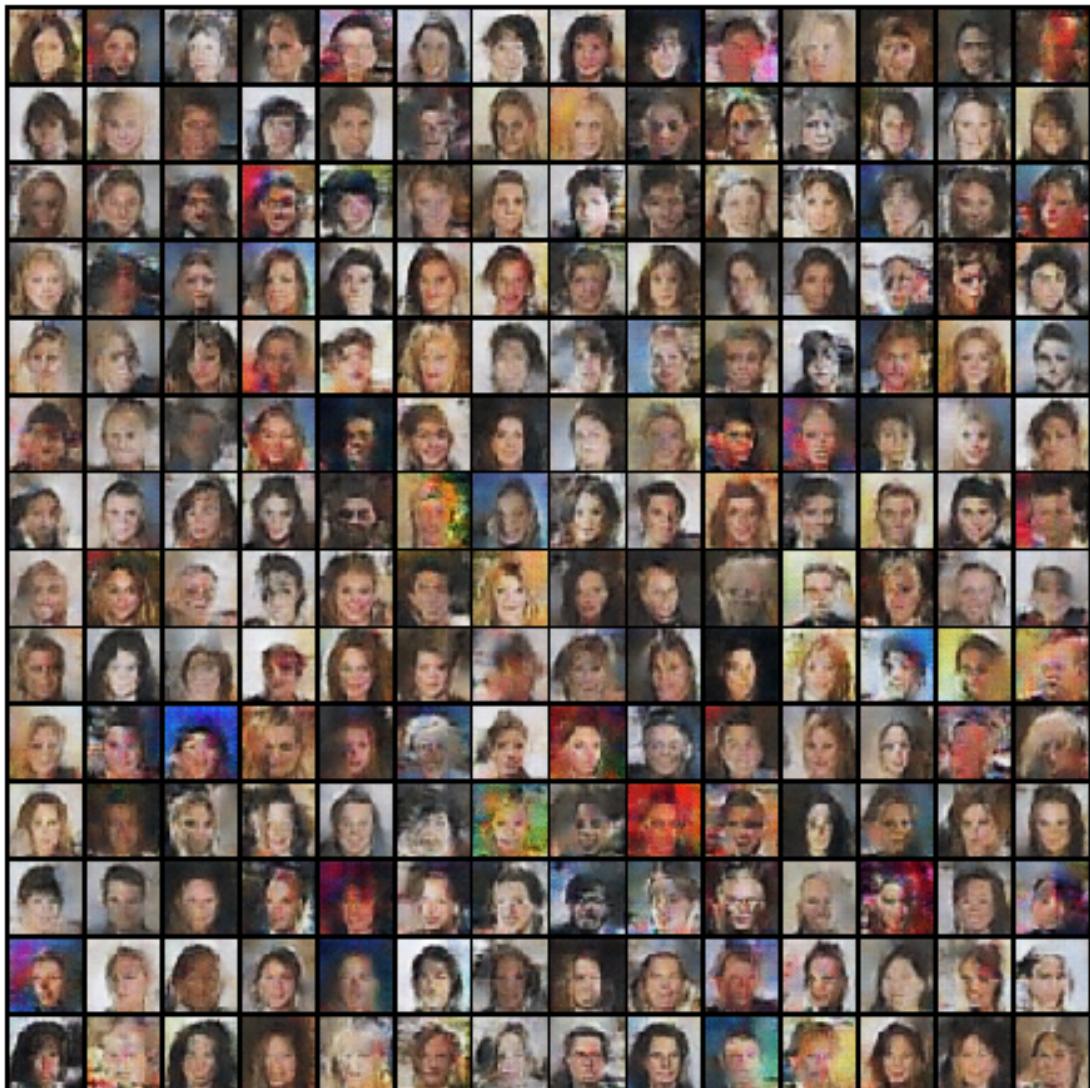
[3525/ 8000]	Loss_D: 0.7241	Loss_G: 2.7329	D(x): 0.8739	D(G(z)): 0
[3550/ 8000]	Loss_D: 0.5291	Loss_G: 2.0744	D(x): 0.8121	D(G(z)): 0
[3575/ 8000]	Loss_D: 1.2647	Loss_G: 2.4433	D(x): 0.8618	D(G(z)): 0
[3600/ 8000]	Loss_D: 0.8901	Loss_G: 0.5755	D(x): 0.4797	D(G(z)): 0



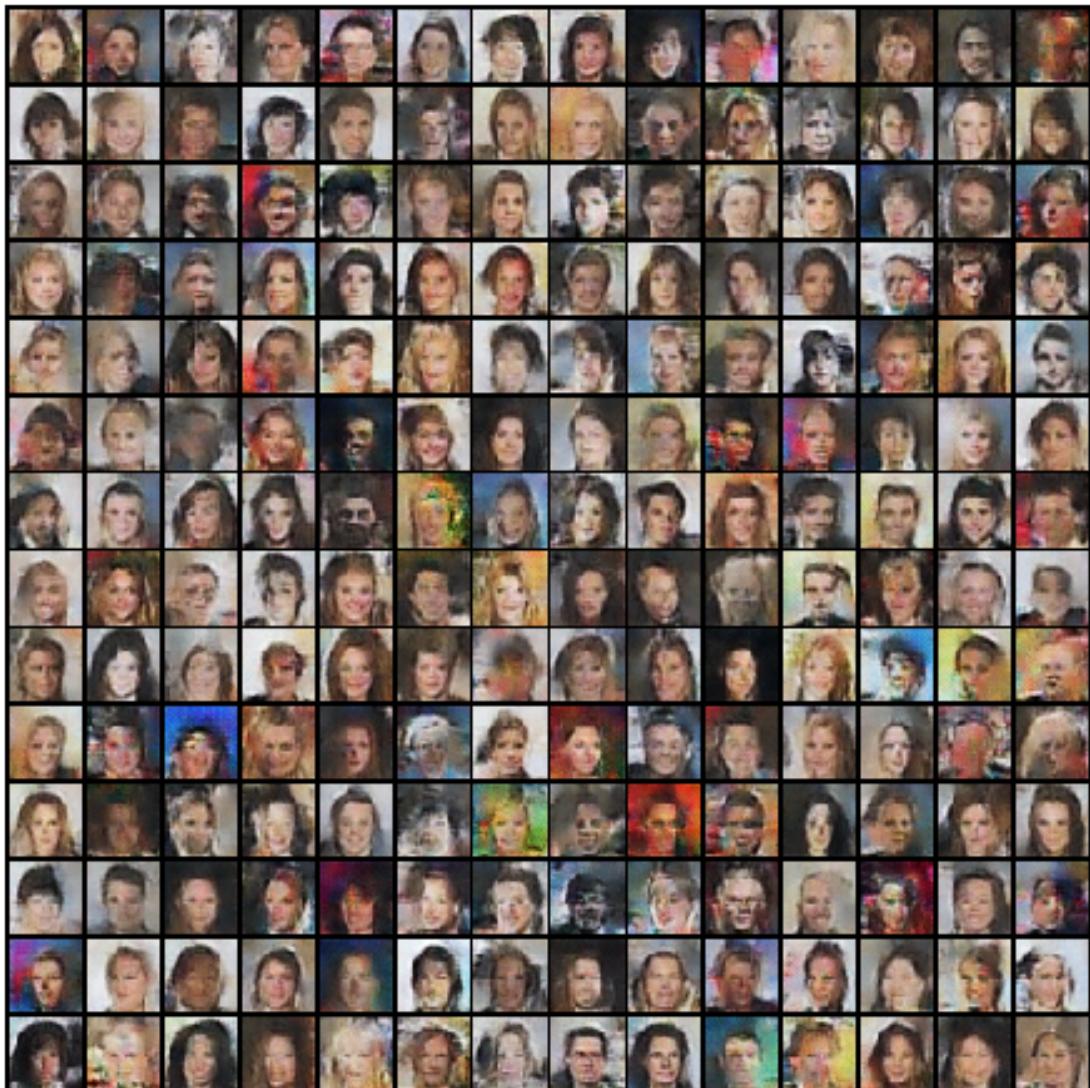
[3625/ 8000]	Loss_D: 0.4997	Loss_G: 1.5910	D(x): 0.7621	D(G(z)): 0
[3650/ 8000]	Loss_D: 0.9506	Loss_G: 0.5205	D(x): 0.4717	D(G(z)): 0
[3675/ 8000]	Loss_D: 1.0268	Loss_G: 1.0599	D(x): 0.4285	D(G(z)): 0
[3700/ 8000]	Loss_D: 0.6092	Loss_G: 2.0306	D(x): 0.8778	D(G(z)): 0



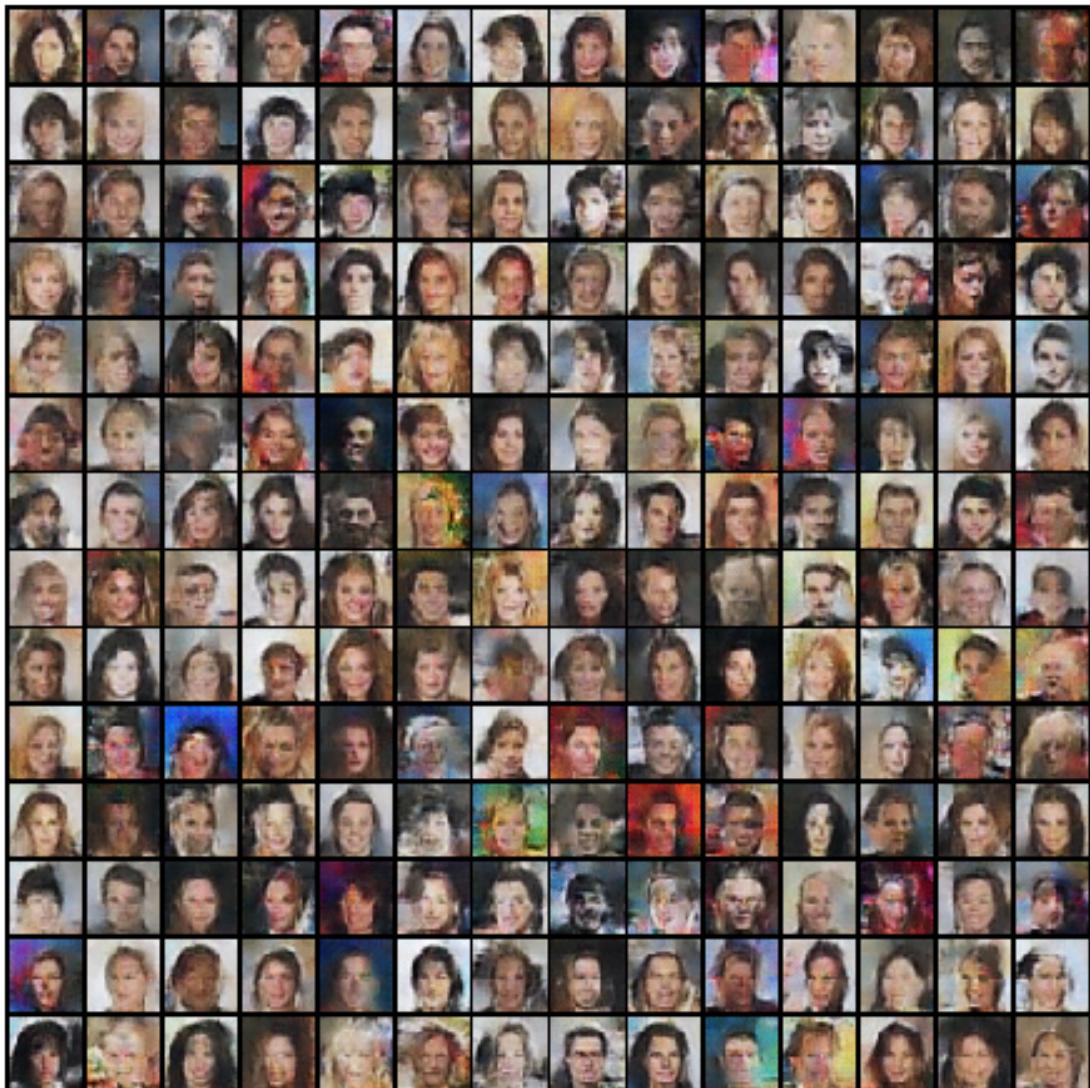
[3725/ 8000]	Loss_D: 2.0431	Loss_G: 3.1848	D(x): 0.9555	D(G(z)): 0
[3750/ 8000]	Loss_D: 0.7736	Loss_G: 3.0089	D(x): 0.9238	D(G(z)): 0
[3775/ 8000]	Loss_D: 0.9810	Loss_G: 2.0792	D(x): 0.7864	D(G(z)): 0
[3800/ 8000]	Loss_D: 0.6608	Loss_G: 2.1256	D(x): 0.7710	D(G(z)): 0



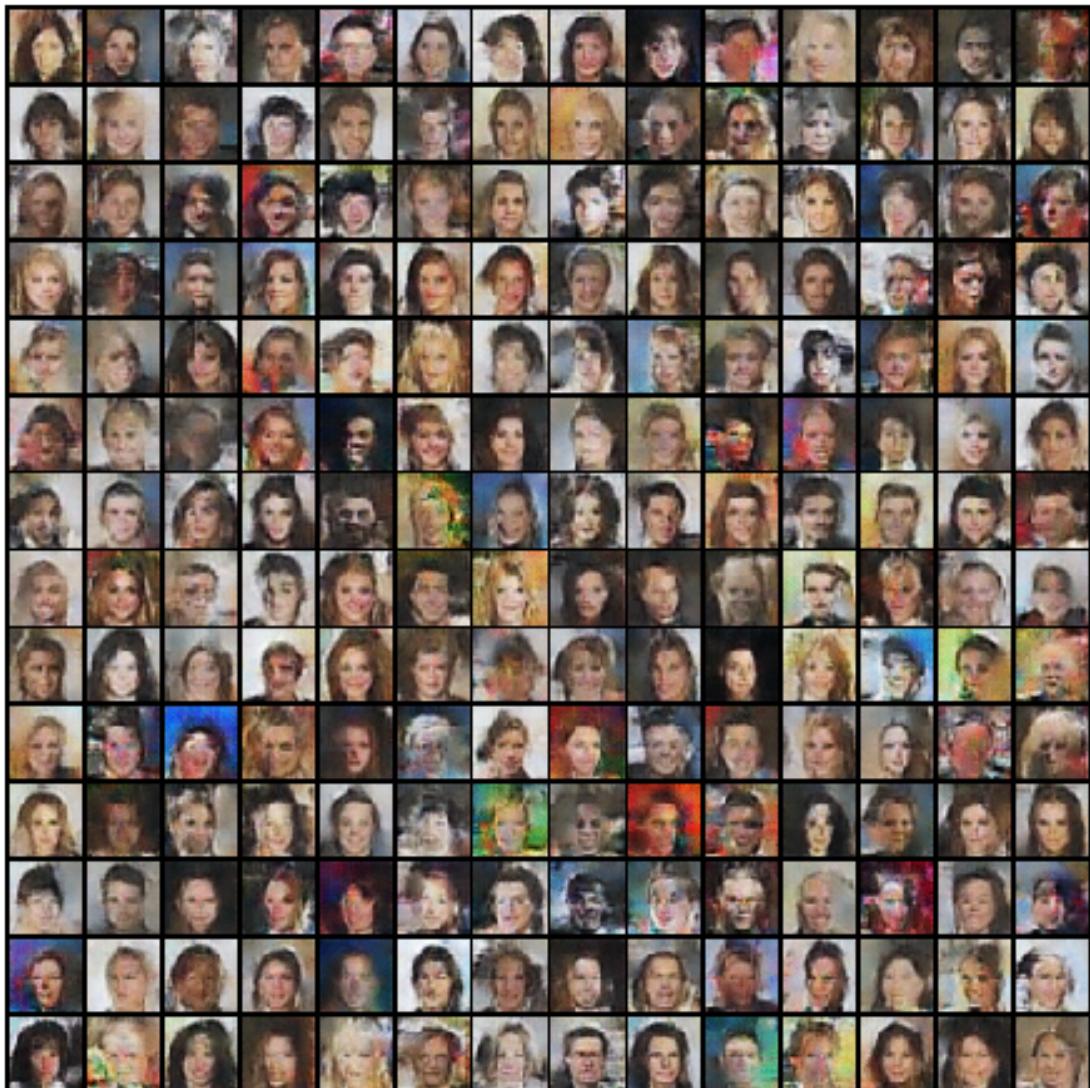
[3825/ 8000]	Loss_D: 0.8741	Loss_G: 2.4020	D(x): 0.9146	D(G(z)): 0
[3850/ 8000]	Loss_D: 0.5820	Loss_G: 1.8914	D(x): 0.7084	D(G(z)): 0
[3875/ 8000]	Loss_D: 1.0014	Loss_G: 1.9570	D(x): 0.8226	D(G(z)): 0
[3900/ 8000]	Loss_D: 0.9818	Loss_G: 1.1234	D(x): 0.4500	D(G(z)): 0



