Face Generation

In this project, you'll use generative adversarial networks to generate new images of faces.

Get the Data

You'll be using two datasets in this project:

- MNIST
- CelebA

Since the celebA dataset is complex and you're doing GANs in a project for the first time, we want you to test your neural network on MNIST before CelebA. Running the GANs on MNIST will allow you to see how well your model trains sooner.

If you're using FloydHub (https://www.floydhub.com/), set `data_dir` to "/input" and use the FloydHub data ID (http://docs.floydhub.com/home/using_datasets/) "R5KrjnANiKVhLWAkpXhNBe".

```
In [1]:  data_dir = './data'

         # FloydHub - Use with data ID "R5KrjnANiKVhLWAkpXhNBe"
         data_dir = '/input'


         """
         DON'T MODIFY ANYTHING IN THIS CELL
         """
         import helper

         #helper.download_extract('mnist', data_dir)
         #helper.download_extract('celeba', data_dir)
```

Explore the Data

MNIST

As you're aware, the MNIST (http://yann.lecun.com/exdb/mnist/) dataset contains images of handwritten digits. You can view the first number of examples by changing `show_n_images`.

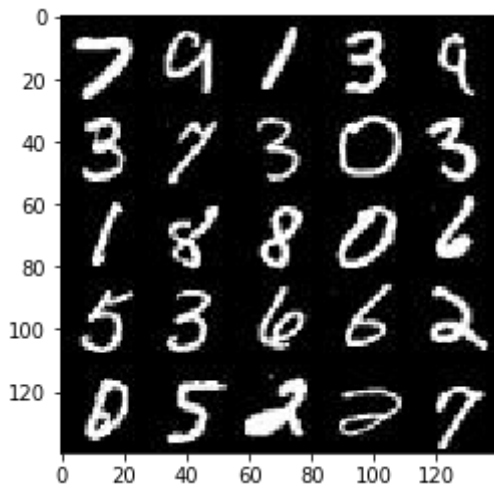In [2]:
```python
show_n_images = 25
data_dir = './data'
data_dir = '/input'
"""
DON'T MODIFY ANYTHING IN THIS CELL
"""
import helper
%matplotlib inline
import os
from glob import glob
from matplotlib import pyplot

mnist_images = helper.get_batch(glob(os.path.join(data_dir, 'mnist/*.jpg'))[:show
pyplot.imshow(helper.images_square_grid(mnist_images, 'L'), cmap='gray')
```

/usr/local/lib/python3.5/site-packages/matplotlib/font_manager.py:280: UserWarn
ing: Matplotlib is building the font cache using fc-list. This may take a momen
t.
 'Matplotlib is building the font cache using fc-list. '

Out[2]: <matplotlib.image.AxesImage at 0x7f7602a2e4a8>

CelebA

The CelebFaces Attributes Dataset (CelebA) (http://mmlab.ie.cuhk.edu.hk/projects/CelebA.html)
dataset contains over 200,000 celebrity images with annotations. Since you're going to be
generating faces, you won't need the annotations. You can view the first number of examples by
changing show_n_images.

In [3]:
```python
import helper
%matplotlib inline
import os
from glob import glob
from matplotlib import pyplot
show_n_images = 25

"""
DON'T MODIFY ANYTHING IN THIS CELL
"""
mnist_images = helper.get_batch(glob(os.path.join(data_dir, 'img_align_celeba/*.j
pyplot.imshow(helper.images_square_grid(mnist_images, 'RGB'))
```

Out[3]: <matplotlib.image.AxesImage at 0x7f760296d8d0>
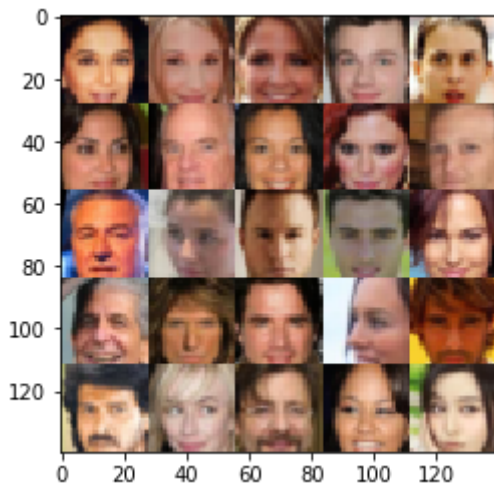
Preprocess the Data

Since the project's main focus is on building the GANs, we'll preprocess the data for you. The values of the MNIST and CelebA dataset will be in the range of -0.5 to 0.5 of 28x28 dimensional images. The CelebA images will be cropped to remove parts of the image that don't include a face, then resized down to 28x28.

The MNIST images are black and white images with a single color channel (https://en.wikipedia.org/wiki/Channel_(digital_image%29) while the CelebA images have 3 color channels (RGB color channel) (https://en.wikipedia.org/wiki/Channel_(digital_image%29#RGB_Images).

Build the Neural Network

You'll build the components necessary to build a GANs by implementing the following functions below:

- model_inputs
- discriminator
- generator
- model_loss

- model_opt
- train

Check the Version of TensorFlow and Access to GPU

This will check to make sure you have the correct version of TensorFlow and access to a GPU

In [4]:
```python
"""
DON'T MODIFY ANYTHING IN THIS CELL
"""
from distutils.version import LooseVersion
import warnings
import tensorflow as tf

# Check TensorFlow Version
assert LooseVersion(tf.__version__) >= LooseVersion('1.0'), 'Please use TensorFlo
print('TensorFlow Version: {}'.format(tf.__version__))

# Check for a GPU
if not tf.test.gpu_device_name():
    warnings.warn('No GPU found. Please use a GPU to train your neural network.')
else:
    print('Default GPU Device: {}'.format(tf.test.gpu_device_name()))
```

```
TensorFlow Version: 1.1.0
Default GPU Device: /gpu:0
```

Input

Implement the `model_inputs` function to create TF Placeholders for the Neural Network. It should create the following placeholders:

- Real input images placeholder with rank 4 using `image_width`, `image_height`, and `image_channels`.
- Z input placeholder with rank 2 using `z_dim`.
- Learning rate placeholder with rank 0.

Return the placeholders in the following the tuple (tensor of real input images, tensor of z data)

```
In [5]:  import helper
         # %matplotlib inline
         # import os
         # from glob import glob
         # from matplotlib import pyplot
         import problem_unittests as tests

         def model_inputs(image_width, image_height, image_channels, z_dim):
             """
             Create the model inputs
             :param image_width: The input image width
             :param image_height: The input image height
             :param image_channels: The number of image channels
             :param z_dim: The dimension of Z
             :return: Tuple of (tensor of real input images, tensor of z data, learning ra
             """
             # TODO: Implement Function
             input_real = tf.placeholder(tf.float32, (None,image_width, image_height, imag
             input_z = tf.placeholder(tf.float32, (None, z_dim), name="input_z")
             lr = tf.placeholder(tf.float32, name="learning_rate")

             return input_real, input_z, lr



         """
         DON'T MODIFY ANYTHING IN THIS CELL THAT IS BELOW THIS LINE
         """
         tests.test_model_inputs(model_inputs)
```

Tests Passed

Discriminator

Implement `discriminator` to create a discriminator neural network that discriminates on `images`. This function should be able to reuse the variables in the neural network. Use tf.variable_scope (https://www.tensorflow.org/api_docs/python/tf/variable_scope) with a scope name of "discriminator" to allow the variables to be reused. The function should return a tuple of (tensor output of the discriminator, tensor logits of the discriminator).

In [6]:
```python
def discriminator(images, reuse=False):
    """
    Create the discriminator network
    :param images: Tensor of input image(s)
    :param reuse: Boolean if the weights should be reused
    :return: Tuple of (tensor output of the discriminator, tensor logits of the d
    """
    alpha = 0.2
    # TODO: Implement Function
    with tf.variable_scope("discriminator", reuse=reuse):
        x1 = tf.layers.conv2d(images, 32, 5, strides=2, padding="same")
        x1 = tf.maximum(alpha*x1, x1)

        x2 = tf.layers.conv2d(x1, 64, 5, strides=2, padding="same")
        x2 = tf.layers.batch_normalization(x2, training=True)
        x2 = tf.maximum(alpha*x2, x2)

        x3 = tf.layers.conv2d(x2, 128, 5, strides=2, padding="same")
        x3 = tf.layers.batch_normalization(x3, training=True)
        x3 = tf.maximum(alpha*x3, x3)

        x4 = tf.layers.conv2d(x3, 256, 5, strides=2, padding="same")
        x4 = tf.layers.batch_normalization(x4, training=True)
        x4 = tf.maximum(alpha*x4, x4)

        x4 = tf.reshape(x3, (-1, 2*2*256))
        logits = tf.layers.dense(x4, 1)
        out = tf.sigmoid(logits)

    return out, logits

    """
    DON'T MODIFY ANYTHING IN THIS CELL THAT IS BELOW THIS LINE
    """
    tests.test_discriminator(discriminator, tf)
```

Tests Passed

Generator

Implement `generator` to generate an image using z. This function should be able to reuse the variables in the neural network. Use tf.variable_scope (https://www.tensorflow.org/api_docs/python/tf/variable_scope) with a scope name of "generator" to allow the variables to be reused. The function should return the generated 28 x 28 x out_channel_dim images.

```
In [7]:  def generator(z, out_channel_dim, is_train=True):
             """
             Create the generator network
             :param z: Input z
             :param out_channel_dim: The number of channels in the output image
             :param is_train: Boolean if generator is being used for training
             :return: The tensor output of the generator
             """
             # TODO: Implement Function
              # TODO: Implement Function
             with tf.variable_scope('generator', reuse= not is_train):
                 h1 = tf.layers.dense(z, units=4*4*512)
                 h1 = tf.reshape(h1, (-1, 4, 4, 512))
                 h1 = tf.layers.batch_normalization(h1, training=is_train)
                 h1 = tf.maximum( 0.2 * h1, h1)

                 h2 = tf.layers.conv2d_transpose(h1, filters=128, kernel_size=4, strides=1
                 h2 = tf.layers.batch_normalization(h2, training=is_train)
                 h2 = tf.maximum(0.2 * h2, h2)

                 h3 = tf.layers.conv2d_transpose(h2, filters=64, kernel_size=5, strides=2,
                 h3 = tf.layers.batch_normalization(h3, training=is_train)
                 h3 = tf.maximum(0.2 * h3, h3)

                 h3 = tf.layers.conv2d_transpose(h3, filters=32, kernel_size=5, strides=2,
                 h3 = tf.layers.batch_normalization(h3, training=is_train)
                 h3 = tf.maximum(0.2 * h3, h3)

                 logits = tf.layers.conv2d_transpose(h3, filters=out_channel_dim, kernel_s
                 out = tf.tanh(logits)

                 return out


             """
             DON'T MODIFY ANYTHING IN THIS CELL THAT IS BELOW THIS LINE
             """
             tests.test_generator(generator, tf)
```

Tests Passed

Loss

Implement `model_loss` to build the GANs for training and calculate the loss. The function should return a tuple of (discriminator loss, generator loss). Use the following functions you implemented:

- discriminator(images, reuse=False)
- generator(z, out_channel_dim, is_train=True)

```
In [8]: def model_loss(input_real, input_z, out_channel_dim):
            """
            Get the loss for the discriminator and generator
            :param input_real: Images from the real dataset
            :param input_z: Z input
            :param out_channel_dim: The number of channels in the output image
            :return: A tuple of (discriminator loss, generator loss)
            """
            # TODO: Implement Function
            gen_model = generator(input_z, out_channel_dim)
            disc_model_real, disc_logits_real = discriminator(input_real)
            disc_model_fake, disc_logits_fake = discriminator(gen_model, reuse=True)

            disc_loss_real = tf.reduce_mean(tf.nn.sigmoid_cross_entropy_with_logits(logit
                                                                                   labels
            disc_loss_fake = tf.reduce_mean(tf.nn.sigmoid_cross_entropy_with_logits(logit
                                                                                   labels
            gen_loss = tf.reduce_mean(tf.nn.sigmoid_cross_entropy_with_logits(logits=disc
                                                                             labels=tf.on

            disc_loss = disc_loss_real + disc_loss_fake

            return disc_loss, gen_loss


        """
        DON'T MODIFY ANYTHING IN THIS CELL THAT IS BELOW THIS LINE
        """
        tests.test_model_loss(model_loss)
```

Tests Passed

Optimization

Implement `model_opt` to create the optimization operations for the GANs. Use
[tf.trainable_variables (https://www.tensorflow.org/api_docs/python/tf/trainable_variables)](https://www.tensorflow.org/api_docs/python/tf/trainable_variables) to
get all the trainable variables. Filter the variables with names that are in the discriminator and
generator scope names. The function should return a tuple of (discriminator training operation,
generator training operation).

```python
In [9]: def model_opt(d_loss, g_loss, learning_rate, beta1):
            """
            Get optimization operations
            :param d_loss: Discriminator loss Tensor
            :param g_loss: Generator loss Tensor
            :param learning_rate: Learning Rate Placeholder
            :param beta1: The exponential decay rate for the 1st moment in the optimizer
            :return: A tuple of (discriminator training operation, generator training ope
            """
            # TODO: Implement Function
            train_vars = tf.trainable_variables()
            gen_vars = [x for x in train_vars if x.name.startswith('generator')]
            disc_vars = [x for x in train_vars if x.name.startswith('discriminator')]
            with tf.control_dependencies(tf.get_collection(tf.GraphKeys.UPDATE_OPS)):
                disc_train_opt = tf.train.AdamOptimizer(learning_rate=learning_rate, beta
                gen_train_opt = tf.train.AdamOptimizer(learning_rate=learning_rate, beta1


            return disc_train_opt, gen_train_opt



        """
        DON'T MODIFY ANYTHING IN THIS CELL THAT IS BELOW THIS LINE
        """
        tests.test_model_opt(model_opt, tf)
```

Tests Passed

Neural Network Training

Show Output

Use this function to show the current output of the generator during training. It will help you determine how well the GANs is training.

In [10]:
```python
"""
DON'T MODIFY ANYTHING IN THIS CELL
"""
import numpy as np

def show_generator_output(sess, n_images, input_z, out_channel_dim, image_mode):
    """
    Show example output for the generator
    :param sess: TensorFlow session
    :param n_images: Number of Images to display
    :param input_z: Input Z Tensor
    :param out_channel_dim: The number of channels in the output image
    :param image_mode: The mode to use for images ("RGB" or "L")
    """
    cmap = None if image_mode == 'RGB' else 'gray'
    z_dim = input_z.get_shape().as_list()[-1]
    example_z = np.random.uniform(-1, 1, size=[n_images, z_dim])

    samples = sess.run(
        generator(input_z, out_channel_dim, False),
        feed_dict={input_z: example_z})

    images_grid = helper.images_square_grid(samples, image_mode)
    pyplot.imshow(images_grid, cmap=cmap)
    pyplot.show()
```

Train

Implement `train` to build and train the GANs. Use the following functions you implemented:

- `model_inputs(image_width, image_height, image_channels, z_dim)`
- `model_loss(input_real, input_z, out_channel_dim)`
- `model_opt(d_loss, g_loss, learning_rate, beta1)`

Use the `show_generator_output` to show generator output while you train. Running `show_generator_output` for every batch will drastically increase training time and increase the size of the notebook. It's recommended to print the `generator` output every 100 batches.

In [11]:
```python
def train(epoch_count, batch_size, z_dim, learning_rate, beta1, get_batches, data
    """
    Train the GAN
    :param epoch_count: Number of epochs
    :param batch_size: Batch Size
    :param z_dim: Z dimension
    :param learning_rate: Learning Rate
    :param beta1: The exponential decay rate for the 1st moment in the optimizer
    :param get_batches: Function to get batches
    :param data_shape: Shape of the data
    :param data_image_mode: The image mode to use for images ("RGB" or "L")
    """
    # TODO: Build Model
    print_every = 10
    show_every = 100
    step = 0

    samples, width, height, channels = data_shape

    input_real, input_z, lr = model_inputs(width, height, channels, z_dim)
    d_loss, g_loss = model_loss(input_real, input_z, channels)
    d_train_opt, g_train_opt = model_opt(d_loss, g_loss, lr, beta1)

    saver = tf.train.Saver()

    steps = 0

    with tf.Session() as sess:
        sess.run(tf.global_variables_initializer())
        for epoch_i in range(epoch_count):
            for batch_images in get_batches(batch_size):
                # TODO: Train Model


                # Sample random noise for G
                batch_z = np.random.uniform(-1, 1, size=(batch_size, z_dim))
                batch_images = batch_images * 2.0

                # Run optimizers
                sess.run(d_train_opt, feed_dict={input_real: batch_images, input_
                sess.run(g_train_opt, feed_dict={input_real: batch_images, input_

                steps += 1
                if steps % print_every == 0:
                    # At the end of each epoch, get the losses and print them out
                    train_loss_d = d_loss.eval({input_real: batch_images, input_z
                    train_loss_g = g_loss.eval({input_real: batch_images, input_z

                    print("Epoch {}/{}...".format(epoch_i+1, epoch_count),
                          "Discriminator Loss: {:.4f}...".format(train_loss_d),
                          "Generator Loss: {:.4f}".format(train_loss_g))

                    if steps % show_every == 0:
                        show_generator_output(sess, 16, input_z, channels, data_image
```