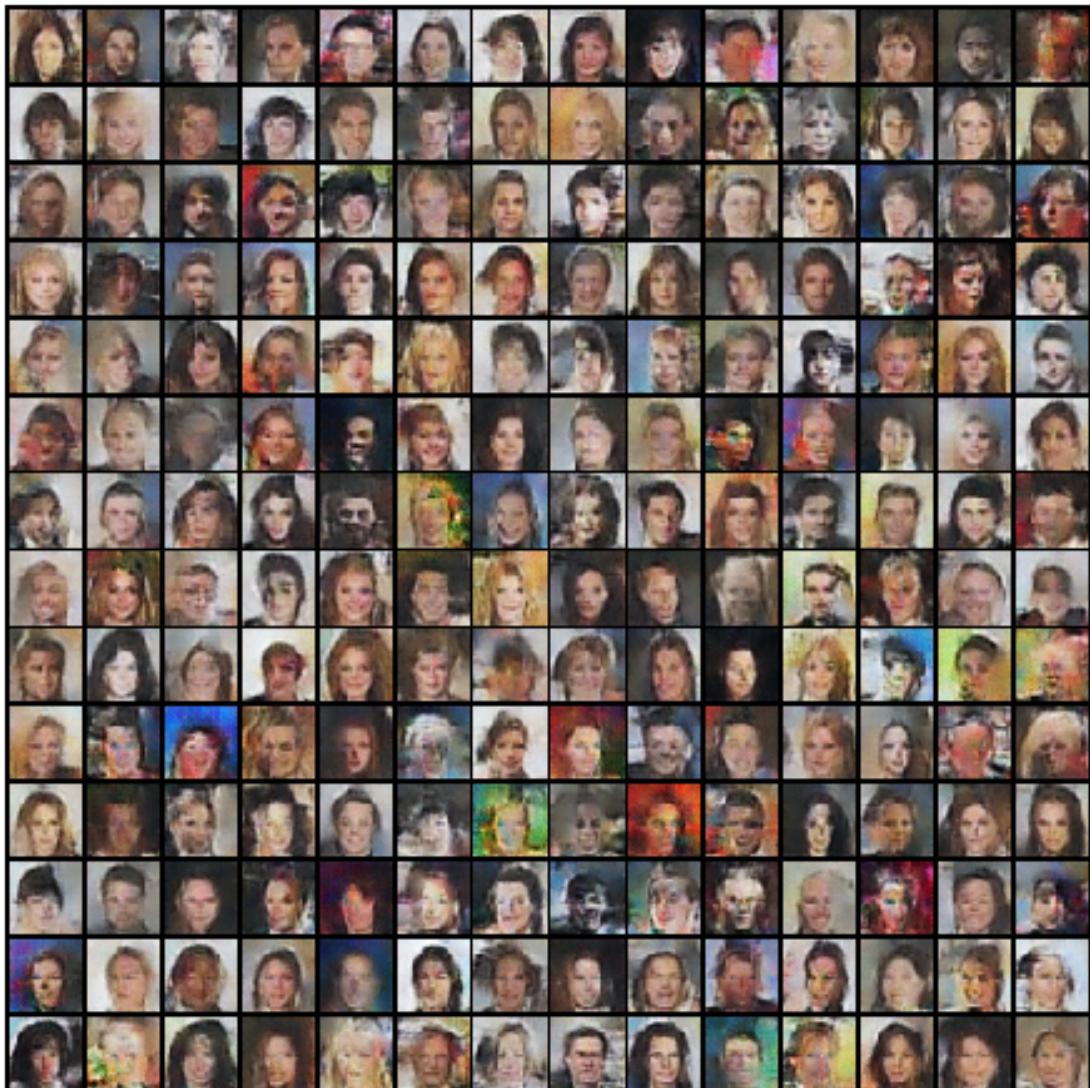
[3925/ 8000]	Loss_D: 0.8056	Loss_G: 0.7246	D(x): 0.5732	D(G(z)): 0
[3950/ 8000]	Loss_D: 0.7634	Loss_G: 3.3021	D(x): 0.9366	D(G(z)): 0
[3975/ 8000]	Loss_D: 0.5385	Loss_G: 3.1003	D(x): 0.8775	D(G(z)): 0
[4000/ 8000]	Loss_D: 0.3792	Loss_G: 1.8486	D(x): 0.8158	D(G(z)): 0



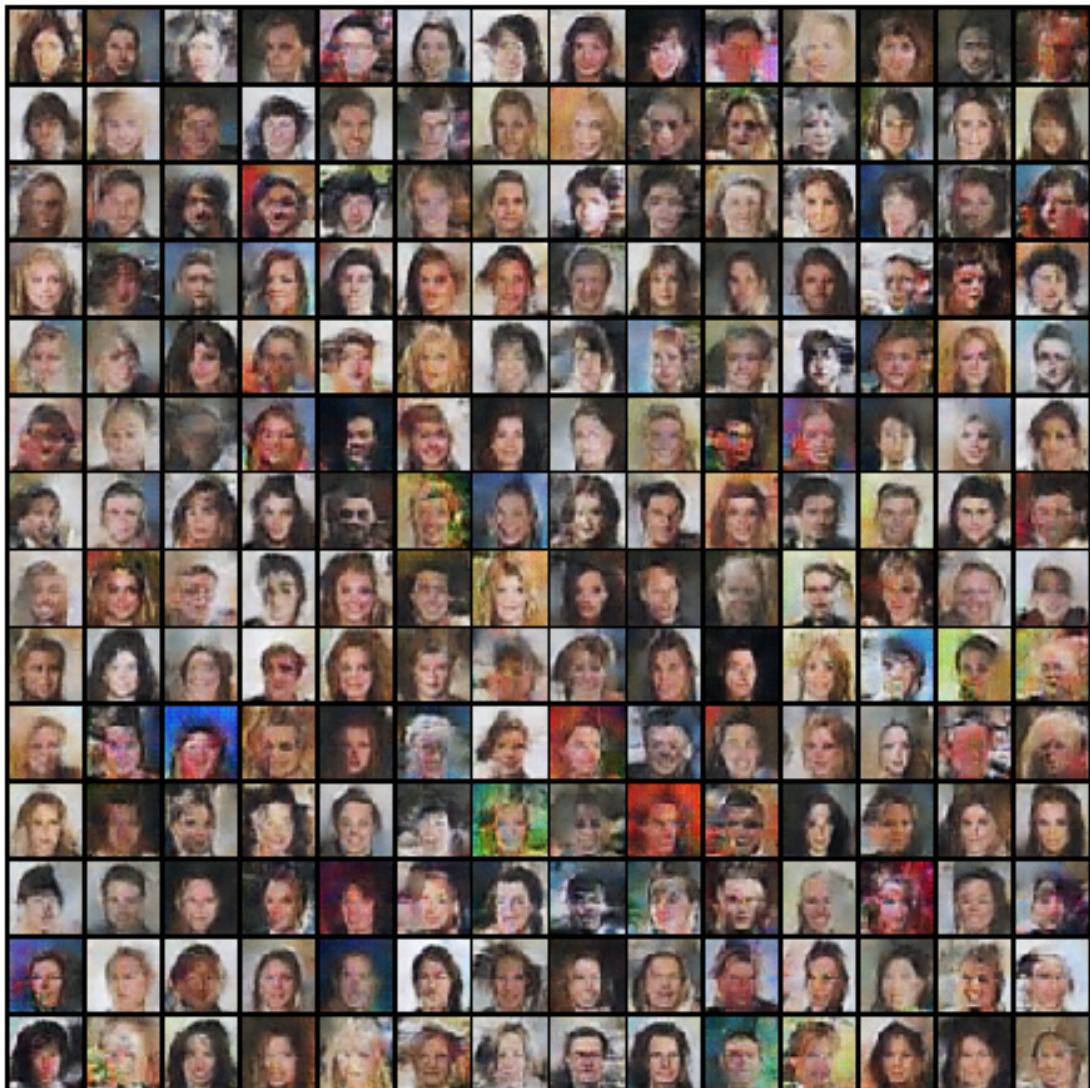
[4025/ 8000]	Loss_D: 0.4525	Loss_G: 1.8006	D(x): 0.8079	D(G(z)): 0
[4050/ 8000]	Loss_D: 0.9500	Loss_G: 2.7747	D(x): 0.9084	D(G(z)): 0
[4075/ 8000]	Loss_D: 0.5439	Loss_G: 1.7607	D(x): 0.7840	D(G(z)): 0
[4100/ 8000]	Loss_D: 0.8737	Loss_G: 2.7838	D(x): 0.9330	D(G(z)): 0



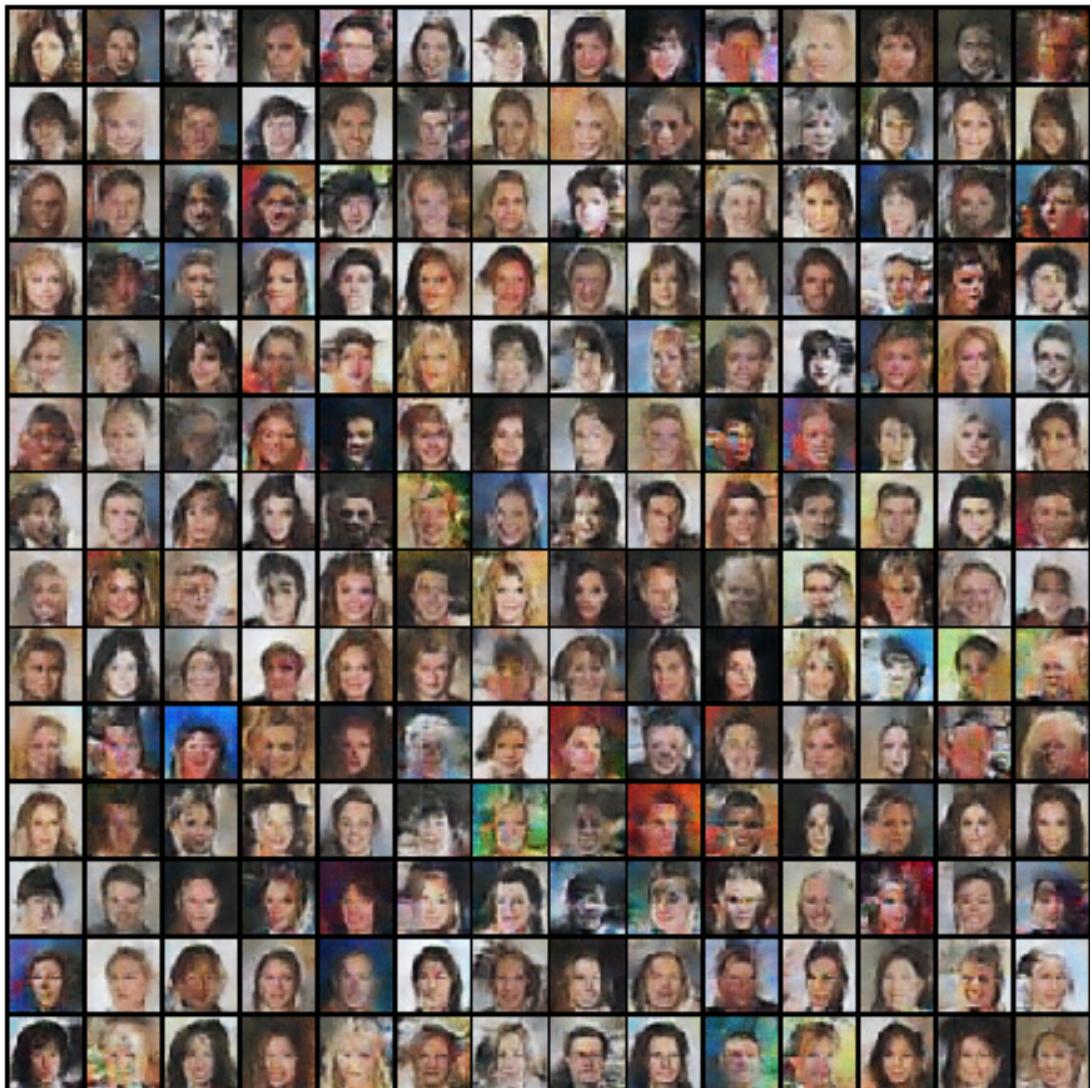
[4125/ 8000]	Loss_D: 0.7790	Loss_G: 1.7911	D(x): 0.7477	D(G(z)): 0
[4150/ 8000]	Loss_D: 0.5717	Loss_G: 2.3980	D(x): 0.8259	D(G(z)): 0
[4175/ 8000]	Loss_D: 0.6952	Loss_G: 2.8752	D(x): 0.9181	D(G(z)): 0
[4200/ 8000]	Loss_D: 0.4261	Loss_G: 1.9231	D(x): 0.7871	D(G(z)): 0



[4225/ 8000]	Loss_D: 1.9553	Loss_G: 5.9946	D(x): 0.9529	D(G(z)): 0
[4250/ 8000]	Loss_D: 0.5809	Loss_G: 1.6973	D(x): 0.7392	D(G(z)): 0
[4275/ 8000]	Loss_D: 0.5110	Loss_G: 1.6590	D(x): 0.7551	D(G(z)): 0
[4300/ 8000]	Loss_D: 0.9423	Loss_G: 0.7461	D(x): 0.4662	D(G(z)): 0



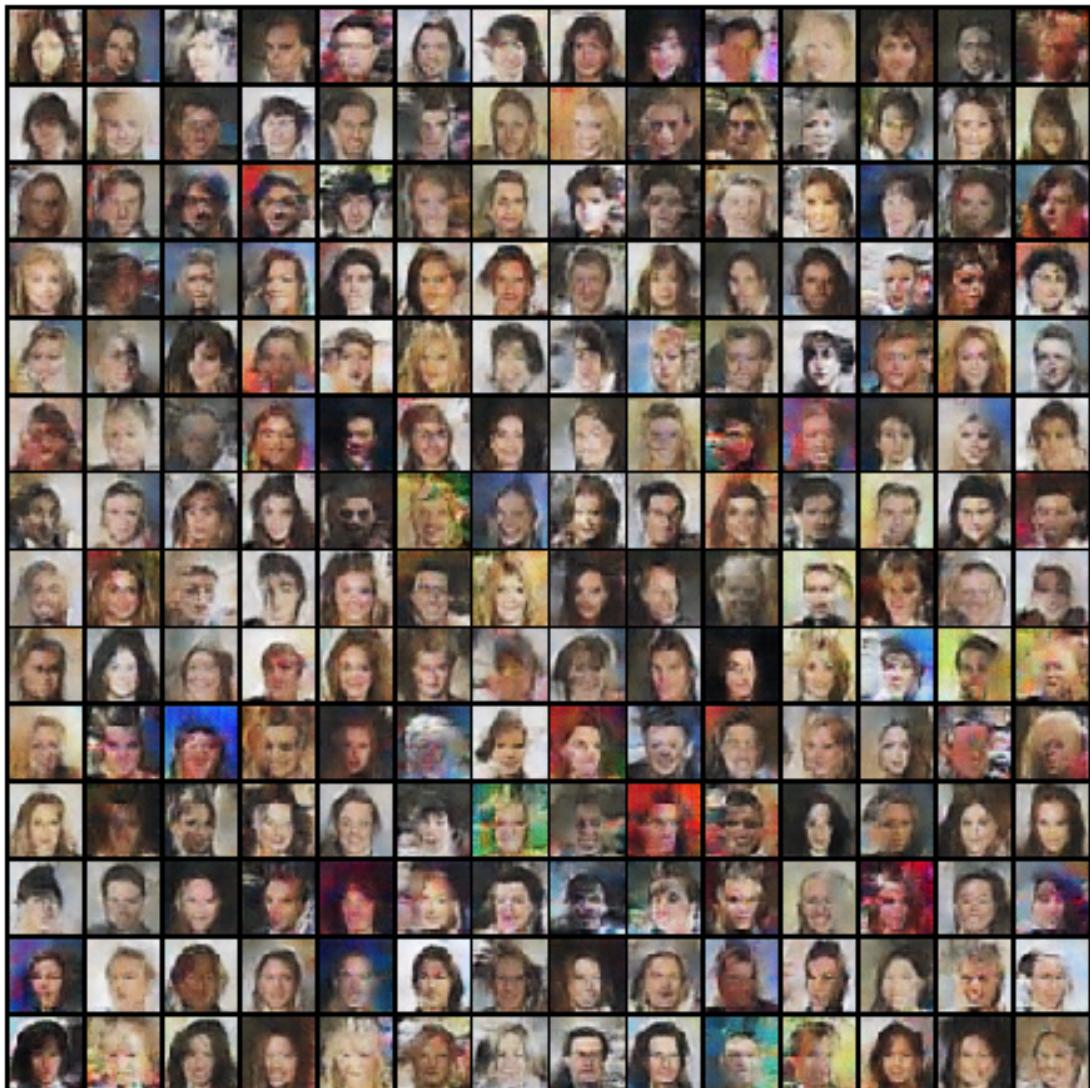
[4325/ 8000]	Loss_D: 0.5388	Loss_G: 1.5948	D(x): 0.7402	D(G(z)): 0
[4350/ 8000]	Loss_D: 0.5201	Loss_G: 1.2201	D(x): 0.6943	D(G(z)): 0
[4375/ 8000]	Loss_D: 0.4906	Loss_G: 2.2704	D(x): 0.8263	D(G(z)): 0
[4400/ 8000]	Loss_D: 0.5195	Loss_G: 1.6779	D(x): 0.6857	D(G(z)): 0



[4425/ 8000]	Loss_D: 0.5692	Loss_G: 2.9152	D(x): 0.8619	D(G(z)): 0
[4450/ 8000]	Loss_D: 1.1548	Loss_G: 3.3075	D(x): 0.8593	D(G(z)): 0
[4475/ 8000]	Loss_D: 0.5935	Loss_G: 1.2799	D(x): 0.6700	D(G(z)): 0
[4500/ 8000]	Loss_D: 0.5965	Loss_G: 1.1966	D(x): 0.6716	D(G(z)): 0



[4525/ 8000]	Loss_D: 0.5757	Loss_G: 3.6006	D(x): 0.9389	D(G(z)): 0
[4550/ 8000]	Loss_D: 0.8109	Loss_G: 1.7514	D(x): 0.5389	D(G(z)): 0
[4575/ 8000]	Loss_D: 0.3845	Loss_G: 2.0574	D(x): 0.8219	D(G(z)): 0
[4600/ 8000]	Loss_D: 0.9165	Loss_G: 1.9807	D(x): 0.7760	D(G(z)): 0



[4625/ 8000]	Loss_D: 1.1086	Loss_G: 0.5143	D(x): 0.4070	D(G(z)): 0
[4650/ 8000]	Loss_D: 0.9934	Loss_G: 2.8707	D(x): 0.9106	D(G(z)): 0
[4675/ 8000]	Loss_D: 0.4552	Loss_G: 2.2162	D(x): 0.8576	D(G(z)): 0
[4700/ 8000]	Loss_D: 0.6243	Loss_G: 2.9560	D(x): 0.9074	D(G(z)): 0



[4725/ 8000]	Loss_D: 0.4579	Loss_G: 1.9205	D(x): 0.7743	D(G(z)): 0
[4750/ 8000]	Loss_D: 0.7018	Loss_G: 1.5322	D(x): 0.6434	D(G(z)): 0
[4775/ 8000]	Loss_D: 0.4338	Loss_G: 1.9633	D(x): 0.8234	D(G(z)): 0
[4800/ 8000]	Loss_D: 0.8852	Loss_G: 1.6580	D(x): 0.7766	D(G(z)): 0



[4825/ 8000]	Loss_D: 0.4837	Loss_G: 2.2274	D(x): 0.8472	D(G(z)): 0
[4850/ 8000]	Loss_D: 0.5367	Loss_G: 1.8033	D(x): 0.7392	D(G(z)): 0
[4875/ 8000]	Loss_D: 0.5286	Loss_G: 2.6762	D(x): 0.8971	D(G(z)): 0
[4900/ 8000]	Loss_D: 0.8527	Loss_G: 1.4647	D(x): 0.6801	D(G(z)): 0



[4925/ 8000]	Loss_D: 0.6020	Loss_G: 1.2903	D(x): 0.6325	D(G(z)): 0
[4950/ 8000]	Loss_D: 0.5395	Loss_G: 1.0827	D(x): 0.6625	D(G(z)): 0
[4975/ 8000]	Loss_D: 0.9190	Loss_G: 1.6112	D(x): 0.6063	D(G(z)): 0
[5000/ 8000]	Loss_D: 0.4695	Loss_G: 1.9958	D(x): 0.8429	D(G(z)): 0



[5025/ 8000]	Loss_D: 0.8184	Loss_G: 2.9573	D(x): 0.9444	D(G(z)): 0
[5050/ 8000]	Loss_D: 0.4257	Loss_G: 2.6751	D(x): 0.8982	D(G(z)): 0
[5075/ 8000]	Loss_D: 0.6065	Loss_G: 3.1311	D(x): 0.9199	D(G(z)): 0
[5100/ 8000]	Loss_D: 0.7931	Loss_G: 4.2530	D(x): 0.9541	D(G(z)): 0



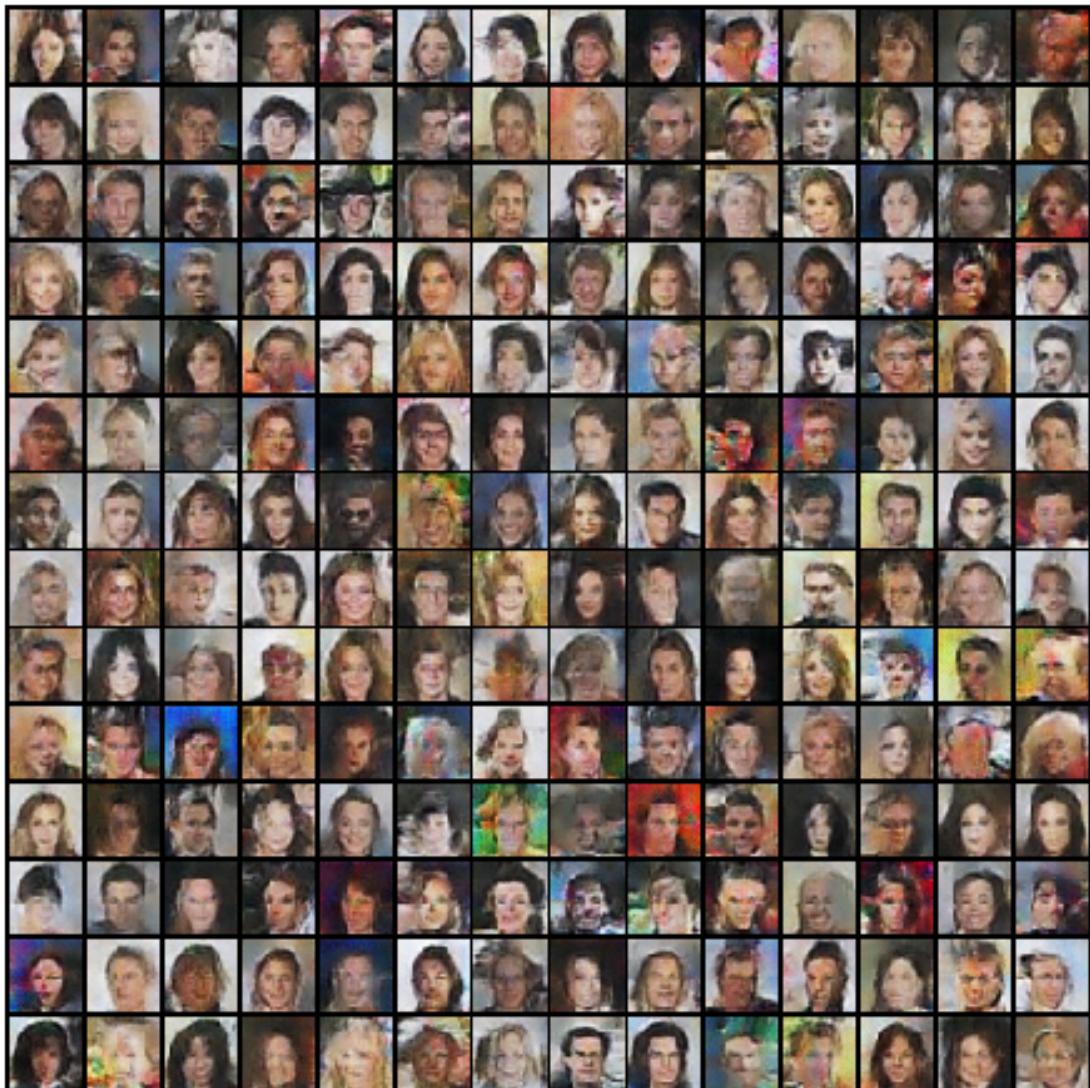
[5125/ 8000]	Loss_D: 0.9387	Loss_G: 0.9507	D(x): 0.5020	D(G(z)): 0
[5150/ 8000]	Loss_D: 0.6900	Loss_G: 1.2264	D(x): 0.5955	D(G(z)): 0
[5175/ 8000]	Loss_D: 0.5971	Loss_G: 2.2318	D(x): 0.7584	D(G(z)): 0
[5200/ 8000]	Loss_D: 0.3695	Loss_G: 2.1985	D(x): 0.8312	D(G(z)): 0



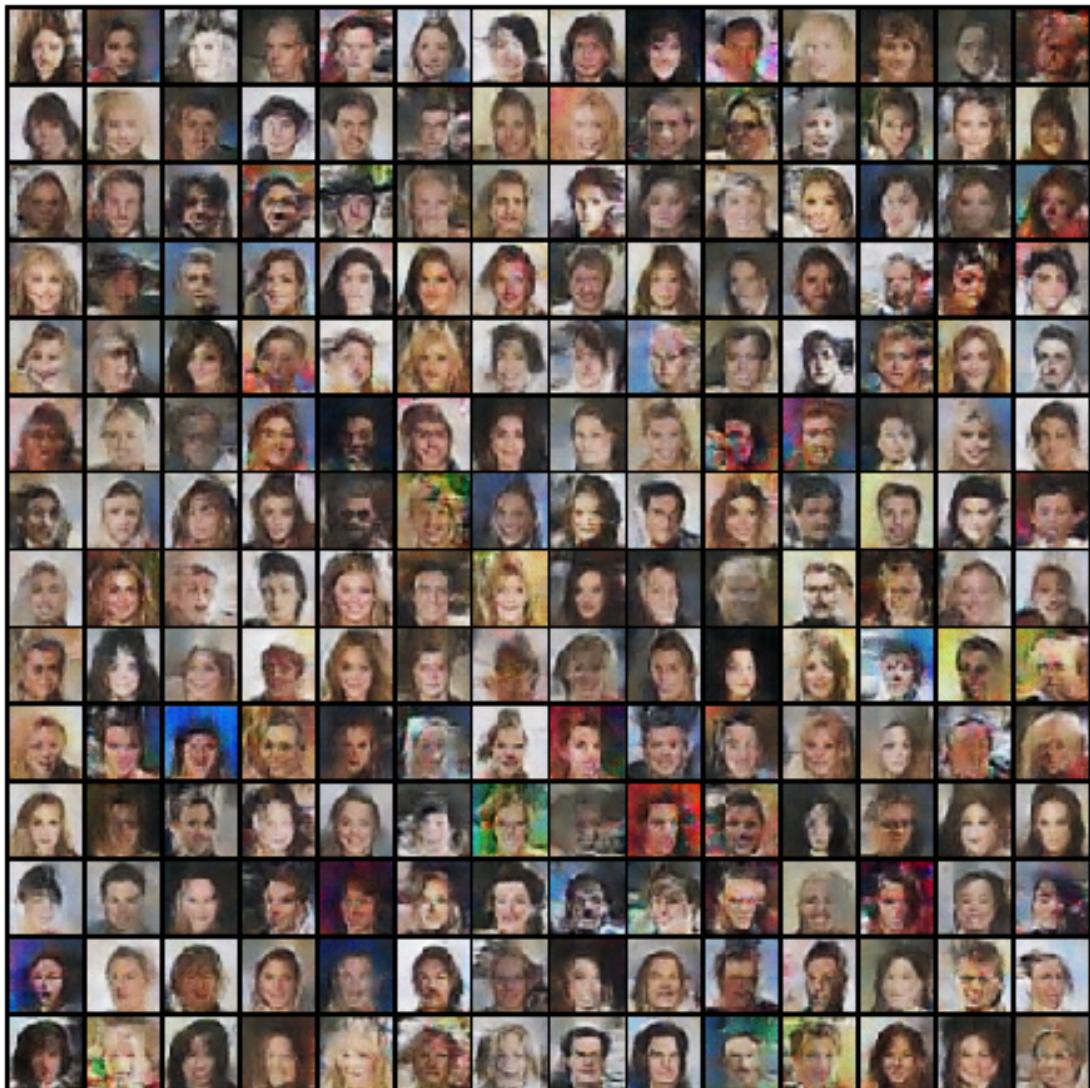
[5225/ 8000]	Loss_D: 0.4342	Loss_G: 2.6791	D(x): 0.8641	D(G(z)): 0
[5250/ 8000]	Loss_D: 0.4909	Loss_G: 2.3197	D(x): 0.7974	D(G(z)): 0
[5275/ 8000]	Loss_D: 0.7755	Loss_G: 0.7213	D(x): 0.5444	D(G(z)): 0
[5300/ 8000]	Loss_D: 0.3799	Loss_G: 2.2453	D(x): 0.8344	D(G(z)): 0