MNIST

Test your GANs architecture on MNIST. After 2 epochs, the GANs should be able to generate images that look like handwritten digits. Make sure the loss of the generator is lower than the loss of the discriminator or close to 0.

```
In [ ]: batch_size = 64
        z_dim = 128
        learning_rate = 0.0001
        beta1 = 0.4

        """
        DON'T MODIFY ANYTHING IN THIS CELL THAT IS BELOW THIS LINE
        """
        epochs = 2

        mnist_dataset = helper.Dataset('mnist', glob(os.path.join(data_dir, 'mnist/*.jpg'
        with tf.Graph().as_default():
            train(epochs, batch_size, z_dim, learning_rate, beta1, mnist_dataset.get_batc
                  mnist_dataset.shape, mnist_dataset.image_mode)
```
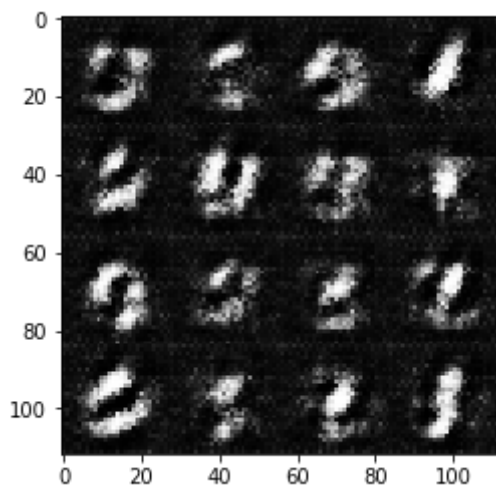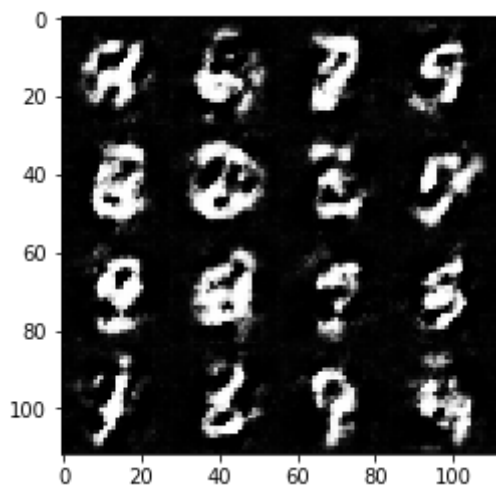
```
Epoch 1/2... Discriminator Loss: 2.0293... Generator Loss: 0.3265
Epoch 1/2... Discriminator Loss: 1.6737... Generator Loss: 0.4930
Epoch 1/2... Discriminator Loss: 1.4583... Generator Loss: 0.6595
Epoch 1/2... Discriminator Loss: 1.3904... Generator Loss: 0.6813
Epoch 1/2... Discriminator Loss: 1.5180... Generator Loss: 0.6500
Epoch 1/2... Discriminator Loss: 1.6531... Generator Loss: 0.6850
Epoch 1/2... Discriminator Loss: 1.4031... Generator Loss: 0.8199
Epoch 1/2... Discriminator Loss: 1.3363... Generator Loss: 0.8602
Epoch 1/2... Discriminator Loss: 1.2485... Generator Loss: 0.9827
Epoch 1/2... Discriminator Loss: 1.2024... Generator Loss: 1.0280
```
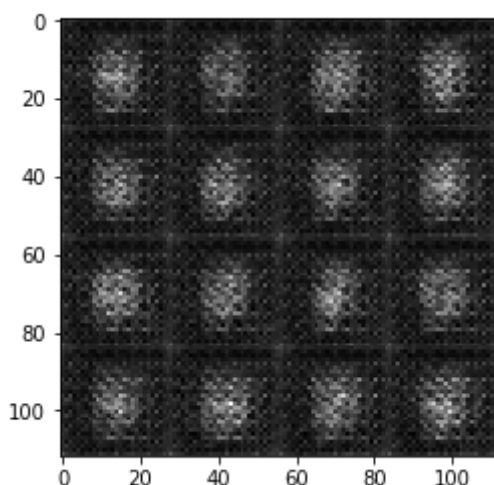


```
Epoch 1/2... Discriminator Loss: 0.9760... Generator Loss: 1.2099
Epoch 1/2... Discriminator Loss: 1.0000... Generator Loss: 1.1496
Epoch 1/2... Discriminator Loss: 0.9610... Generator Loss: 1.1155
Epoch 1/2... Discriminator Loss: 1.1198... Generator Loss: 0.9198
Epoch 1/2... Discriminator Loss: 1.3573... Generator Loss: 0.8666
Epoch 1/2... Discriminator Loss: 1.3250... Generator Loss: 0.8690
Epoch 1/2... Discriminator Loss: 1.3072... Generator Loss: 0.8701
Epoch 1/2... Discriminator Loss: 1.1633... Generator Loss: 1.0007
Epoch 1/2... Discriminator Loss: 1.3346... Generator Loss: 0.8302
Epoch 1/2... Discriminator Loss: 1.2674... Generator Loss: 0.9082
```
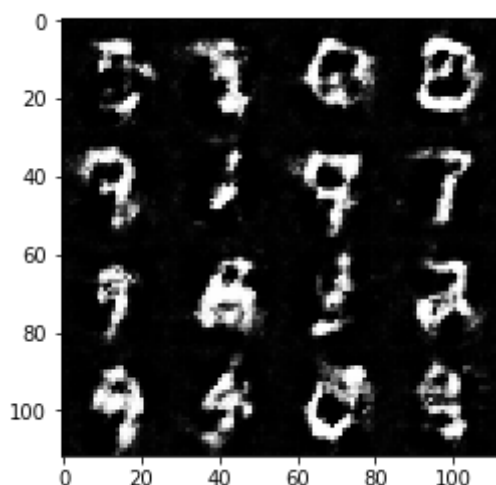
```
Epoch 1/2... Discriminator Loss: 1.3439... Generator Loss: 0.8249
Epoch 1/2... Discriminator Loss: 1.3525... Generator Loss: 0.8653
Epoch 1/2... Discriminator Loss: 1.2516... Generator Loss: 0.8952
Epoch 1/2... Discriminator Loss: 1.3492... Generator Loss: 0.8249
Epoch 1/2... Discriminator Loss: 1.2470... Generator Loss: 0.9091
Epoch 1/2... Discriminator Loss: 1.3426... Generator Loss: 0.8448
Epoch 1/2... Discriminator Loss: 1.2635... Generator Loss: 0.8865
Epoch 1/2... Discriminator Loss: 1.2306... Generator Loss: 0.8543
Epoch 1/2... Discriminator Loss: 1.2890... Generator Loss: 0.8624
Epoch 1/2... Discriminator Loss: 1.2369... Generator Loss: 0.9487
```
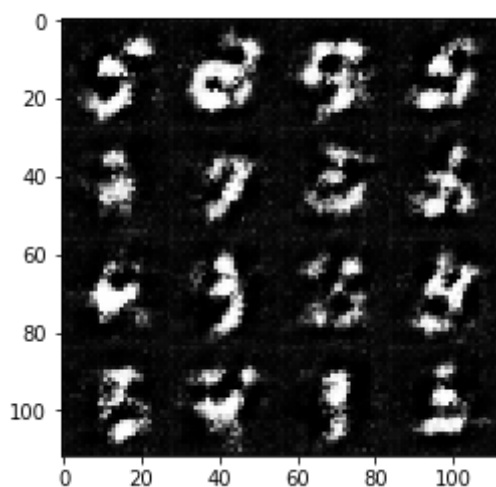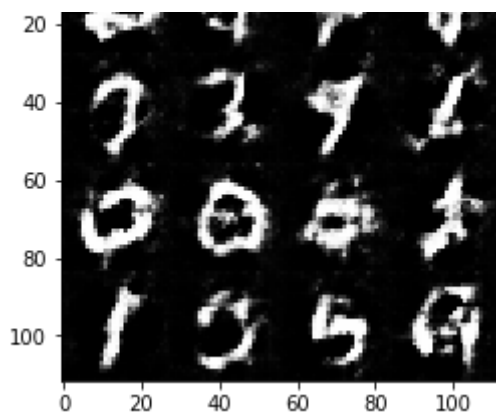


```
Epoch 1/2... Discriminator Loss: 1.2642... Generator Loss: 0.8529
Epoch 1/2... Discriminator Loss: 1.2591... Generator Loss: 0.9158
Epoch 1/2... Discriminator Loss: 1.2470... Generator Loss: 0.8648
Epoch 1/2... Discriminator Loss: 1.2975... Generator Loss: 0.6958
Epoch 1/2... Discriminator Loss: 1.2328... Generator Loss: 0.9644
Epoch 1/2... Discriminator Loss: 1.2255... Generator Loss: 1.0293
Epoch 1/2... Discriminator Loss: 1.2318... Generator Loss: 0.8874
Epoch 1/2... Discriminator Loss: 1.2810... Generator Loss: 0.7328
Epoch 1/2... Discriminator Loss: 1.2214... Generator Loss: 0.8558
Epoch 1/2... Discriminator Loss: 1.4092... Generator Loss: 0.5083
```
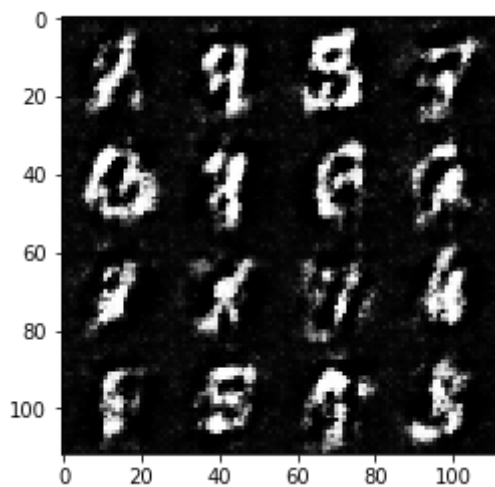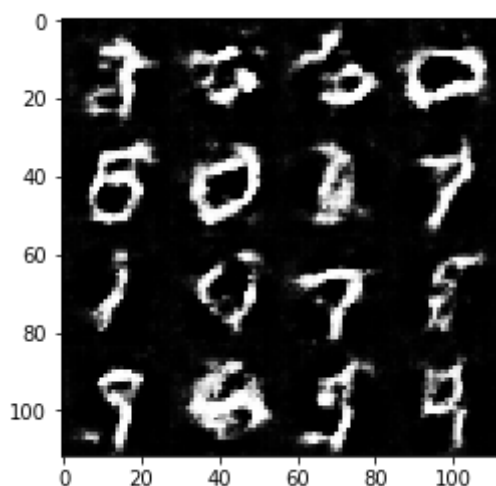
```
Epoch 1/2... Discriminator Loss: 1.1525... Generator Loss: 0.9878
Epoch 1/2... Discriminator Loss: 1.3062... Generator Loss: 0.6424
Epoch 1/2... Discriminator Loss: 1.3109... Generator Loss: 0.9210
Epoch 1/2... Discriminator Loss: 1.1606... Generator Loss: 0.8572
Epoch 1/2... Discriminator Loss: 1.2614... Generator Loss: 0.7236
Epoch 1/2... Discriminator Loss: 1.2121... Generator Loss: 0.8235
Epoch 1/2... Discriminator Loss: 1.1400... Generator Loss: 1.1432
Epoch 1/2... Discriminator Loss: 1.1784... Generator Loss: 0.8029
Epoch 1/2... Discriminator Loss: 1.1636... Generator Loss: 0.9995
Epoch 1/2... Discriminator Loss: 1.1611... Generator Loss: 0.8141
```
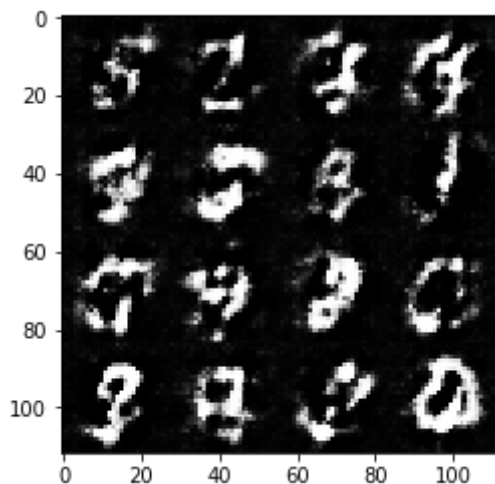


```
Epoch 1/2... Discriminator Loss: 1.2817... Generator Loss: 0.6463
Epoch 1/2... Discriminator Loss: 1.1232... Generator Loss: 0.9502
Epoch 1/2... Discriminator Loss: 1.1003... Generator Loss: 1.2196
Epoch 1/2... Discriminator Loss: 1.2422... Generator Loss: 0.6762
Epoch 1/2... Discriminator Loss: 1.2132... Generator Loss: 0.7801
Epoch 1/2... Discriminator Loss: 1.1523... Generator Loss: 0.8821
Epoch 1/2... Discriminator Loss: 1.1277... Generator Loss: 0.8663
Epoch 1/2... Discriminator Loss: 1.1015... Generator Loss: 1.1076
Epoch 1/2... Discriminator Loss: 1.1490... Generator Loss: 0.7873
Epoch 1/2... Discriminator Loss: 1.0981... Generator Loss: 0.8181
```
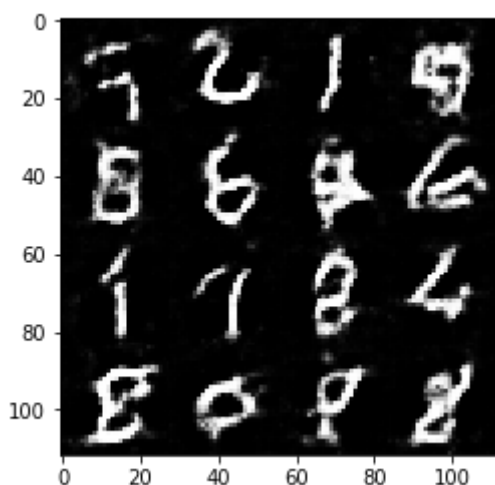
```
Epoch 1/2... Discriminator Loss: 1.1043... Generator Loss: 1.1957
Epoch 1/2... Discriminator Loss: 1.0923... Generator Loss: 0.9899
Epoch 1/2... Discriminator Loss: 1.1522... Generator Loss: 0.8017
Epoch 1/2... Discriminator Loss: 1.1686... Generator Loss: 0.7197
Epoch 1/2... Discriminator Loss: 1.1983... Generator Loss: 0.7875
Epoch 1/2... Discriminator Loss: 1.2445... Generator Loss: 1.4444
Epoch 1/2... Discriminator Loss: 1.0901... Generator Loss: 1.0018
Epoch 1/2... Discriminator Loss: 1.1734... Generator Loss: 0.7231
Epoch 1/2... Discriminator Loss: 1.3750... Generator Loss: 1.5179
Epoch 1/2... Discriminator Loss: 1.1757... Generator Loss: 1.0920
```



```
Epoch 1/2... Discriminator Loss: 1.1637... Generator Loss: 0.7634
Epoch 1/2... Discriminator Loss: 1.0785... Generator Loss: 1.1904
Epoch 1/2... Discriminator Loss: 1.1388... Generator Loss: 0.8683
Epoch 1/2... Discriminator Loss: 1.2117... Generator Loss: 0.8841
Epoch 1/2... Discriminator Loss: 1.2141... Generator Loss: 0.8927
Epoch 1/2... Discriminator Loss: 1.1998... Generator Loss: 1.0054
Epoch 1/2... Discriminator Loss: 1.2139... Generator Loss: 0.9954
Epoch 1/2... Discriminator Loss: 1.1937... Generator Loss: 0.7767
Epoch 1/2... Discriminator Loss: 1.2478... Generator Loss: 0.7228
Epoch 1/2... Discriminator Loss: 1.2261... Generator Loss: 1.2517
```
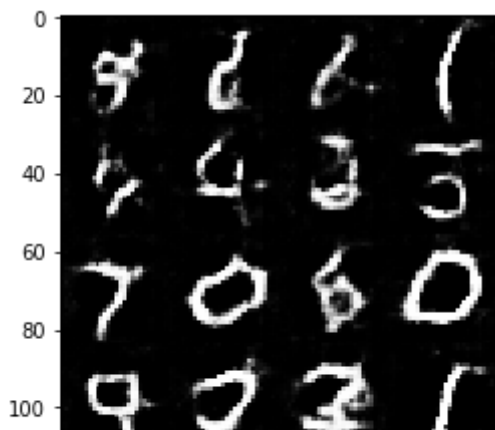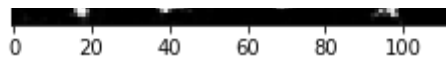
```
Epoch 1/2... Discriminator Loss: 1.2347... Generator Loss: 1.1126
Epoch 1/2... Discriminator Loss: 1.1868... Generator Loss: 1.1061
Epoch 1/2... Discriminator Loss: 1.1991... Generator Loss: 1.0689
Epoch 1/2... Discriminator Loss: 1.2392... Generator Loss: 0.7115
Epoch 1/2... Discriminator Loss: 1.2257... Generator Loss: 0.8076
Epoch 1/2... Discriminator Loss: 1.3041... Generator Loss: 0.6475
Epoch 1/2... Discriminator Loss: 1.2089... Generator Loss: 0.8073
Epoch 1/2... Discriminator Loss: 1.2149... Generator Loss: 1.0391
Epoch 1/2... Discriminator Loss: 1.3019... Generator Loss: 0.6708
Epoch 1/2... Discriminator Loss: 1.3320... Generator Loss: 0.6451
```



```
Epoch 1/2... Discriminator Loss: 1.2652... Generator Loss: 1.1518
Epoch 1/2... Discriminator Loss: 1.1743... Generator Loss: 1.1729
Epoch 1/2... Discriminator Loss: 1.2985... Generator Loss: 0.7313
Epoch 2/2... Discriminator Loss: 1.2093... Generator Loss: 0.9646
Epoch 2/2... Discriminator Loss: 1.2126... Generator Loss: 1.1082
Epoch 2/2... Discriminator Loss: 1.1964... Generator Loss: 0.9898
Epoch 2/2... Discriminator Loss: 1.2032... Generator Loss: 0.8193
Epoch 2/2... Discriminator Loss: 1.2617... Generator Loss: 0.6330
Epoch 2/2... Discriminator Loss: 1.1889... Generator Loss: 1.1036
Epoch 2/2... Discriminator Loss: 1.2777... Generator Loss: 0.8375
```
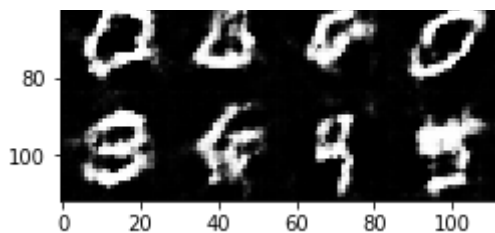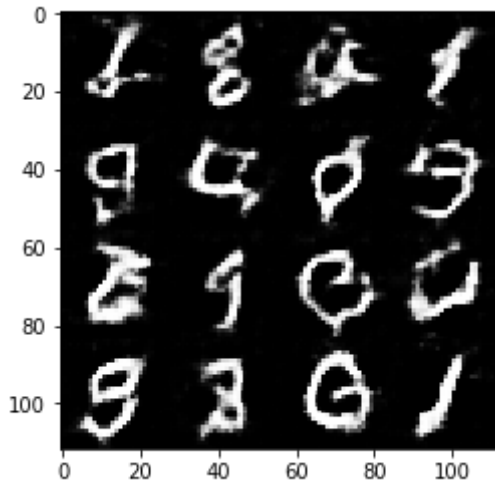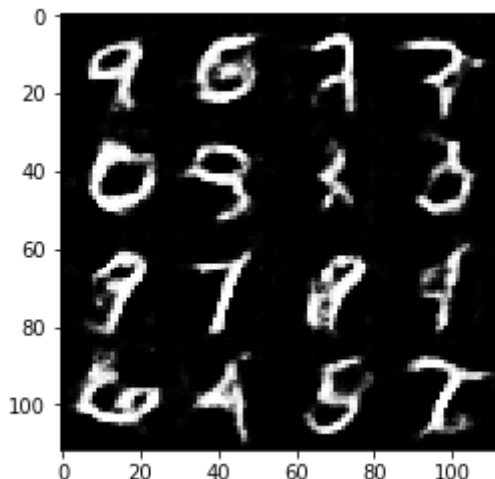
```
Epoch 2/2... Discriminator Loss: 1.2470... Generator Loss: 1.0280
Epoch 2/2... Discriminator Loss: 1.2486... Generator Loss: 0.7429
Epoch 2/2... Discriminator Loss: 1.2461... Generator Loss: 0.8131
Epoch 2/2... Discriminator Loss: 1.2183... Generator Loss: 1.0352
Epoch 2/2... Discriminator Loss: 1.2224... Generator Loss: 0.8664
Epoch 2/2... Discriminator Loss: 1.2866... Generator Loss: 0.7849
Epoch 2/2... Discriminator Loss: 1.2491... Generator Loss: 0.8811
Epoch 2/2... Discriminator Loss: 1.2401... Generator Loss: 0.8430
Epoch 2/2... Discriminator Loss: 1.3646... Generator Loss: 1.1929
Epoch 2/2... Discriminator Loss: 1.3378... Generator Loss: 0.6528
```



```
Epoch 2/2... Discriminator Loss: 1.2285... Generator Loss: 1.0087
Epoch 2/2... Discriminator Loss: 1.2480... Generator Loss: 0.7374
Epoch 2/2... Discriminator Loss: 1.2229... Generator Loss: 0.8391
Epoch 2/2... Discriminator Loss: 1.2770... Generator Loss: 0.6674
Epoch 2/2... Discriminator Loss: 1.3067... Generator Loss: 0.7926
Epoch 2/2... Discriminator Loss: 1.1663... Generator Loss: 0.9593
Epoch 2/2... Discriminator Loss: 1.2391... Generator Loss: 0.9785
Epoch 2/2... Discriminator Loss: 1.3064... Generator Loss: 0.8609
Epoch 2/2... Discriminator Loss: 1.3412... Generator Loss: 0.6076
Epoch 2/2... Discriminator Loss: 1.2365... Generator Loss: 0.9989
```
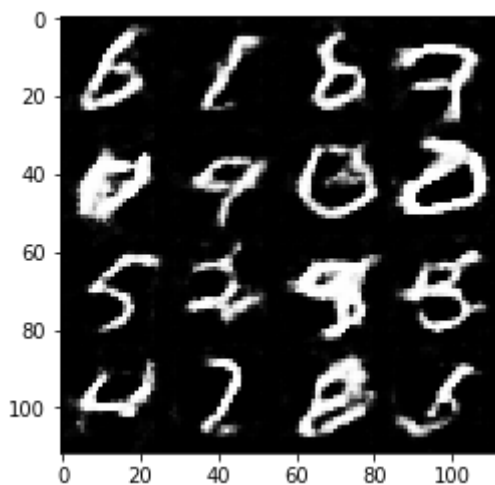
```
Epoch 2/2... Discriminator Loss: 1.2447... Generator Loss: 0.6972
Epoch 2/2... Discriminator Loss: 1.2238... Generator Loss: 0.7975
Epoch 2/2... Discriminator Loss: 1.2949... Generator Loss: 0.7359
Epoch 2/2... Discriminator Loss: 1.2959... Generator Loss: 0.6493
Epoch 2/2... Discriminator Loss: 1.2049... Generator Loss: 1.1020
Epoch 2/2... Discriminator Loss: 1.2959... Generator Loss: 1.1588
Epoch 2/2... Discriminator Loss: 1.2451... Generator Loss: 0.6959
Epoch 2/2... Discriminator Loss: 1.2687... Generator Loss: 0.9215
Epoch 2/2... Discriminator Loss: 1.3711... Generator Loss: 0.5947
Epoch 2/2... Discriminator Loss: 1.3039... Generator Loss: 0.6432
```
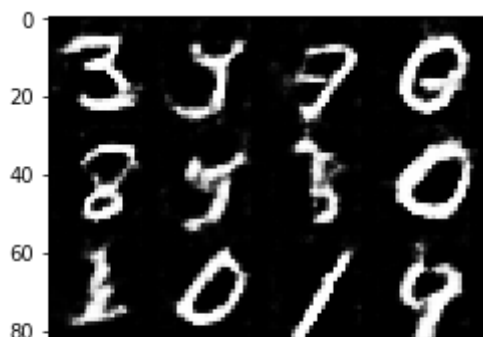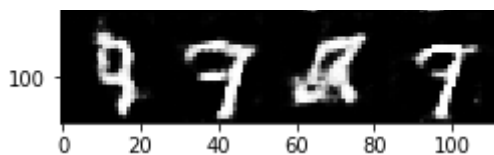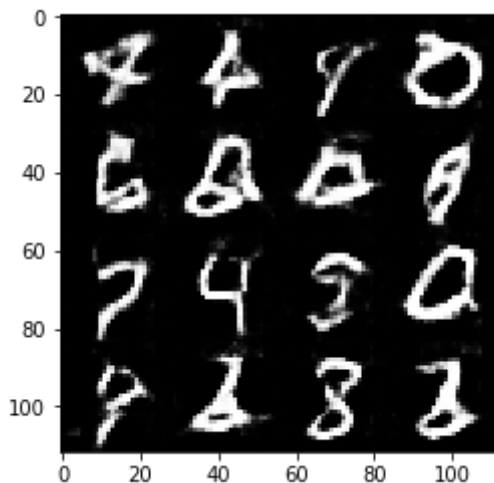


```
Epoch 2/2... Discriminator Loss: 1.3257... Generator Loss: 0.6073
Epoch 2/2... Discriminator Loss: 1.2230... Generator Loss: 0.9454
Epoch 2/2... Discriminator Loss: 1.2161... Generator Loss: 1.0956
Epoch 2/2... Discriminator Loss: 1.2443... Generator Loss: 1.1725
Epoch 2/2... Discriminator Loss: 1.2459... Generator Loss: 0.8616
Epoch 2/2... Discriminator Loss: 1.2758... Generator Loss: 0.6150

Epoch 2/2... Discriminator Loss: 1.2276... Generator Loss: 1.0859
Epoch 2/2... Discriminator Loss: 1.2365... Generator Loss: 0.6683
Epoch 2/2... Discriminator Loss: 1.2010... Generator Loss: 0.8514
Epoch 2/2... Discriminator Loss: 1.2725... Generator Loss: 0.9490
```



```
Epoch 2/2... Discriminator Loss: 1.2418... Generator Loss: 1.0516
Epoch 2/2... Discriminator Loss: 1.1929... Generator Loss: 0.8043
```
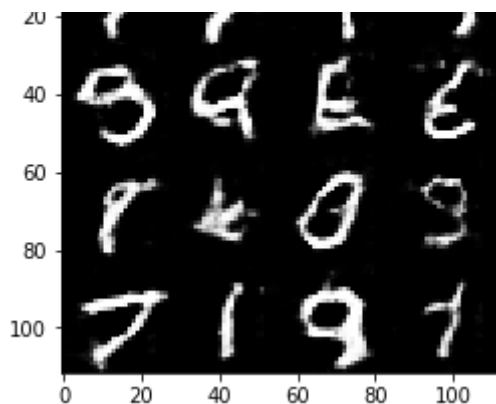
```
Epoch 2/2... Discriminator Loss: 1.2341... Generator Loss: 0.8045
Epoch 2/2... Discriminator Loss: 1.2967... Generator Loss: 0.6855
Epoch 2/2... Discriminator Loss: 1.2126... Generator Loss: 0.8611
Epoch 2/2... Discriminator Loss: 1.2330... Generator Loss: 0.7154
Epoch 2/2... Discriminator Loss: 1.1540... Generator Loss: 1.0946
Epoch 2/2... Discriminator Loss: 1.3161... Generator Loss: 0.7068
Epoch 2/2... Discriminator Loss: 1.3501... Generator Loss: 0.7930
Epoch 2/2... Discriminator Loss: 1.1886... Generator Loss: 1.1267
```



```
Epoch 2/2... Discriminator Loss: 1.2802... Generator Loss: 0.6608
Epoch 2/2... Discriminator Loss: 1.2436... Generator Loss: 0.7399
Epoch 2/2... Discriminator Loss: 1.2157... Generator Loss: 0.9591
Epoch 2/2... Discriminator Loss: 1.2725... Generator Loss: 0.6566
Epoch 2/2... Discriminator Loss: 1.2540... Generator Loss: 0.7256
Epoch 2/2... Discriminator Loss: 1.2039... Generator Loss: 0.7086
Epoch 2/2... Discriminator Loss: 1.2304... Generator Loss: 0.8012
Epoch 2/2... Discriminator Loss: 1.2852... Generator Loss: 0.7730
Epoch 2/2... Discriminator Loss: 1.3883... Generator Loss: 1.2379
Epoch 2/2... Discriminator Loss: 1.2499... Generator Loss: 0.7568
```

```
Epoch 2/2... Discriminator Loss: 1.2836... Generator Loss: 1.1104
Epoch 2/2... Discriminator Loss: 1.2564... Generator Loss: 0.7884
Epoch 2/2... Discriminator Loss: 1.1693... Generator Loss: 0.9290
Epoch 2/2... Discriminator Loss: 1.2432... Generator Loss: 0.6960
Epoch 2/2... Discriminator Loss: 1.3100... Generator Loss: 0.6873
Epoch 2/2... Discriminator Loss: 1.2347... Generator Loss: 1.2478
Epoch 2/2... Discriminator Loss: 1.1658... Generator Loss: 0.9704
Epoch 2/2... Discriminator Loss: 1.2306... Generator Loss: 0.7326
Epoch 2/2... Discriminator Loss: 1.4219... Generator Loss: 0.5037
Epoch 2/2... Discriminator Loss: 1.1451... Generator Loss: 0.9181
```



```
Epoch 2/2... Discriminator Loss: 1.3078... Generator Loss: 0.6088
Epoch 2/2... Discriminator Loss: 1.1617... Generator Loss: 0.8936
Epoch 2/2... Discriminator Loss: 1.1815... Generator Loss: 0.9299
Epoch 2/2... Discriminator Loss: 1.2081... Generator Loss: 0.9479
Epoch 2/2... Discriminator Loss: 1.3292... Generator Loss: 0.6807
Epoch 2/2... Discriminator Loss: 1.2022... Generator Loss: 1.1138
Epoch 2/2... Discriminator Loss: 1.2346... Generator Loss: 0.6751
Epoch 2/2... Discriminator Loss: 1.2257... Generator Loss: 0.9417
Epoch 2/2... Discriminator Loss: 1.2200... Generator Loss: 0.9528
Epoch 2/2... Discriminator Loss: 1.1737... Generator Loss: 1.0289
```

```
Epoch 2/2... Discriminator Loss: 1.2048... Generator Loss: 1.1987
Epoch 2/2... Discriminator Loss: 1.2436... Generator Loss: 0.7749
Epoch 2/2... Discriminator Loss: 1.1692... Generator Loss: 0.8375
Epoch 2/2... Discriminator Loss: 1.2293... Generator Loss: 0.7227
Epoch 2/2... Discriminator Loss: 1.1839... Generator Loss: 1.0156
Epoch 2/2... Discriminator Loss: 1.1914... Generator Loss: 0.7293
Epoch 2/2... Discriminator Loss: 1.2722... Generator Loss: 0.7451
```