[5325/ 8000]	Loss_D: 0.6446	Loss_G: 4.0084	D(x): 0.9568	D(G(z)): 0
[5350/ 8000]	Loss_D: 0.4270	Loss_G: 2.4551	D(x): 0.7942	D(G(z)): 0
[5375/ 8000]	Loss_D: 0.4248	Loss_G: 2.6787	D(x): 0.8993	D(G(z)): 0
[5400/ 8000]	Loss_D: 0.6106	Loss_G: 1.2187	D(x): 0.6372	D(G(z)): 0



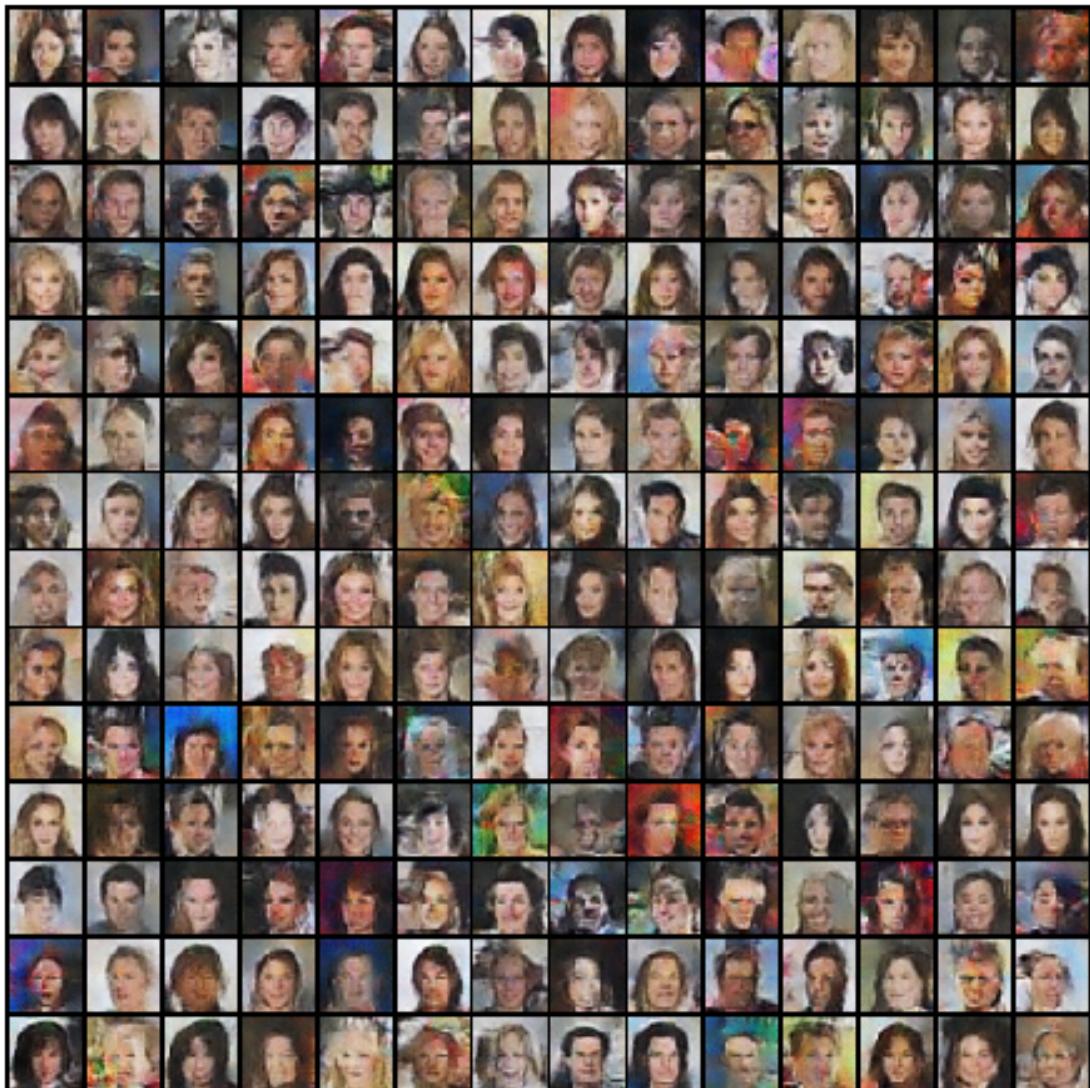
[5425/ 8000]	Loss_D: 1.3848	Loss_G: 1.8087	D(x): 0.7915	D(G(z)): 0
[5450/ 8000]	Loss_D: 0.3861	Loss_G: 3.1965	D(x): 0.9163	D(G(z)): 0
[5475/ 8000]	Loss_D: 0.3571	Loss_G: 2.3777	D(x): 0.8210	D(G(z)): 0
[5500/ 8000]	Loss_D: 0.5650	Loss_G: 2.9943	D(x): 0.9098	D(G(z)): 0



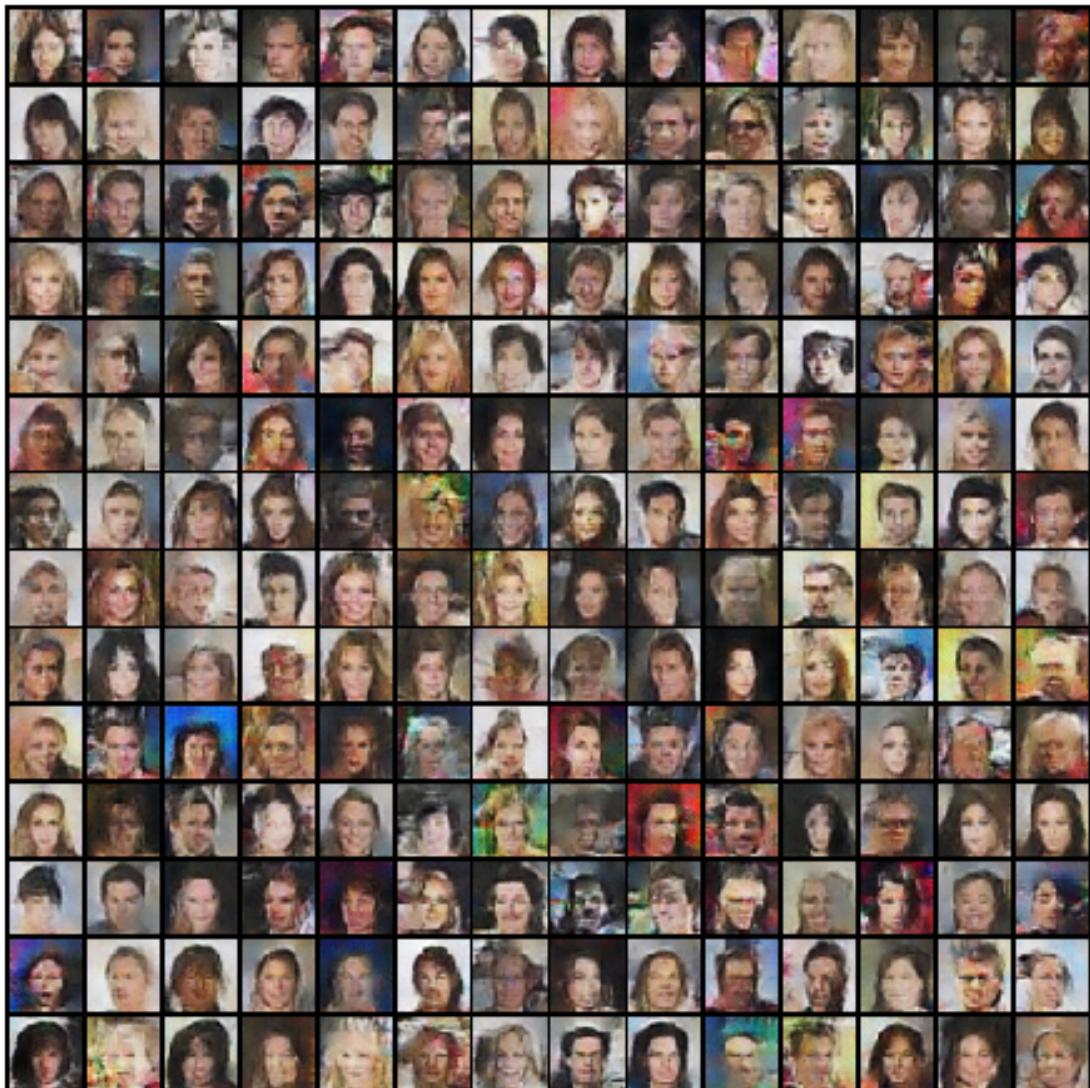
[5525/ 8000]	Loss_D: 0.3954	Loss_G: 2.1482	D(x): 0.7988	D(G(z)): 0
[5550/ 8000]	Loss_D: 0.7859	Loss_G: 2.0795	D(x): 0.6735	D(G(z)): 0
[5575/ 8000]	Loss_D: 0.3776	Loss_G: 2.0340	D(x): 0.8261	D(G(z)): 0
[5600/ 8000]	Loss_D: 0.4474	Loss_G: 1.9387	D(x): 0.7120	D(G(z)): 0



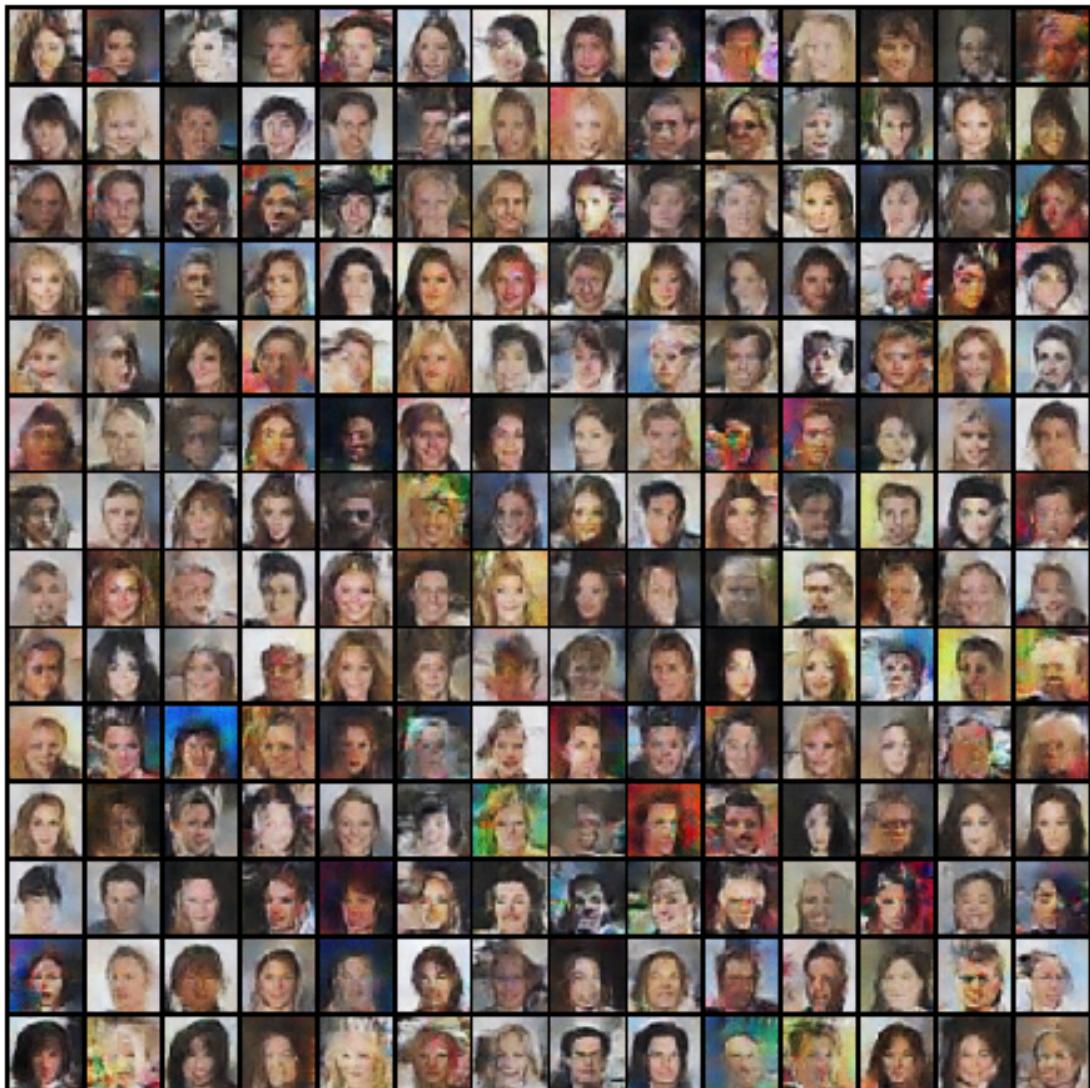
[5625/ 8000]	Loss_D: 0.5366	Loss_G: 4.1132	D(x): 0.9569	D(G(z)): 0
[5650/ 8000]	Loss_D: 0.9325	Loss_G: 1.5332	D(x): 0.4838	D(G(z)): 0
[5675/ 8000]	Loss_D: 0.5548	Loss_G: 2.2872	D(x): 0.8153	D(G(z)): 0
[5700/ 8000]	Loss_D: 0.4054	Loss_G: 1.7081	D(x): 0.7997	D(G(z)): 0



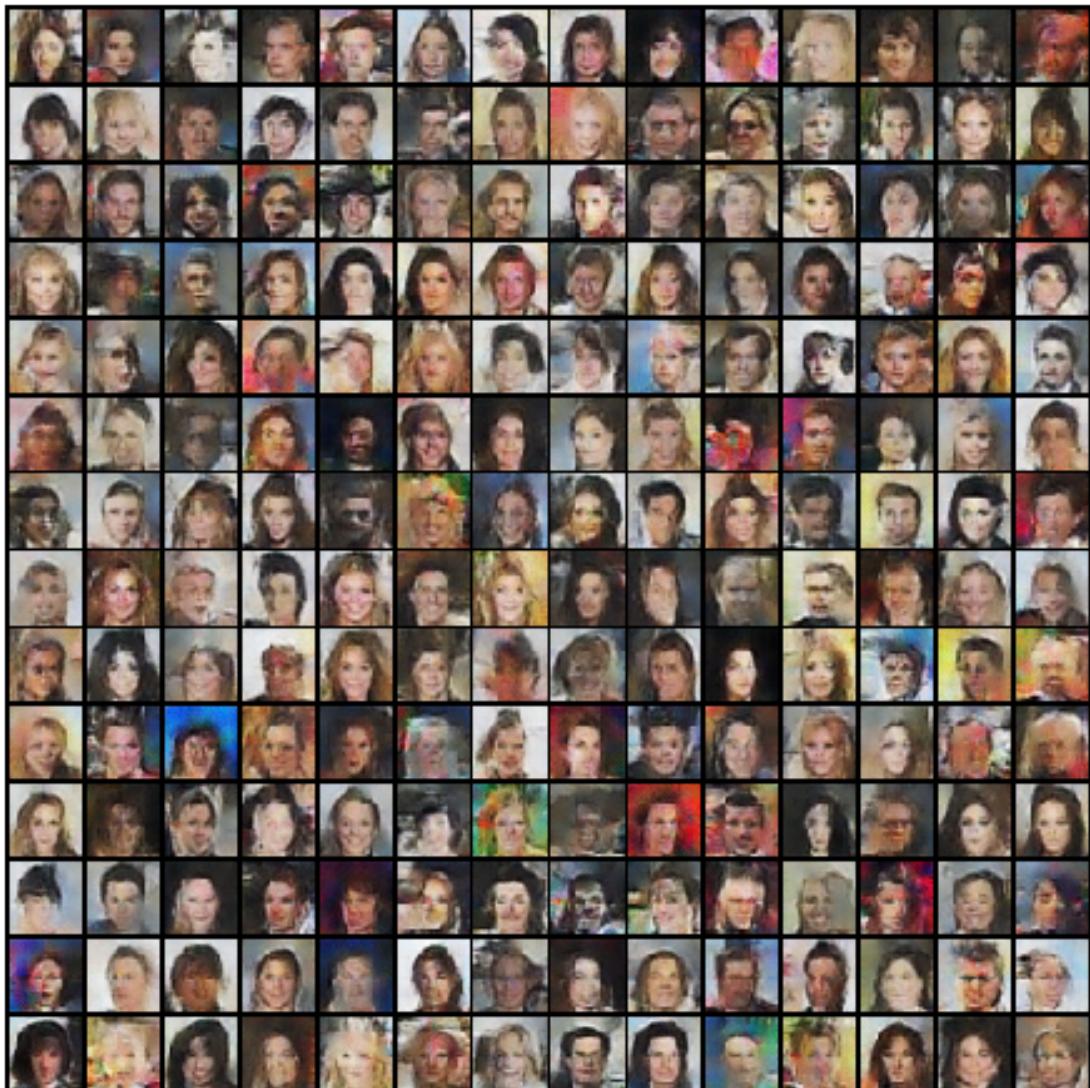
[5725/ 8000]	Loss_D: 0.4605	Loss_G: 1.6392	D(x): 0.7415	D(G(z)): 0
[5750/ 8000]	Loss_D: 0.6196	Loss_G: 3.6307	D(x): 0.9297	D(G(z)): 0
[5775/ 8000]	Loss_D: 1.0054	Loss_G: 3.5951	D(x): 0.9556	D(G(z)): 0
[5800/ 8000]	Loss_D: 0.7941	Loss_G: 2.3088	D(x): 0.9022	D(G(z)): 0