CelebA

Run your GANs on CelebA. It will take around 20 minutes on the average GPU to run one epoch. You can run the whole epoch or stop when it starts to generate realistic faces.

```
In [13]: batch_size = 64
         z_dim = 100
         learning_rate = 0.0005
         beta1 = 0.1


         """
         DON'T MODIFY ANYTHING IN THIS CELL THAT IS BELOW THIS LINE
         """
         epochs = 1

         celeba_dataset = helper.Dataset('celeba', glob(os.path.join(data_dir, 'img_align_
         with tf.Graph().as_default():
             train(epochs, batch_size, z_dim, learning_rate, beta1, celeba_dataset.get_bat
                   celeba_dataset.shape, celeba_dataset.image_mode)
```

```
Epoch 1/1... Discriminator Loss: 1.0075... Generator Loss: 1.9114
Epoch 1/1... Discriminator Loss: 1.2263... Generator Loss: 3.2585
Epoch 1/1... Discriminator Loss: 1.6704... Generator Loss: 5.1184
Epoch 1/1... Discriminator Loss: 1.5163... Generator Loss: 2.4485
Epoch 1/1... Discriminator Loss: 1.2493... Generator Loss: 2.2407
Epoch 1/1... Discriminator Loss: 1.3296... Generator Loss: 1.0225
Epoch 1/1... Discriminator Loss: 1.3088... Generator Loss: 1.0063
Epoch 1/1... Discriminator Loss: 1.8890... Generator Loss: 1.4383
Epoch 1/1... Discriminator Loss: 1.3384... Generator Loss: 0.9578
Epoch 1/1... Discriminator Loss: 1.3457... Generator Loss: 0.9417
```
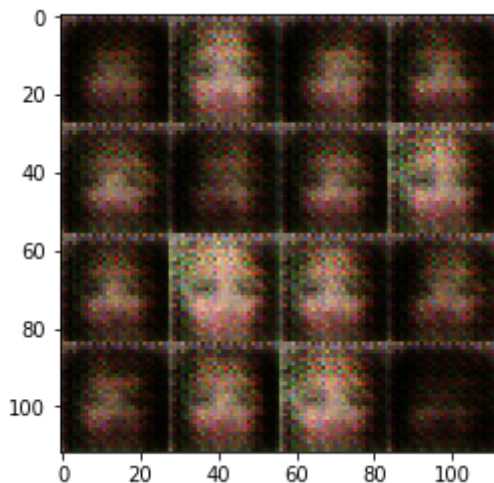


```
Epoch 1/1... Discriminator Loss: 1.2959... Generator Loss: 1.2109
Epoch 1/1... Discriminator Loss: 1.4248... Generator Loss: 1.1774
Epoch 1/1... Discriminator Loss: 1.3793... Generator Loss: 1.0639
Epoch 1/1... Discriminator Loss: 1.3220... Generator Loss: 1.0931
Epoch 1/1... Discriminator Loss: 1.4785... Generator Loss: 0.4999
Epoch 1/1... Discriminator Loss: 1.5988... Generator Loss: 0.4310
Epoch 1/1... Discriminator Loss: 1.5702... Generator Loss: 0.4453
Epoch 1/1... Discriminator Loss: 1.5292... Generator Loss: 0.5058
Epoch 1/1... Discriminator Loss: 1.5447... Generator Loss: 0.4452
Epoch 1/1... Discriminator Loss: 1.3204... Generator Loss: 0.6502
```
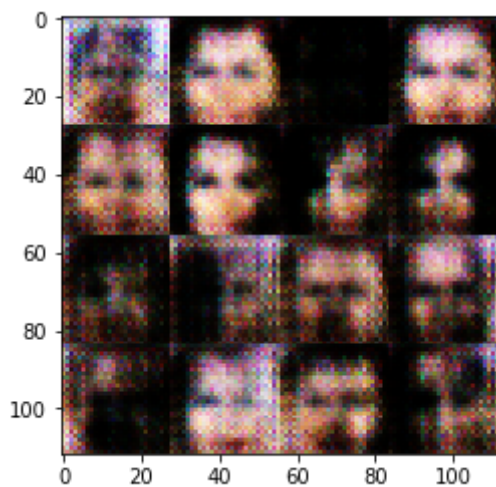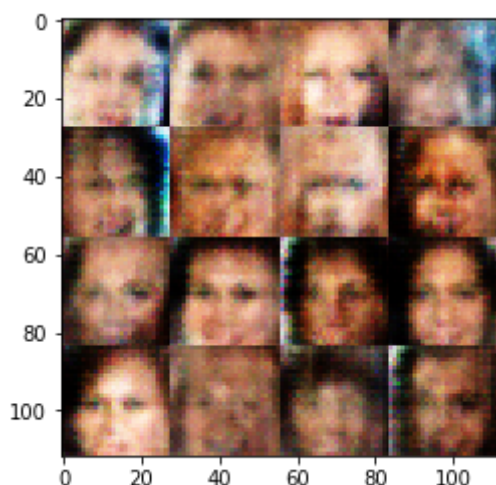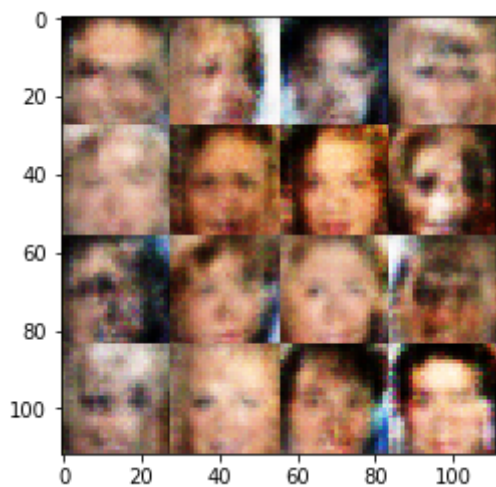
```
Epoch 1/1... Discriminator Loss: 1.4665... Generator Loss: 0.5341
Epoch 1/1... Discriminator Loss: 1.3493... Generator Loss: 0.6853
Epoch 1/1... Discriminator Loss: 1.3544... Generator Loss: 0.6561
Epoch 1/1... Discriminator Loss: 1.4301... Generator Loss: 0.5567
Epoch 1/1... Discriminator Loss: 1.4838... Generator Loss: 0.5018
Epoch 1/1... Discriminator Loss: 1.4106... Generator Loss: 0.9306
Epoch 1/1... Discriminator Loss: 1.2221... Generator Loss: 1.2996
Epoch 1/1... Discriminator Loss: 1.4745... Generator Loss: 0.7821
Epoch 1/1... Discriminator Loss: 1.8969... Generator Loss: 1.0527
Epoch 1/1... Discriminator Loss: 1.3418... Generator Loss: 0.7853
```
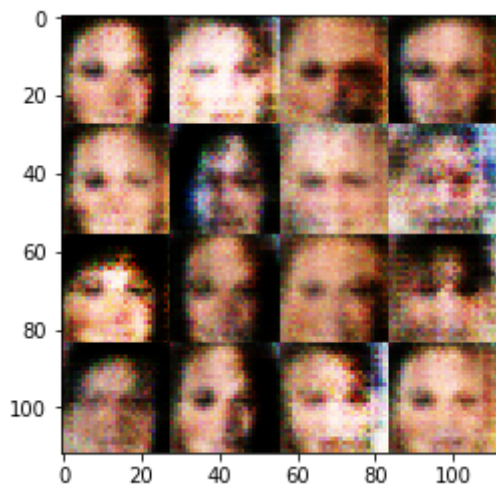


```
Epoch 1/1... Discriminator Loss: 1.3657... Generator Loss: 0.6598
Epoch 1/1... Discriminator Loss: 1.3883... Generator Loss: 0.5742
Epoch 1/1... Discriminator Loss: 1.4484... Generator Loss: 0.5805
Epoch 1/1... Discriminator Loss: 1.4468... Generator Loss: 0.5591
Epoch 1/1... Discriminator Loss: 1.3102... Generator Loss: 0.8152
Epoch 1/1... Discriminator Loss: 1.3930... Generator Loss: 0.8815
Epoch 1/1... Discriminator Loss: 1.2109... Generator Loss: 1.0498
Epoch 1/1... Discriminator Loss: 1.4074... Generator Loss: 0.6224
Epoch 1/1... Discriminator Loss: 1.4517... Generator Loss: 0.5484
Epoch 1/1... Discriminator Loss: 1.3922... Generator Loss: 0.7886
```
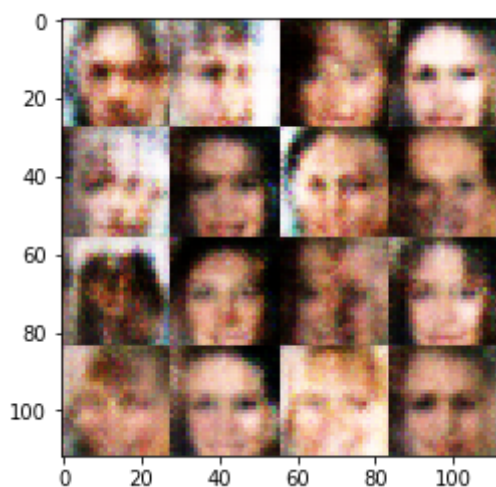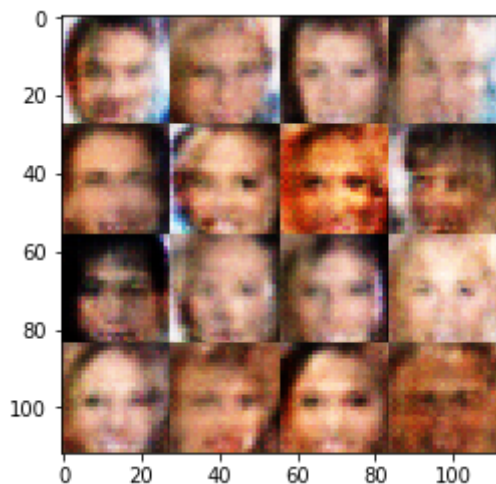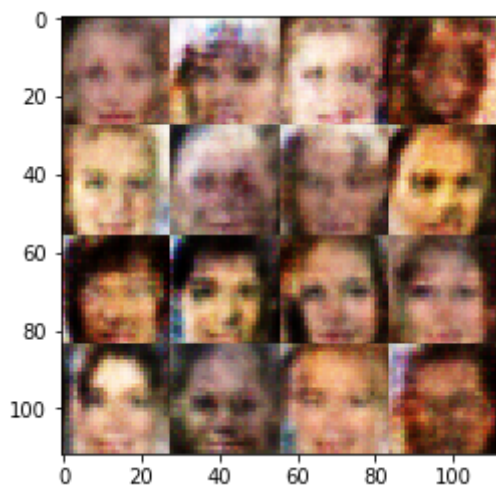
```
Epoch 1/1... Discriminator Loss: 1.3557... Generator Loss: 0.8551
Epoch 1/1... Discriminator Loss: 1.4112... Generator Loss: 0.6552
Epoch 1/1... Discriminator Loss: 1.3905... Generator Loss: 0.6540
Epoch 1/1... Discriminator Loss: 1.4646... Generator Loss: 0.6630
Epoch 1/1... Discriminator Loss: 1.3806... Generator Loss: 0.7529
Epoch 1/1... Discriminator Loss: 1.3178... Generator Loss: 0.8117
Epoch 1/1... Discriminator Loss: 1.3858... Generator Loss: 0.6988
Epoch 1/1... Discriminator Loss: 1.4650... Generator Loss: 0.6236
Epoch 1/1... Discriminator Loss: 1.3711... Generator Loss: 0.7169
Epoch 1/1... Discriminator Loss: 1.3685... Generator Loss: 0.8658
```



```
Epoch 1/1... Discriminator Loss: 1.4035... Generator Loss: 0.7965
Epoch 1/1... Discriminator Loss: 1.5009... Generator Loss: 0.8395
Epoch 1/1... Discriminator Loss: 1.3950... Generator Loss: 0.8750
Epoch 1/1... Discriminator Loss: 1.2914... Generator Loss: 1.1259
Epoch 1/1... Discriminator Loss: 1.3943... Generator Loss: 0.8016
Epoch 1/1... Discriminator Loss: 1.3856... Generator Loss: 0.8843
Epoch 1/1... Discriminator Loss: 1.3191... Generator Loss: 0.9332
Epoch 1/1... Discriminator Loss: 1.4752... Generator Loss: 0.6436
Epoch 1/1... Discriminator Loss: 1.4105... Generator Loss: 0.7957
Epoch 1/1... Discriminator Loss: 1.4208... Generator Loss: 0.8654
```
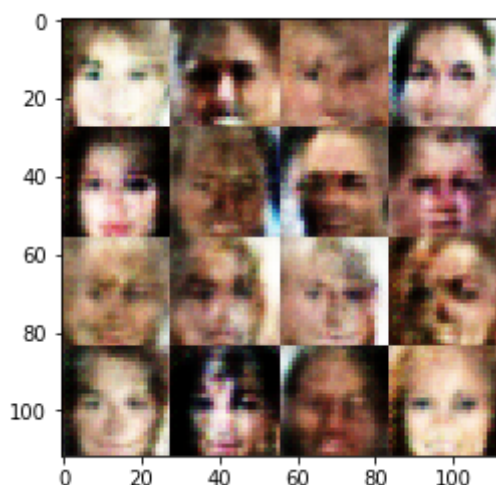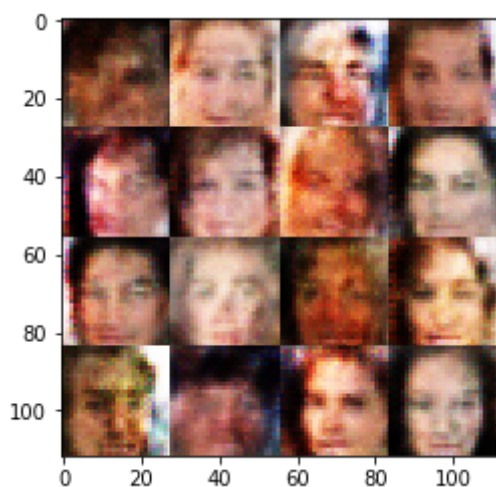
```
Epoch 1/1... Discriminator Loss: 1.3735... Generator Loss: 0.7120
Epoch 1/1... Discriminator Loss: 1.4183... Generator Loss: 0.6793
Epoch 1/1... Discriminator Loss: 1.4072... Generator Loss: 0.7231
Epoch 1/1... Discriminator Loss: 1.4479... Generator Loss: 0.7073
Epoch 1/1... Discriminator Loss: 1.2788... Generator Loss: 0.8254
Epoch 1/1... Discriminator Loss: 1.3278... Generator Loss: 0.7633
Epoch 1/1... Discriminator Loss: 1.3983... Generator Loss: 0.6347
Epoch 1/1... Discriminator Loss: 1.4386... Generator Loss: 0.6139
Epoch 1/1... Discriminator Loss: 1.3975... Generator Loss: 0.8025
Epoch 1/1... Discriminator Loss: 1.3801... Generator Loss: 0.8695
```



```
Epoch 1/1... Discriminator Loss: 1.2991... Generator Loss: 0.8630
Epoch 1/1... Discriminator Loss: 1.3543... Generator Loss: 0.6854
Epoch 1/1... Discriminator Loss: 1.3540... Generator Loss: 0.8428
Epoch 1/1... Discriminator Loss: 1.6273... Generator Loss: 0.9871
Epoch 1/1... Discriminator Loss: 1.4135... Generator Loss: 0.7700
Epoch 1/1... Discriminator Loss: 1.4014... Generator Loss: 0.7795
Epoch 1/1... Discriminator Loss: 1.4220... Generator Loss: 0.6580
Epoch 1/1... Discriminator Loss: 1.3737... Generator Loss: 0.7138
Epoch 1/1... Discriminator Loss: 1.3581... Generator Loss: 0.8649
Epoch 1/1... Discriminator Loss: 1.3165... Generator Loss: 0.8689
```
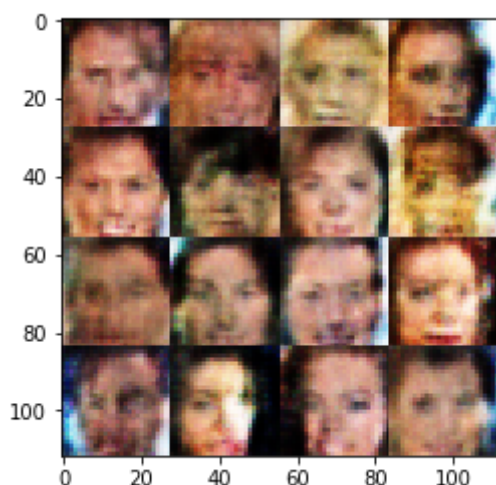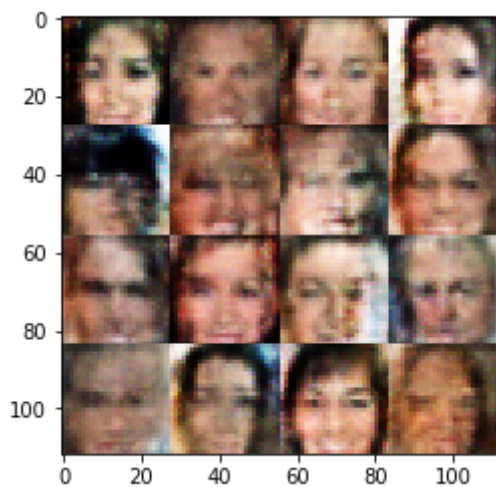
```
Epoch 1/1... Discriminator Loss: 1.4267... Generator Loss: 0.7030
Epoch 1/1... Discriminator Loss: 1.3741... Generator Loss: 0.8017
Epoch 1/1... Discriminator Loss: 1.3891... Generator Loss: 0.7400
Epoch 1/1... Discriminator Loss: 1.3209... Generator Loss: 0.9616
Epoch 1/1... Discriminator Loss: 1.3456... Generator Loss: 0.7729
Epoch 1/1... Discriminator Loss: 1.2987... Generator Loss: 0.8799
Epoch 1/1... Discriminator Loss: 1.3729... Generator Loss: 0.7608
Epoch 1/1... Discriminator Loss: 1.5760... Generator Loss: 0.8301
Epoch 1/1... Discriminator Loss: 1.3608... Generator Loss: 0.7458