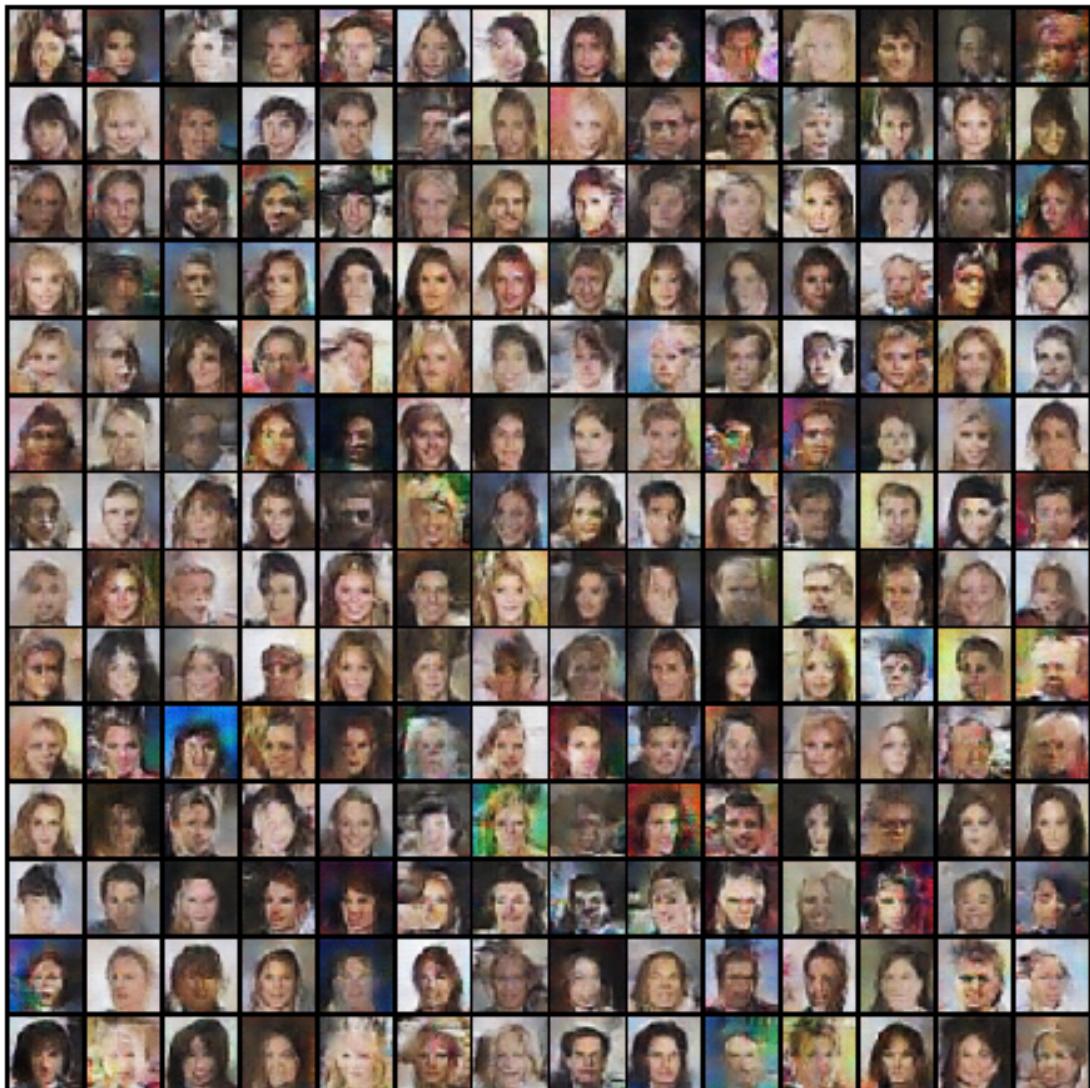
[5825/ 8000]	Loss_D: 0.3805	Loss_G: 1.8775	D(x): 0.7719	D(G(z)): 0
[5850/ 8000]	Loss_D: 0.4282	Loss_G: 2.1472	D(x): 0.7670	D(G(z)): 0
[5875/ 8000]	Loss_D: 0.7308	Loss_G: 1.0258	D(x): 0.5408	D(G(z)): 0
[5900/ 8000]	Loss_D: 0.9421	Loss_G: 3.9014	D(x): 0.9634	D(G(z)): 0



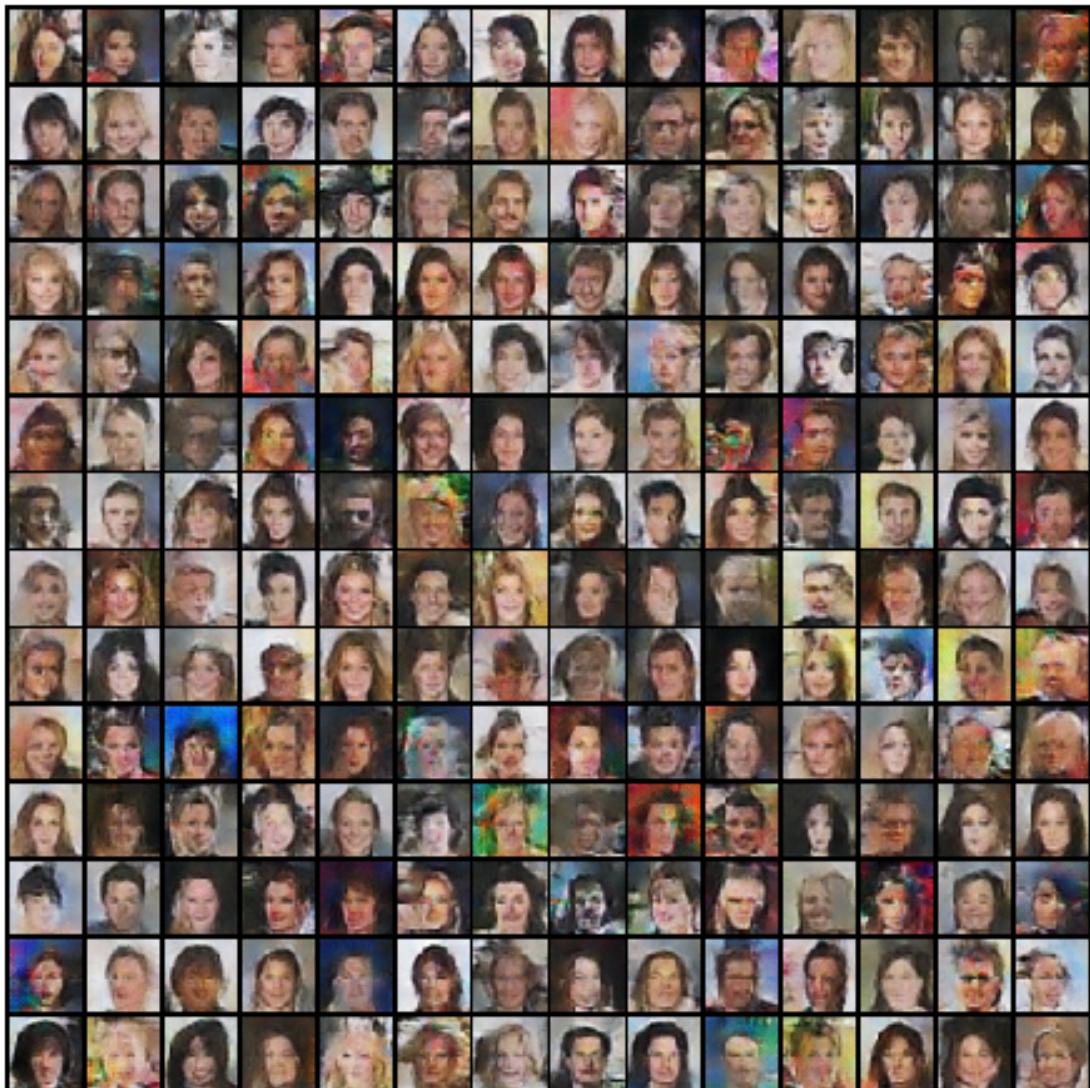
[5925/ 8000]	Loss_D: 0.3599	Loss_G: 1.8544	D(x): 0.8143	D(G(z)): 0
[5950/ 8000]	Loss_D: 0.4107	Loss_G: 2.3545	D(x): 0.8889	D(G(z)): 0
[5975/ 8000]	Loss_D: 0.4288	Loss_G: 2.5658	D(x): 0.9186	D(G(z)): 0
[6000/ 8000]	Loss_D: 0.4307	Loss_G: 1.9640	D(x): 0.8075	D(G(z)): 0



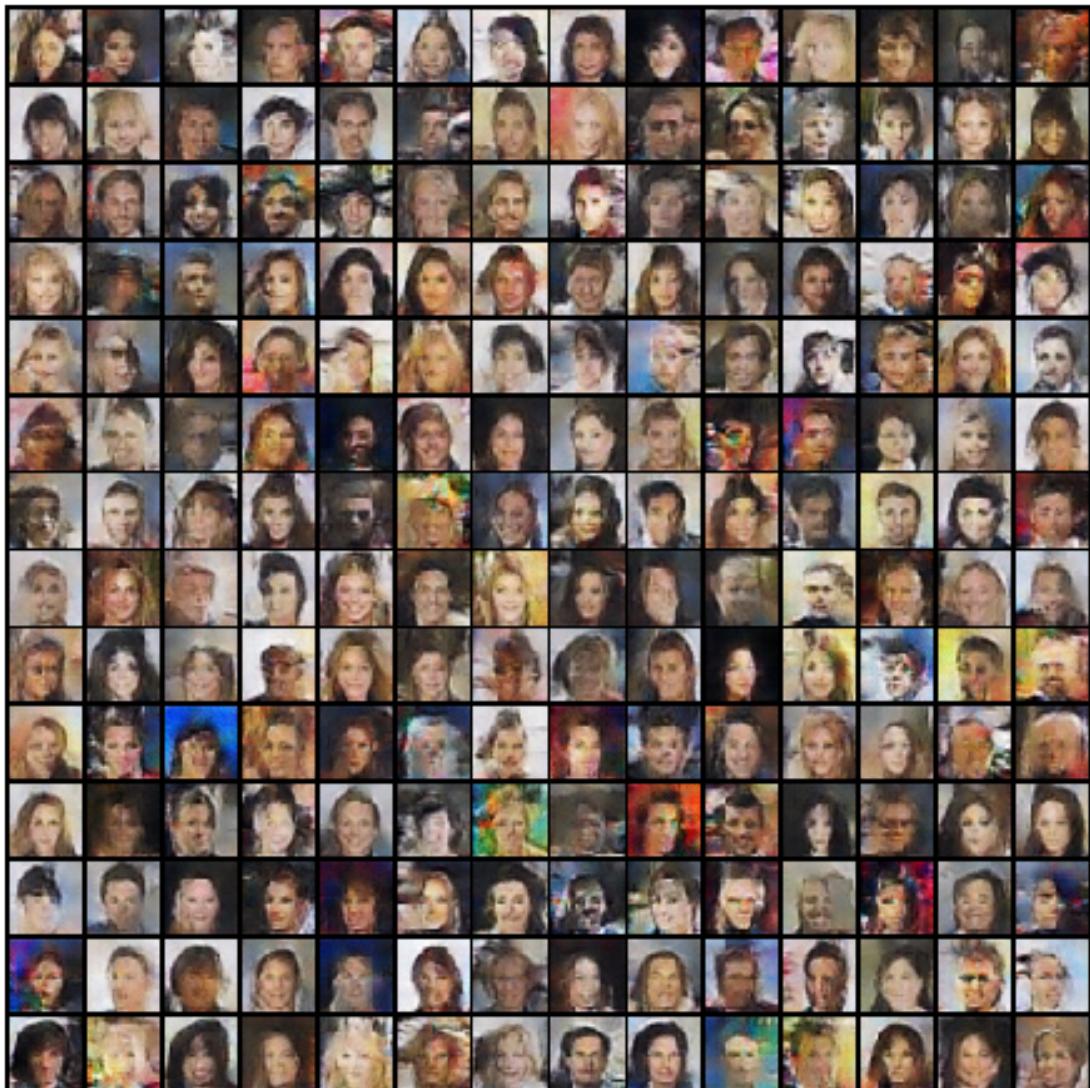
[6025/ 8000]	Loss_D: 0.4395	Loss_G: 2.0803	D(x): 0.8538	D(G(z)): 0
[6050/ 8000]	Loss_D: 0.3939	Loss_G: 2.7341	D(x): 0.8965	D(G(z)): 0
[6075/ 8000]	Loss_D: 0.4414	Loss_G: 1.3974	D(x): 0.7043	D(G(z)): 0
[6100/ 8000]	Loss_D: 0.4906	Loss_G: 1.9653	D(x): 0.7370	D(G(z)): 0



[6125/ 8000]	Loss_D: 1.0871	Loss_G: 2.7479	D(x): 0.9329	D(G(z)): 0
[6150/ 8000]	Loss_D: 1.9465	Loss_G: 2.0043	D(x): 0.9343	D(G(z)): 0
[6175/ 8000]	Loss_D: 0.6713	Loss_G: 2.0891	D(x): 0.7499	D(G(z)): 0
[6200/ 8000]	Loss_D: 0.3055	Loss_G: 2.8091	D(x): 0.8632	D(G(z)): 0



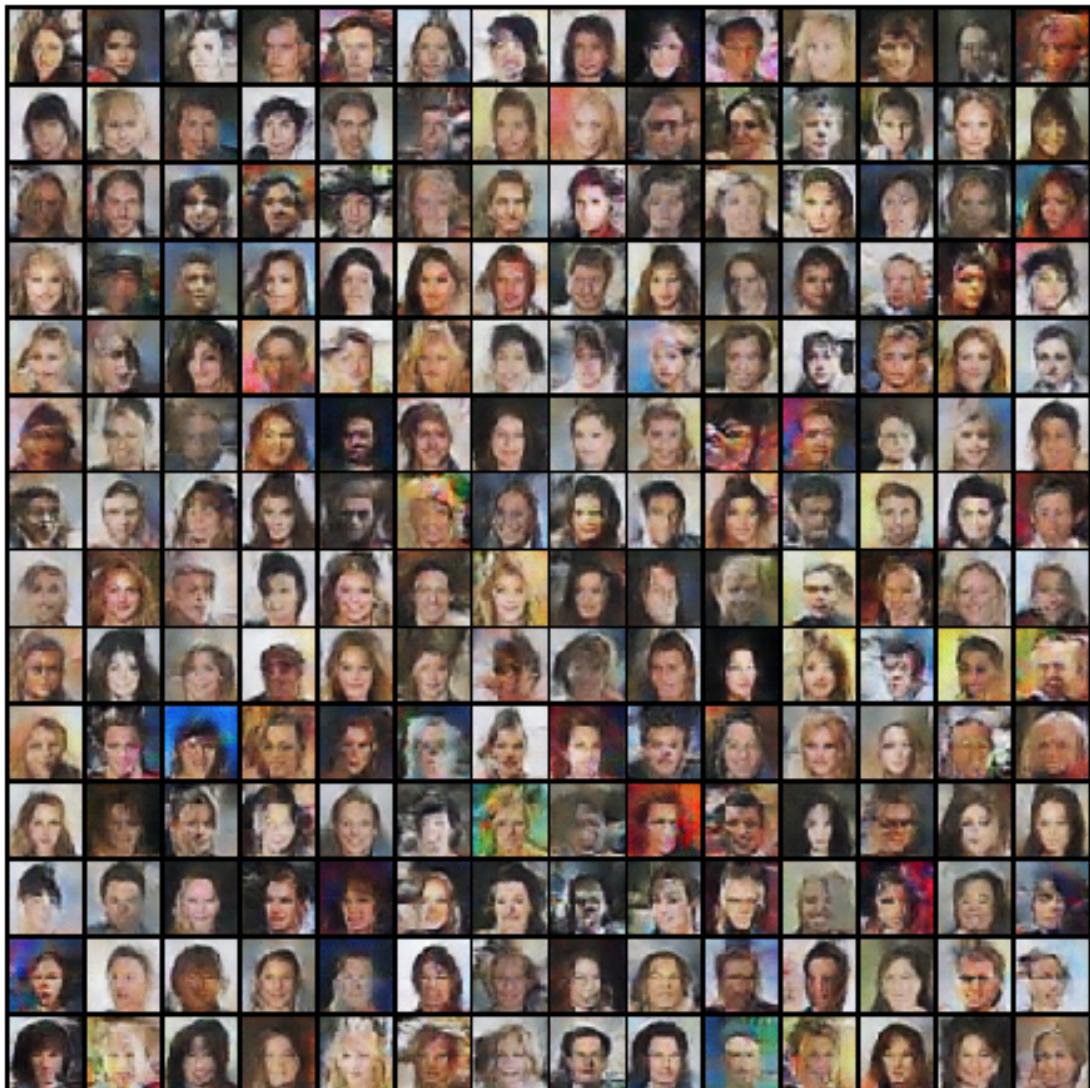
[6225/ 8000]	Loss_D: 1.3650	Loss_G: 0.9717	D(x): 0.3365	D(G(z)): 0
[6250/ 8000]	Loss_D: 0.3657	Loss_G: 1.9722	D(x): 0.8251	D(G(z)): 0
[6275/ 8000]	Loss_D: 0.3878	Loss_G: 1.2177	D(x): 0.7477	D(G(z)): 0
[6300/ 8000]	Loss_D: 0.4844	Loss_G: 2.3484	D(x): 0.7920	D(G(z)): 0



[6325/ 8000]	Loss_D: 0.4112	Loss_G: 2.2288	D(x): 0.8174	D(G(z)): 0
[6350/ 8000]	Loss_D: 0.6144	Loss_G: 1.9092	D(x): 0.7302	D(G(z)): 0
[6375/ 8000]	Loss_D: 1.8427	Loss_G: 0.6229	D(x): 0.2077	D(G(z)): 0
[6400/ 8000]	Loss_D: 0.6056	Loss_G: 1.2462	D(x): 0.6000	D(G(z)): 0



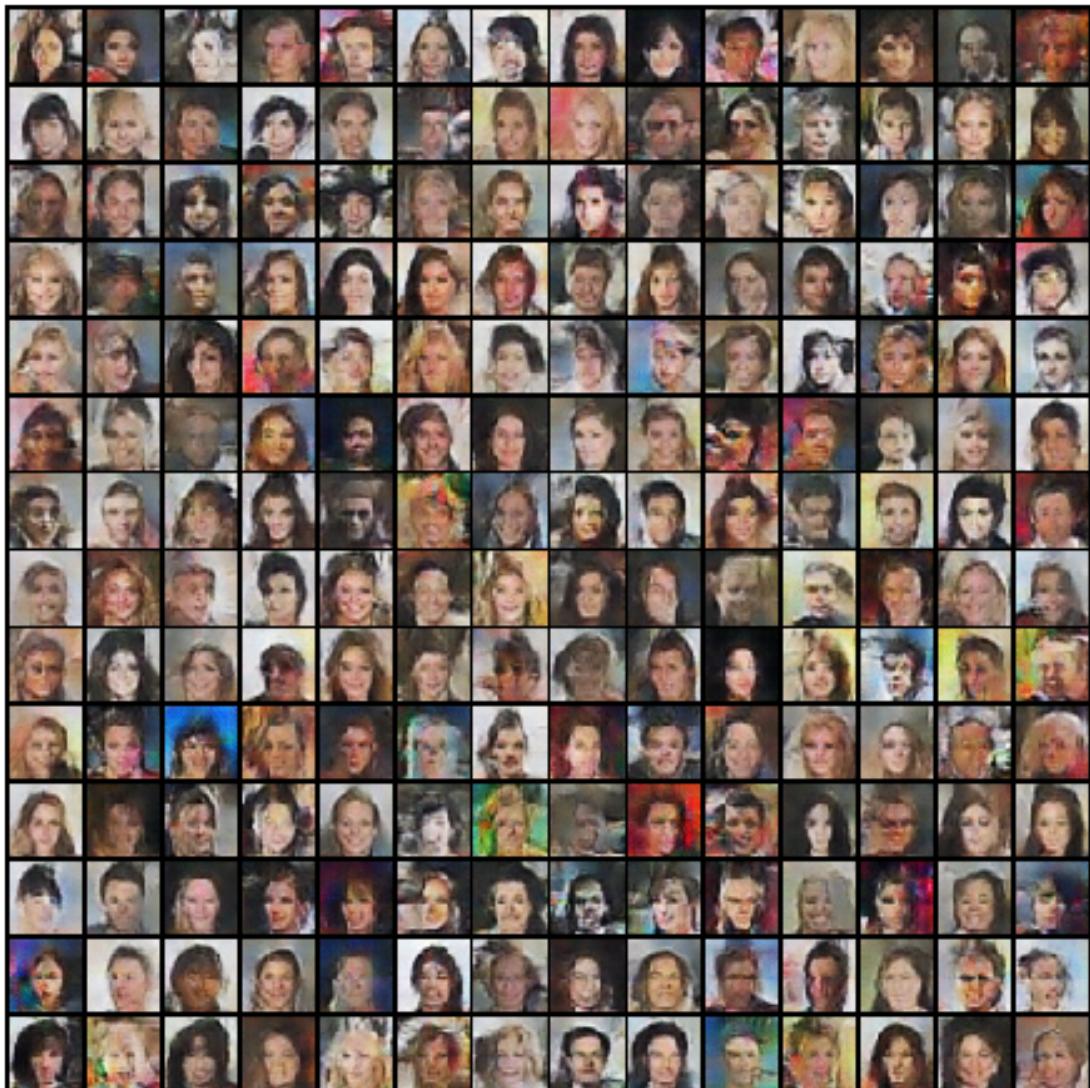
[6425/ 8000]	Loss_D: 0.7732	Loss_G: 1.0466	D(x): 0.5294	D(G(z)): 0
[6450/ 8000]	Loss_D: 0.3724	Loss_G: 3.4845	D(x): 0.9329	D(G(z)): 0
[6475/ 8000]	Loss_D: 0.4319	Loss_G: 1.5781	D(x): 0.7312	D(G(z)): 0
[6500/ 8000]	Loss_D: 0.2869	Loss_G: 2.2099	D(x): 0.8241	D(G(z)): 0



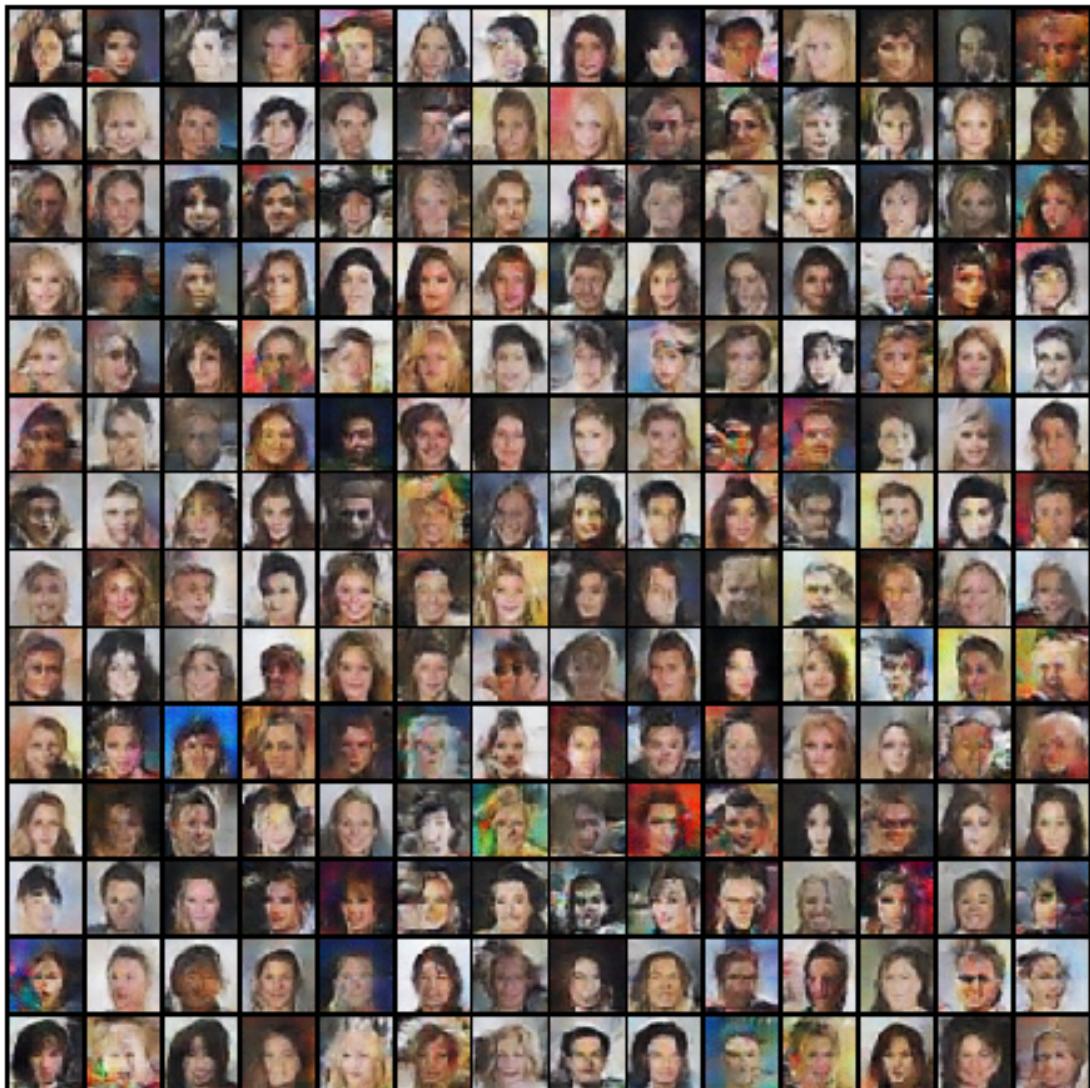
[6525/ 8000]	Loss_D: 1.5649	Loss_G: 0.2349	D(x): 0.2744	D(G(z)): 0
[6550/ 8000]	Loss_D: 0.5895	Loss_G: 2.8232	D(x): 0.9142	D(G(z)): 0
[6575/ 8000]	Loss_D: 0.3971	Loss_G: 2.1404	D(x): 0.8175	D(G(z)): 0
[6600/ 8000]	Loss_D: 0.3158	Loss_G: 2.3239	D(x): 0.9126	D(G(z)): 0



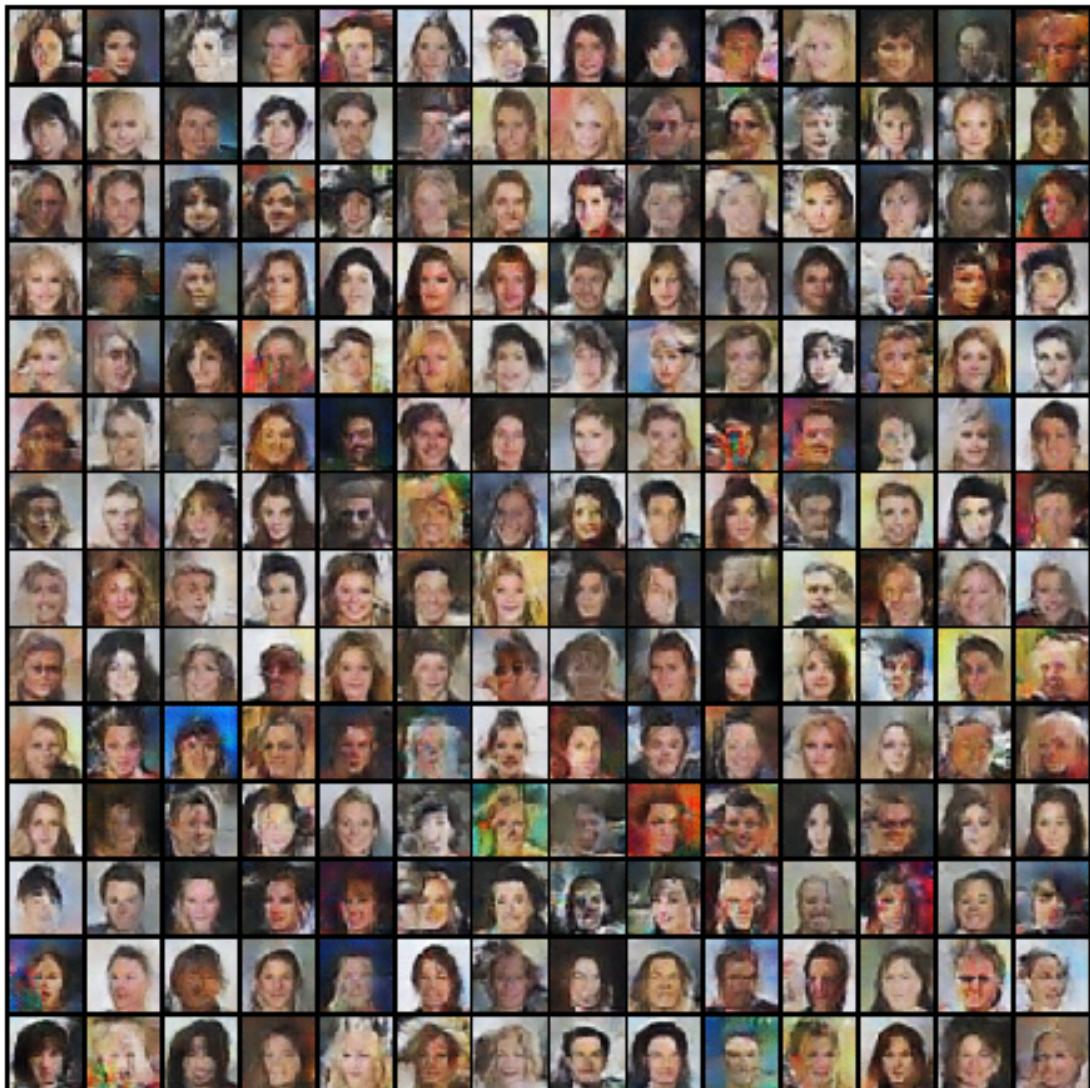
[6625/ 8000]	Loss_D: 2.0394	Loss_G: 0.2097	D(x): 0.1828	D(G(z)): 0
[6650/ 8000]	Loss_D: 0.4143	Loss_G: 3.8469	D(x): 0.9378	D(G(z)): 0
[6675/ 8000]	Loss_D: 0.6238	Loss_G: 2.7833	D(x): 0.7802	D(G(z)): 0
[6700/ 8000]	Loss_D: 0.4851	Loss_G: 2.2485	D(x): 0.7628	D(G(z)): 0