Epoch 1/1... Discriminator Loss: 1.3497... Generator Loss: 0.7812
```



```
Epoch 1/1... Discriminator Loss: 1.4132... Generator Loss: 0.7518
Epoch 1/1... Discriminator Loss: 1.3754... Generator Loss: 0.7545
Epoch 1/1... Discriminator Loss: 1.3648... Generator Loss: 0.8320
Epoch 1/1... Discriminator Loss: 1.4141... Generator Loss: 0.7397
Epoch 1/1... Discriminator Loss: 1.3886... Generator Loss: 0.7277
Epoch 1/1... Discriminator Loss: 1.3725... Generator Loss: 0.8616
Epoch 1/1... Discriminator Loss: 1.3964... Generator Loss: 0.6505
Epoch 1/1... Discriminator Loss: 1.2918... Generator Loss: 0.9799
Epoch 1/1... Discriminator Loss: 1.3810... Generator Loss: 0.7502
Epoch 1/1... Discriminator Loss: 1.3794... Generator Loss: 0.7346
```
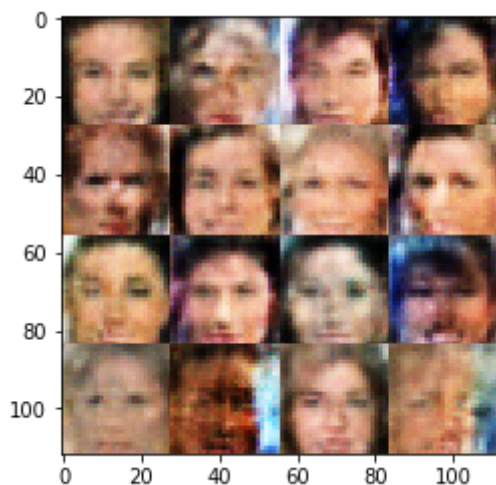
```
Epoch 1/1... Discriminator Loss: 1.3678... Generator Loss: 0.7242
Epoch 1/1... Discriminator Loss: 1.3312... Generator Loss: 0.8223
Epoch 1/1... Discriminator Loss: 1.3929... Generator Loss: 0.7175
Epoch 1/1... Discriminator Loss: 1.3977... Generator Loss: 0.6241
Epoch 1/1... Discriminator Loss: 1.3817... Generator Loss: 0.7198
Epoch 1/1... Discriminator Loss: 1.3631... Generator Loss: 0.7194
Epoch 1/1... Discriminator Loss: 1.3850... Generator Loss: 0.7907
Epoch 1/1... Discriminator Loss: 1.4063... Generator Loss: 0.7451
Epoch 1/1... Discriminator Loss: 1.3790... Generator Loss: 0.7179
Epoch 1/1... Discriminator Loss: 1.4208... Generator Loss: 0.9038
```



```
Epoch 1/1... Discriminator Loss: 1.3566... Generator Loss: 0.7033
Epoch 1/1... Discriminator Loss: 1.3237... Generator Loss: 0.8438
Epoch 1/1... Discriminator Loss: 1.3480... Generator Loss: 0.7387
Epoch 1/1... Discriminator Loss: 1.2879... Generator Loss: 1.0446
Epoch 1/1... Discriminator Loss: 1.3784... Generator Loss: 0.7611
Epoch 1/1... Discriminator Loss: 1.4068... Generator Loss: 0.6683
Epoch 1/1... Discriminator Loss: 1.3825... Generator Loss: 0.7322
Epoch 1/1... Discriminator Loss: 1.2948... Generator Loss: 0.8373
Epoch 1/1... Discriminator Loss: 1.3404... Generator Loss: 0.7407
Epoch 1/1... Discriminator Loss: 1.4003... Generator Loss: 0.7224
```
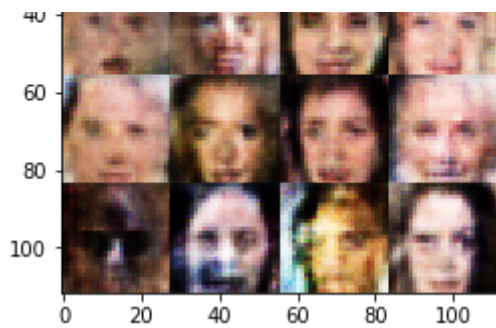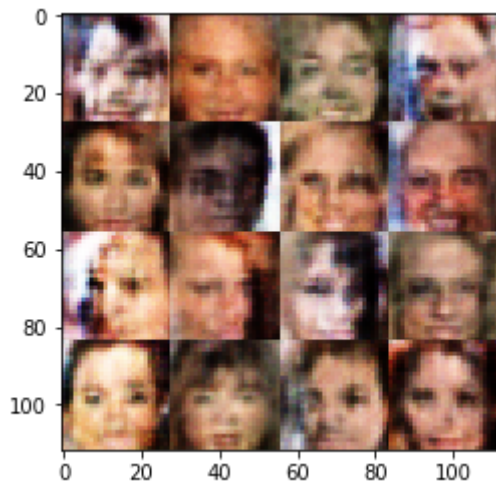
```
Epoch 1/1... Discriminator Loss: 1.3833... Generator Loss: 0.7075
Epoch 1/1... Discriminator Loss: 1.3942... Generator Loss: 0.8366
Epoch 1/1... Discriminator Loss: 1.3672... Generator Loss: 0.7341
Epoch 1/1... Discriminator Loss: 1.3831... Generator Loss: 0.7799
Epoch 1/1... Discriminator Loss: 1.2791... Generator Loss: 0.9228
Epoch 1/1... Discriminator Loss: 1.3474... Generator Loss: 0.7878
Epoch 1/1... Discriminator Loss: 1.3448... Generator Loss: 0.7747
Epoch 1/1... Discriminator Loss: 1.3937... Generator Loss: 0.7855
Epoch 1/1... Discriminator Loss: 1.4172... Generator Loss: 0.7470
Epoch 1/1... Discriminator Loss: 1.4100... Generator Loss: 0.8090
```



```
Epoch 1/1... Discriminator Loss: 1.4248... Generator Loss: 0.7785
Epoch 1/1... Discriminator Loss: 1.3637... Generator Loss: 0.8519
Epoch 1/1... Discriminator Loss: 1.5174... Generator Loss: 0.9021
Epoch 1/1... Discriminator Loss: 1.4049... Generator Loss: 0.8099
Epoch 1/1... Discriminator Loss: 1.3121... Generator Loss: 0.8131
Epoch 1/1... Discriminator Loss: 1.4451... Generator Loss: 0.7390
Epoch 1/1... Discriminator Loss: 1.3157... Generator Loss: 0.8581
Epoch 1/1... Discriminator Loss: 1.3239... Generator Loss: 0.7965
Epoch 1/1... Discriminator Loss: 1.4188... Generator Loss: 0.8066
Epoch 1/1... Discriminator Loss: 1.3764... Generator Loss: 0.7251
```
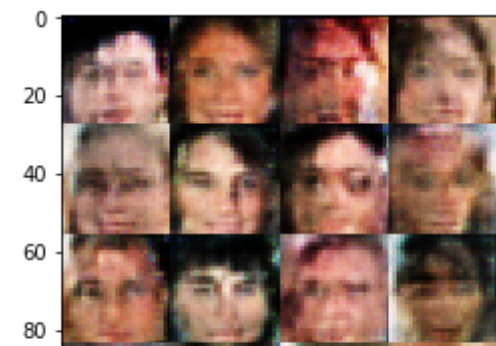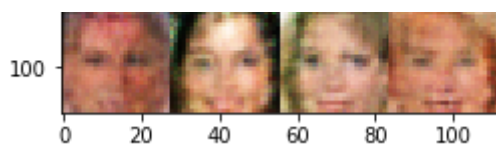
```
Epoch 1/1... Discriminator Loss: 1.2949... Generator Loss: 0.9027
Epoch 1/1... Discriminator Loss: 1.3104... Generator Loss: 0.8439
Epoch 1/1... Discriminator Loss: 1.3922... Generator Loss: 0.6827
Epoch 1/1... Discriminator Loss: 1.4603... Generator Loss: 0.8051
Epoch 1/1... Discriminator Loss: 1.3925... Generator Loss: 0.6665
Epoch 1/1... Discriminator Loss: 1.3485... Generator Loss: 0.8421
Epoch 1/1... Discriminator Loss: 1.3980... Generator Loss: 0.6549
Epoch 1/1... Discriminator Loss: 1.4384... Generator Loss: 0.6922
Epoch 1/1... Discriminator Loss: 1.3947... Generator Loss: 0.7075
Epoch 1/1... Discriminator Loss: 1.3633... Generator Loss: 0.7221
```
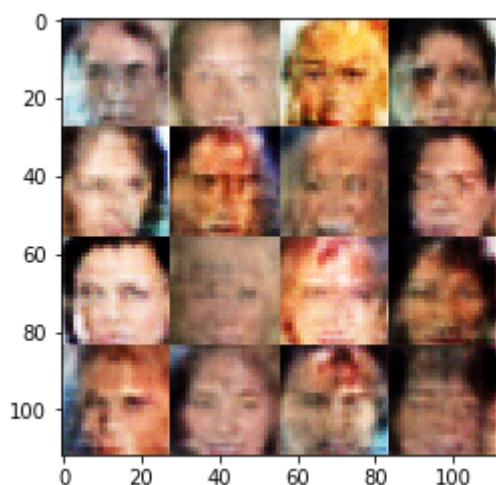


```
Epoch 1/1... Discriminator Loss: 1.4264... Generator Loss: 0.8091
Epoch 1/1... Discriminator Loss: 1.3994... Generator Loss: 0.6229
Epoch 1/1... Discriminator Loss: 1.4016... Generator Loss: 0.6320
Epoch 1/1... Discriminator Loss: 1.3278... Generator Loss: 0.7924
Epoch 1/1... Discriminator Loss: 1.4523... Generator Loss: 0.7112
Epoch 1/1... Discriminator Loss: 1.4338... Generator Loss: 0.7165
Epoch 1/1... Discriminator Loss: 1.3892... Generator Loss: 0.8854
Epoch 1/1... Discriminator Loss: 1.3725... Generator Loss: 0.8162
Epoch 1/1... Discriminator Loss: 1.4407... Generator Loss: 0.8568
Epoch 1/1... Discriminator Loss: 1.4019... Generator Loss: 0.7888
```
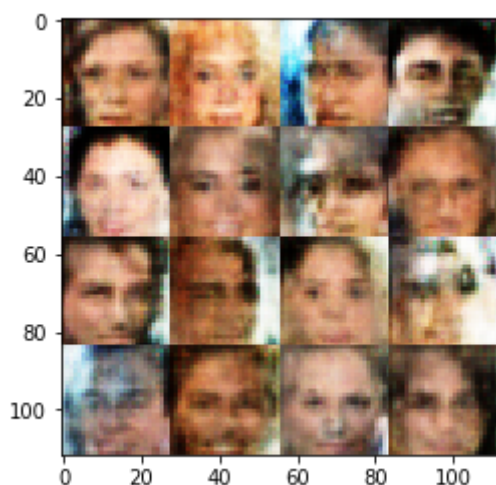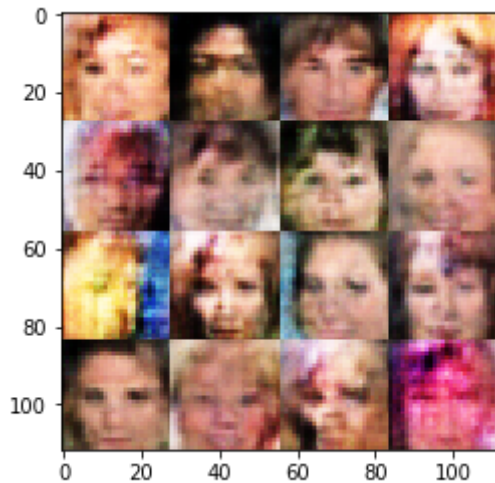
```
Epoch 1/1... Discriminator Loss: 1.4039... Generator Loss: 0.8020
Epoch 1/1... Discriminator Loss: 1.3803... Generator Loss: 0.7708
Epoch 1/1... Discriminator Loss: 1.1970... Generator Loss: 1.2832
Epoch 1/1... Discriminator Loss: 1.4310... Generator Loss: 0.7239
Epoch 1/1... Discriminator Loss: 1.4604... Generator Loss: 0.7227
Epoch 1/1... Discriminator Loss: 1.4003... Generator Loss: 0.6521
Epoch 1/1... Discriminator Loss: 1.3284... Generator Loss: 0.8242
Epoch 1/1... Discriminator Loss: 1.3783... Generator Loss: 0.7917
Epoch 1/1... Discriminator Loss: 1.3626... Generator Loss: 0.7214
Epoch 1/1... Discriminator Loss: 1.5595... Generator Loss: 0.4010
```



```
Epoch 1/1... Discriminator Loss: 1.3303... Generator Loss: 0.8027
Epoch 1/1... Discriminator Loss: 1.1810... Generator Loss: 1.0181
Epoch 1/1... Discriminator Loss: 1.3772... Generator Loss: 0.7038
Epoch 1/1... Discriminator Loss: 1.3577... Generator Loss: 0.7540
Epoch 1/1... Discriminator Loss: 1.3909... Generator Loss: 0.6191
Epoch 1/1... Discriminator Loss: 1.4475... Generator Loss: 0.7128

Epoch 1/1... Discriminator Loss: 1.4124... Generator Loss: 0.8035
Epoch 1/1... Discriminator Loss: 1.4375... Generator Loss: 0.8169
Epoch 1/1... Discriminator Loss: 1.4408... Generator Loss: 0.6334
Epoch 1/1... Discriminator Loss: 1.3914... Generator Loss: 0.7697
```
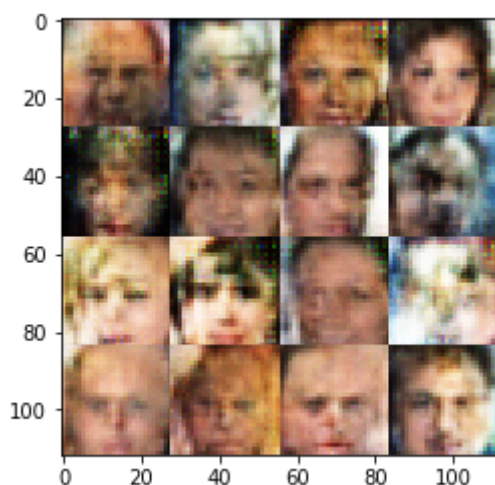
Epoch 1/1... Discriminator Loss: 1.3288... Generator Loss: 0.8998
Epoch 1/1... Discriminator Loss: 1.3906... Generator Loss: 0.8430
Epoch 1/1... Discriminator Loss: 1.4071... Generator Loss: 0.9579
Epoch 1/1... Discriminator Loss: 1.3204... Generator Loss: 0.7821
Epoch 1/1... Discriminator Loss: 1.3686... Generator Loss: 0.9943
Epoch 1/1... Discriminator Loss: 1.3273... Generator Loss: 0.8285
Epoch 1/1... Discriminator Loss: 1.3923... Generator Loss: 0.8207
Epoch 1/1... Discriminator Loss: 1.3313... Generator Loss: 0.8543
Epoch 1/1... Discriminator Loss: 1.3632... Generator Loss: 0.8084
Epoch 1/1... Discriminator Loss: 1.4202... Generator Loss: 0.6259