[6725/ 8000]	Loss_D: 0.3043	Loss_G: 2.9790	D(x): 0.9060	D(G(z)): 0
[6750/ 8000]	Loss_D: 0.3363	Loss_G: 3.2675	D(x): 0.9344	D(G(z)): 0
[6775/ 8000]	Loss_D: 0.5238	Loss_G: 2.7071	D(x): 0.8415	D(G(z)): 0
[6800/ 8000]	Loss_D: 0.3295	Loss_G: 3.5066	D(x): 0.9172	D(G(z)): 0



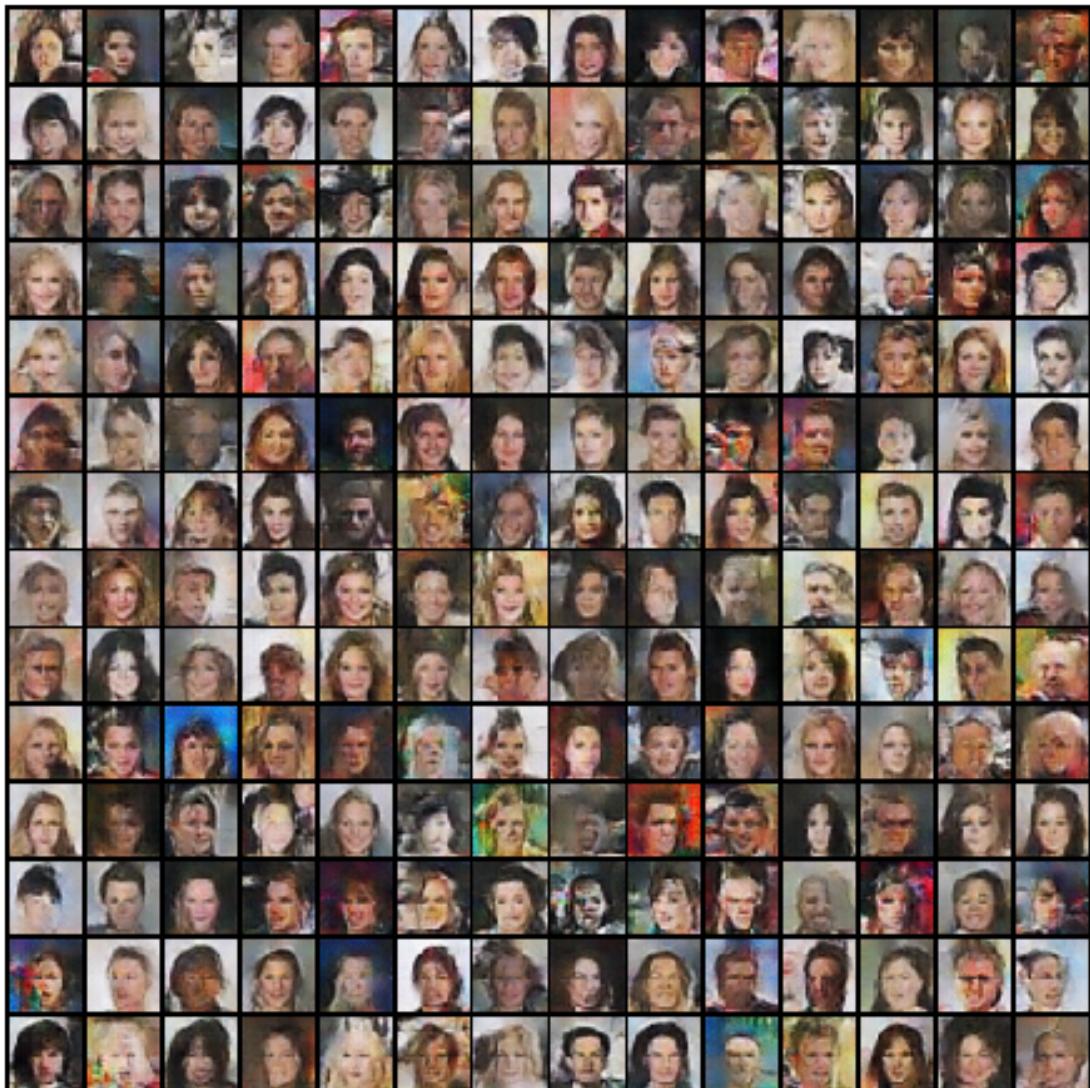
[6825/ 8000]	Loss_D: 0.6304	Loss_G: 1.1026	D(x): 0.5866	D(G(z)): 0
[6850/ 8000]	Loss_D: 0.4361	Loss_G: 1.7376	D(x): 0.7914	D(G(z)): 0
[6875/ 8000]	Loss_D: 0.3984	Loss_G: 2.8737	D(x): 0.8480	D(G(z)): 0
[6900/ 8000]	Loss_D: 0.4898	Loss_G: 1.4195	D(x): 0.6729	D(G(z)): 0



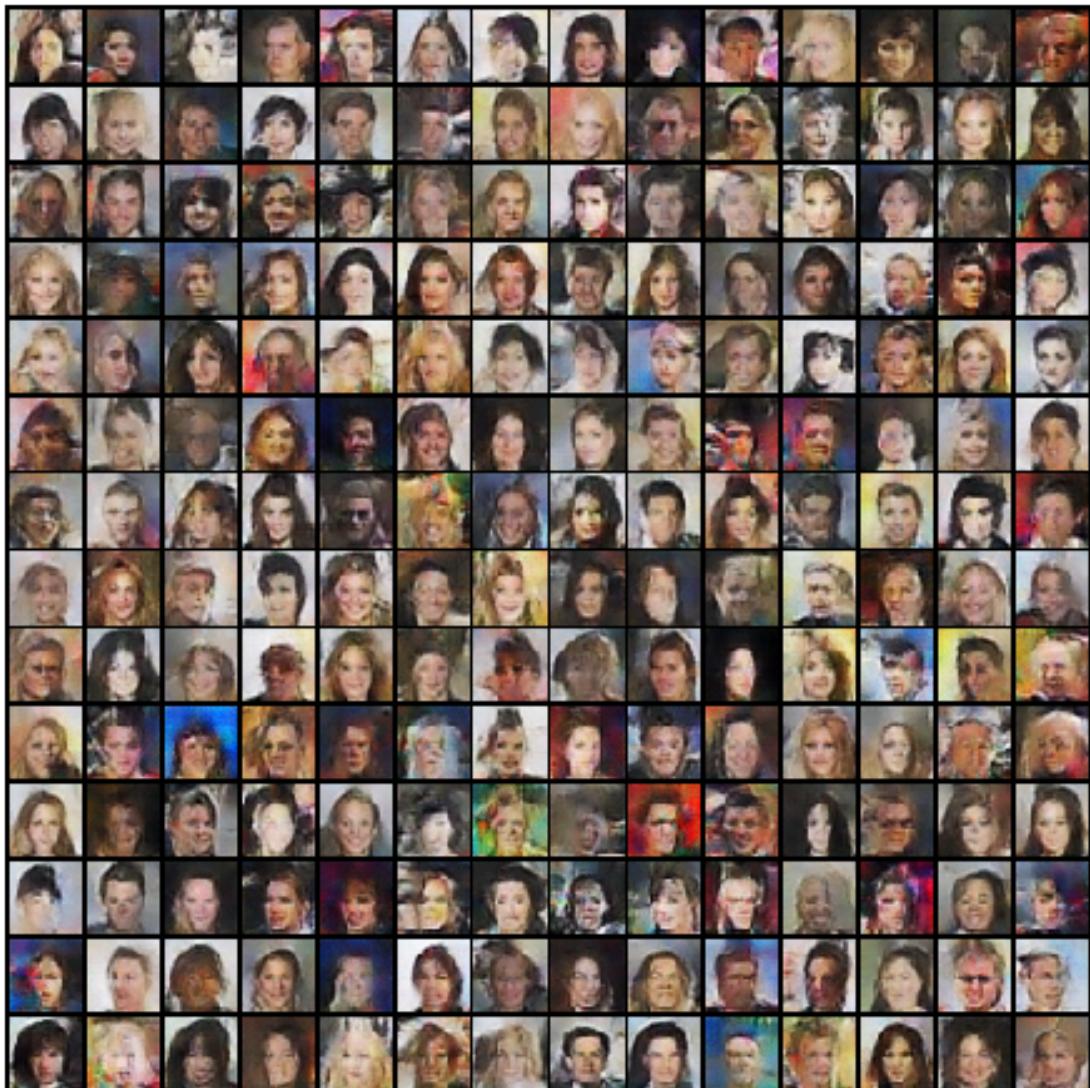
[6925/ 8000]	Loss_D: 0.6729	Loss_G: 1.8395	D(x): 0.7506	D(G(z)): 0
[6950/ 8000]	Loss_D: 0.8223	Loss_G: 1.2764	D(x): 0.5926	D(G(z)): 0
[6975/ 8000]	Loss_D: 0.4289	Loss_G: 2.0570	D(x): 0.7870	D(G(z)): 0
[7000/ 8000]	Loss_D: 0.3188	Loss_G: 2.2196	D(x): 0.8535	D(G(z)): 0



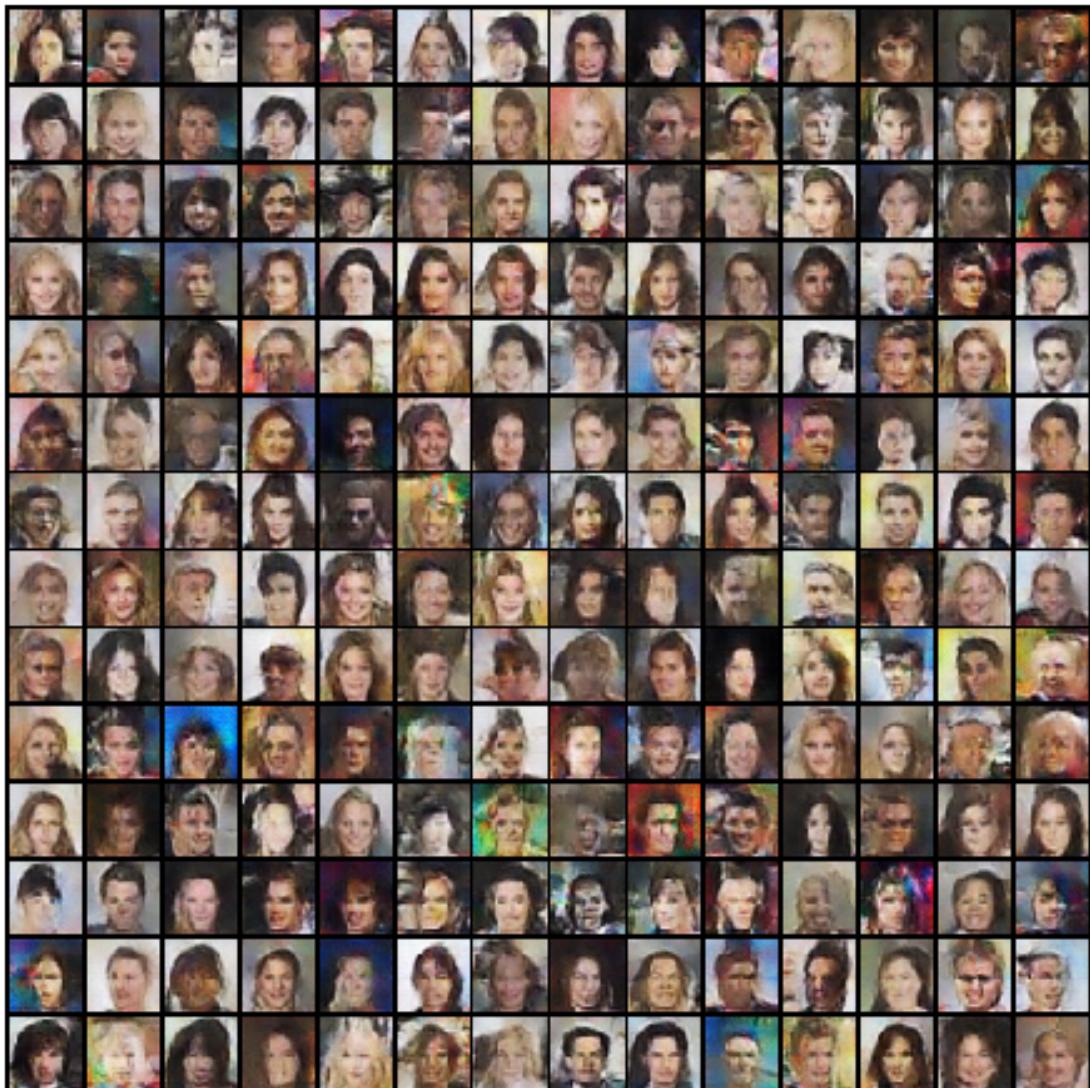
[7025/ 8000]	Loss_D: 0.4434	Loss_G: 3.1910	D(x): 0.9342	D(G(z)): 0
[7050/ 8000]	Loss_D: 0.3233	Loss_G: 2.5990	D(x): 0.9126	D(G(z)): 0
[7075/ 8000]	Loss_D: 0.5682	Loss_G: 1.3925	D(x): 0.6522	D(G(z)): 0
[7100/ 8000]	Loss_D: 1.3060	Loss_G: 0.8860	D(x): 0.3782	D(G(z)): 0



[7125/ 8000]	Loss_D: 0.3753	Loss_G: 1.9484	D(x): 0.7782	D(G(z)): 0
[7150/ 8000]	Loss_D: 0.3089	Loss_G: 2.4176	D(x): 0.8635	D(G(z)): 0
[7175/ 8000]	Loss_D: 0.3570	Loss_G: 1.8511	D(x): 0.7913	D(G(z)): 0
[7200/ 8000]	Loss_D: 1.0443	Loss_G: 0.9622	D(x): 0.4666	D(G(z)): 0



[7225/ 8000]	Loss_D: 0.2754	Loss_G: 2.8587	D(x): 0.8838	D(G(z)): 0
[7250/ 8000]	Loss_D: 0.2875	Loss_G: 1.7999	D(x): 0.8129	D(G(z)): 0
[7275/ 8000]	Loss_D: 0.2286	Loss_G: 2.6829	D(x): 0.9367	D(G(z)): 0
[7300/ 8000]	Loss_D: 0.3905	Loss_G: 2.5193	D(x): 0.8722	D(G(z)): 0



[7325/ 8000]	Loss_D: 1.6453	Loss_G: 0.4882	D(x): 0.2799	D(G(z)): 0
[7350/ 8000]	Loss_D: 0.9135	Loss_G: 2.2130	D(x): 0.8395	D(G(z)): 0
[7375/ 8000]	Loss_D: 0.8292	Loss_G: 2.6161	D(x): 0.8043	D(G(z)): 0
[7400/ 8000]	Loss_D: 1.1568	Loss_G: 1.3207	D(x): 0.4263	D(G(z)): 0



[7425/ 8000]	Loss_D: 0.4659	Loss_G: 1.9067	D(x): 0.7103	D(G(z)): 0
[7450/ 8000]	Loss_D: 0.4076	Loss_G: 1.7718	D(x): 0.7407	D(G(z)): 0
[7475/ 8000]	Loss_D: 0.6059	Loss_G: 1.6311	D(x): 0.6255	D(G(z)): 0
[7500/ 8000]	Loss_D: 0.3201	Loss_G: 3.7602	D(x): 0.9326	D(G(z)): 0



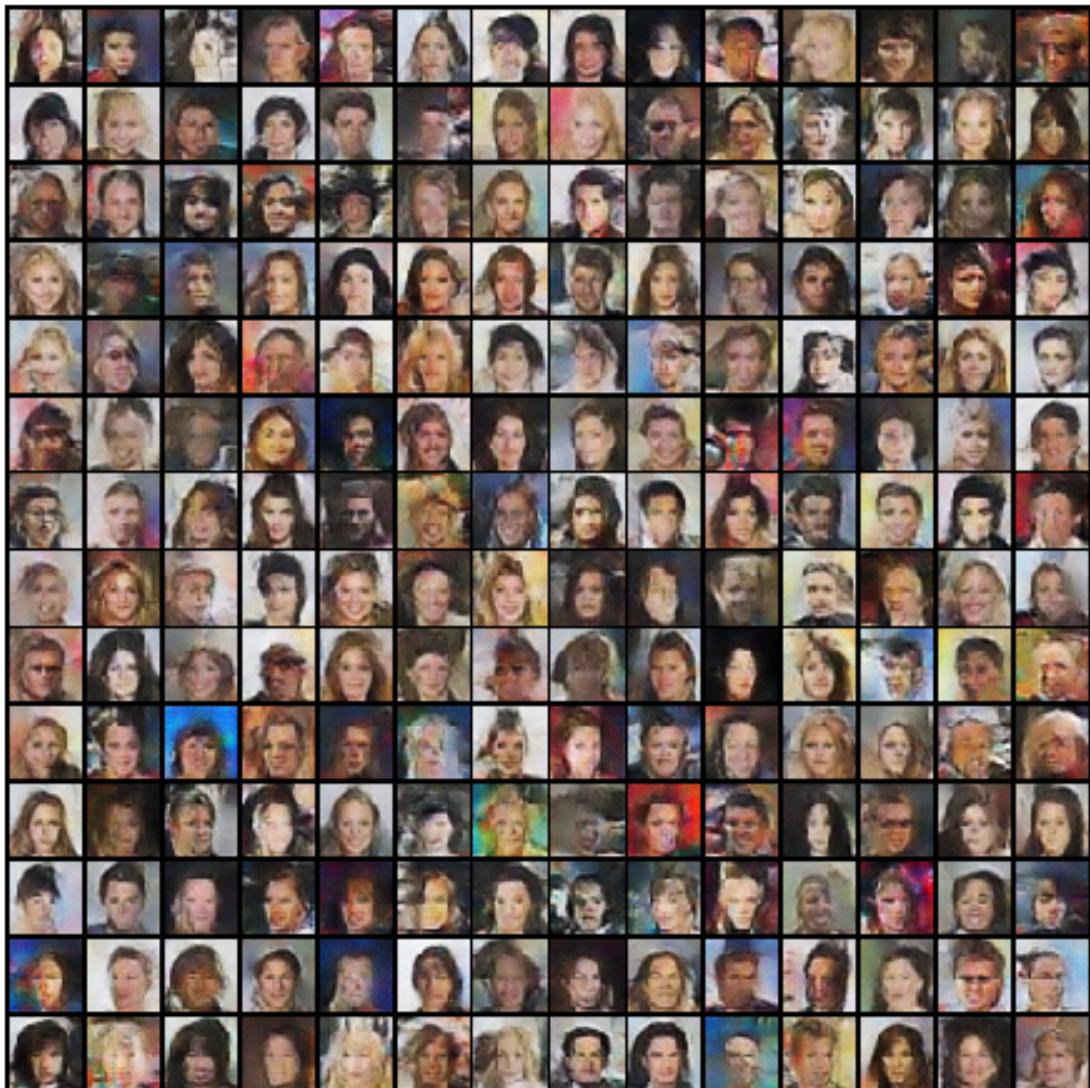
[7525/ 8000]	Loss_D: 0.3769	Loss_G: 3.4744	D(x): 0.9351	D(G(z)): 0
[7550/ 8000]	Loss_D: 0.8142	Loss_G: 4.1299	D(x): 0.9615	D(G(z)): 0
[7575/ 8000]	Loss_D: 1.9274	Loss_G: 0.2947	D(x): 0.2035	D(G(z)): 0
[7600/ 8000]	Loss_D: 1.3583	Loss_G: 2.6996	D(x): 0.9507	D(G(z)): 0



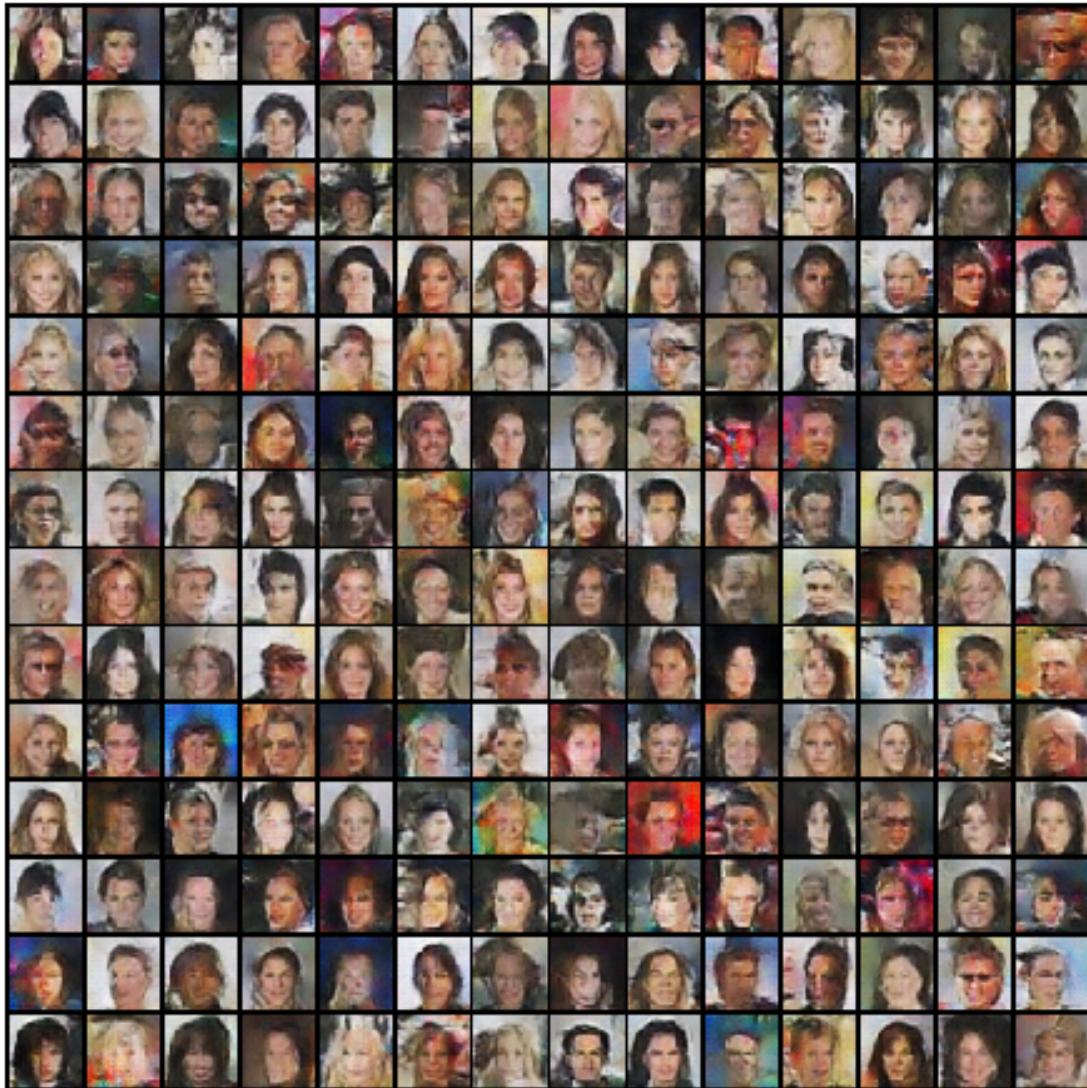
[7625/ 8000]	Loss_D: 0.4189	Loss_G: 2.5293	D(x): 0.7774	D(G(z)): 0
[7650/ 8000]	Loss_D: 0.2897	Loss_G: 2.2742	D(x): 0.8506	D(G(z)): 0
[7675/ 8000]	Loss_D: 0.3232	Loss_G: 2.8561	D(x): 0.8784	D(G(z)): 0
[7700/ 8000]	Loss_D: 0.3207	Loss_G: 2.6629	D(x): 0.9181	D(G(z)): 0



[7725/ 8000]	Loss_D: 1.0007	Loss_G: 3.3231	D(x): 0.9140	D(G(z)): 0
[7750/ 8000]	Loss_D: 0.8186	Loss_G: 1.2347	D(x): 0.5198	D(G(z)): 0
[7775/ 8000]	Loss_D: 0.5449	Loss_G: 3.0770	D(x): 0.8584	D(G(z)): 0
[7800/ 8000]	Loss_D: 0.2933	Loss_G: 2.7737	D(x): 0.9356	D(G(z)): 0



[7825/ 8000]	Loss_D: 0.2602	Loss_G: 2.6242	D(x): 0.8681	D(G(z)): 0
[7850/ 8000]	Loss_D: 0.3135	Loss_G: 2.5433	D(x): 0.9188	D(G(z)): 0
[7875/ 8000]	Loss_D: 0.9509	Loss_G: 1.8737	D(x): 0.7368	D(G(z)): 0
[7900/ 8000]	Loss_D: 0.5572	Loss_G: 3.9976	D(x): 0.9311	D(G(z)): 0



[7925/ 8000]	Loss_D: 1.6073	Loss_G: 0.6528	D(x): 0.2628	D(G(z)): 0.2628
[7950/ 8000]	Loss_D: 0.7979	Loss_G: 0.7643	D(x): 0.5375	D(G(z)): 0.5375
[7975/ 8000]	Loss_D: 1.0758	Loss_G: 1.3025	D(x): 0.4588	D(G(z)): 0.4588

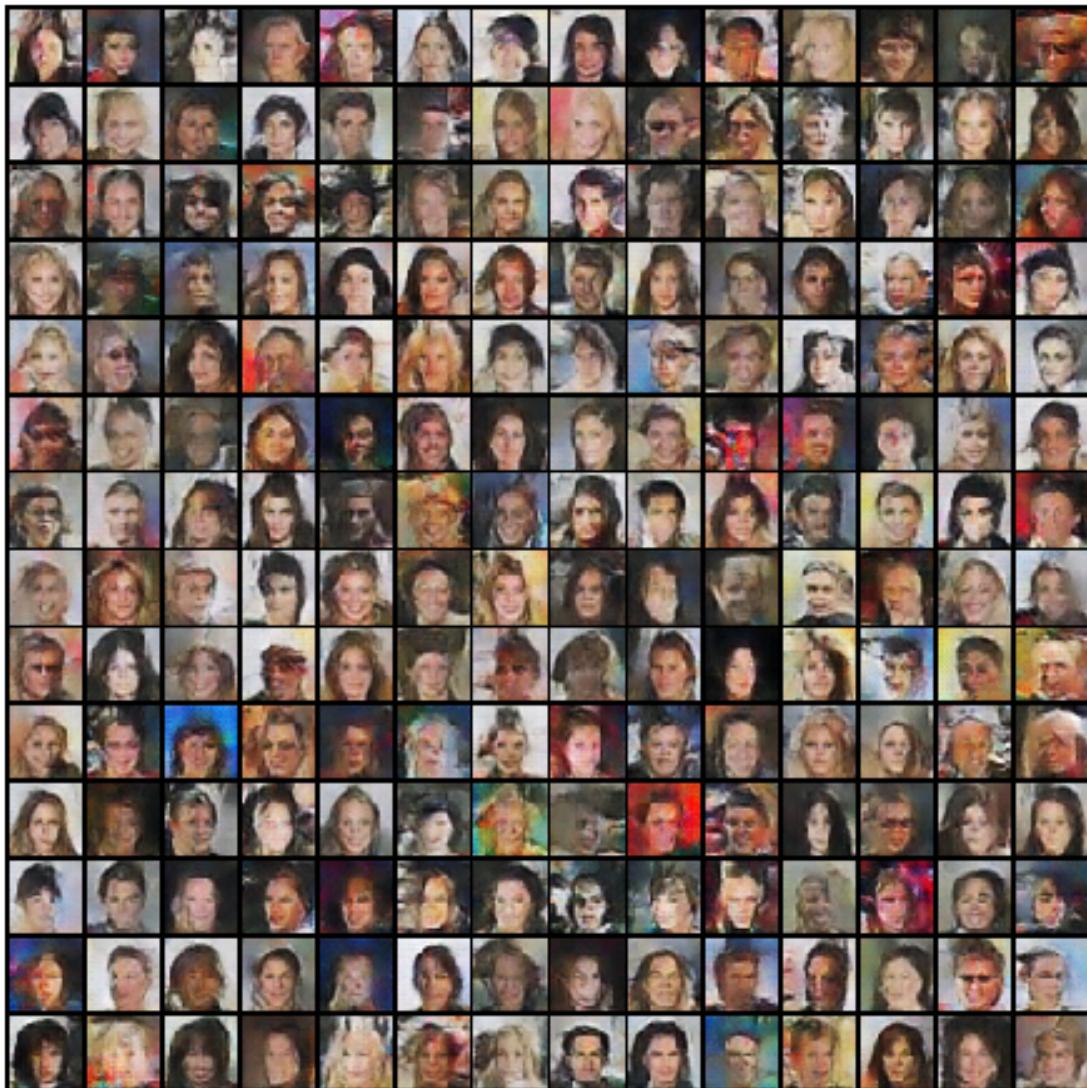
4 Display training evolution

```
In [17]: # Show generations
fig = plt.figure(figsize=(8,8))
plt.axis("off")
ims = [[plt.imshow(np.transpose(i,(1,2,0)), animated=True)] for i in img_list]
ani = animation.ArtistAnimation(fig, ims, interval=1000, repeat_delay=1000, blit=True)
```

```
HTML(ani.to_jshtml())
```

Animation size has reached 21256527 bytes, exceeding the limit of 20971520.0. If you're sure yo

Out[17]: <IPython.core.display.HTML object>



```
In [19]: # Loss evolution
plt.figure(figsize=(10,10))
plt.subplot(2,1,1)
plt.title("Generator Trainig Loss")
plt.plot(G_losses)
```

```

plt.xlabel("iterations")
plt.ylabel("Loss")

plt.subplot(2,1,2)
plt.title("Discriminator Trainig Loss")
plt.plot(D_losses)
plt.xlabel("iterations")
plt.ylabel("Loss")
plt.show()

```