Epoch 1/1... Discriminator Loss: 1.4739... Generator Loss: 0.8011
Epoch 1/1... Discriminator Loss: 1.4168... Generator Loss: 0.7220
Epoch 1/1... Discriminator Loss: 1.4451... Generator Loss: 0.6747
Epoch 1/1... Discriminator Loss: 1.4295... Generator Loss: 0.7389
Epoch 1/1... Discriminator Loss: 1.3547... Generator Loss: 0.7630
Epoch 1/1... Discriminator Loss: 1.3984... Generator Loss: 0.7492
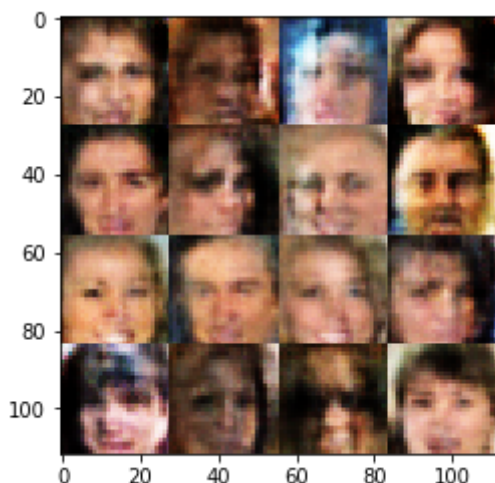Epoch 1/1... Discriminator Loss: 1.3947... Generator Loss: 0.7258

Epoch 1/1... Discriminator Loss: 1.4215... Generator Loss: 0.7355
Epoch 1/1... Discriminator Loss: 1.3751... Generator Loss: 0.7891
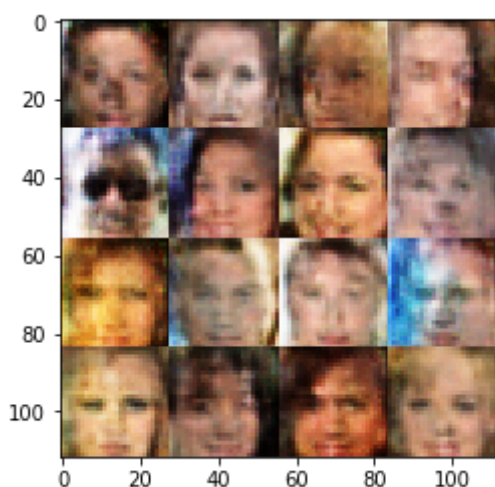Epoch 1/1... Discriminator Loss: 1.2028... Generator Loss: 1.0081

Epoch 1/1... Discriminator Loss: 1.3668... Generator Loss: 0.7871
Epoch 1/1... Discriminator Loss: 1.3877... Generator Loss: 0.6560
Epoch 1/1... Discriminator Loss: 1.3644... Generator Loss: 1.0255
Epoch 1/1... Discriminator Loss: 1.4045... Generator Loss: 0.8120

Epoch 1/1... Discriminator Loss: 1.3221... Generator Loss: 0.8080
Epoch 1/1... Discriminator Loss: 1.3298... Generator Loss: 0.8327
Epoch 1/1... Discriminator Loss: 1.4409... Generator Loss: 0.6987
Epoch 1/1... Discriminator Loss: 1.3807... Generator Loss: 0.7221
Epoch 1/1... Discriminator Loss: 1.3936... Generator Loss: 0.6915
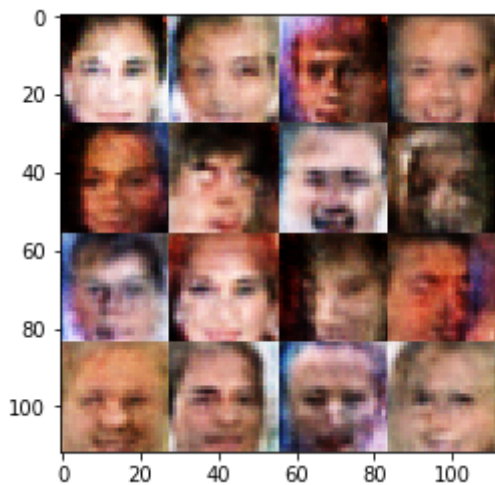Epoch 1/1... Discriminator Loss: 1.3844... Generator Loss: 0.8079

Epoch 1/1... Discriminator Loss: 1.3845... Generator Loss: 0.6316
Epoch 1/1... Discriminator Loss: 1.4077... Generator Loss: 0.8913
Epoch 1/1... Discriminator Loss: 1.3896... Generator Loss: 0.7779
Epoch 1/1... Discriminator Loss: 1.3776... Generator Loss: 0.7244
Epoch 1/1... Discriminator Loss: 1.3118... Generator Loss: 0.8665
Epoch 1/1... Discriminator Loss: 1.3996... Generator Loss: 0.6334
Epoch 1/1... Discriminator Loss: 1.4199... Generator Loss: 0.8481
Epoch 1/1... Discriminator Loss: 1.3850... Generator Loss: 0.8063
Epoch 1/1... Discriminator Loss: 1.3619... Generator Loss: 0.7833
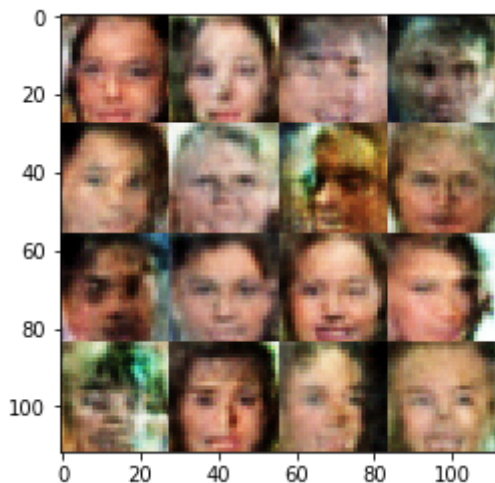Epoch 1/1... Discriminator Loss: 1.3949... Generator Loss: 0.7374

Epoch 1/1... Discriminator Loss: 1.3825... Generator Loss: 0.7251
Epoch 1/1... Discriminator Loss: 1.3956... Generator Loss: 0.7528
Epoch 1/1... Discriminator Loss: 1.2301... Generator Loss: 0.8805
Epoch 1/1... Discriminator Loss: 1.3987... Generator Loss: 0.7667
Epoch 1/1... Discriminator Loss: 1.3840... Generator Loss: 0.7055
Epoch 1/1... Discriminator Loss: 1.3690... Generator Loss: 0.7471
Epoch 1/1... Discriminator Loss: 1.3456... Generator Loss: 0.7999
Epoch 1/1... Discriminator Loss: 1.3833... Generator Loss: 0.7581
Epoch 1/1   Discriminator Loss: 1.3967   Generator Loss: 0.7541

Epoch 1/1... Discriminator Loss: 1.3507... Generator Loss: 0.7541
Epoch 1/1... Discriminator Loss: 1.3526... Generator Loss: 0.7815
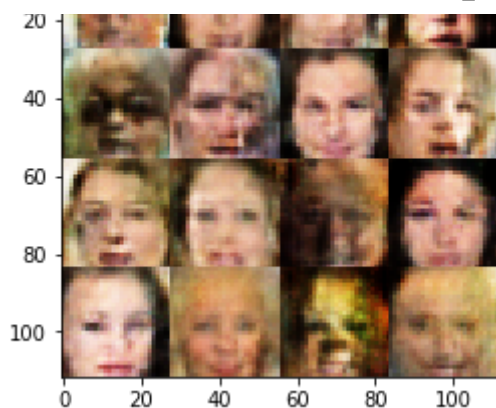


```
Epoch 1/1... Discriminator Loss: 1.4168... Generator Loss: 0.6415
Epoch 1/1... Discriminator Loss: 1.4090... Generator Loss: 0.7066
Epoch 1/1... Discriminator Loss: 1.4372... Generator Loss: 0.8193
Epoch 1/1... Discriminator Loss: 1.3725... Generator Loss: 0.7511
Epoch 1/1... Discriminator Loss: 1.2648... Generator Loss: 0.9553
Epoch 1/1... Discriminator Loss: 1.3821... Generator Loss: 0.8796
Epoch 1/1... Discriminator Loss: 1.3904... Generator Loss: 0.8590
Epoch 1/1... Discriminator Loss: 1.3296... Generator Loss: 0.7924
Epoch 1/1... Discriminator Loss: 1.3984... Generator Loss: 0.9373
Epoch 1/1... Discriminator Loss: 1.3836... Generator Loss: 0.8085
```
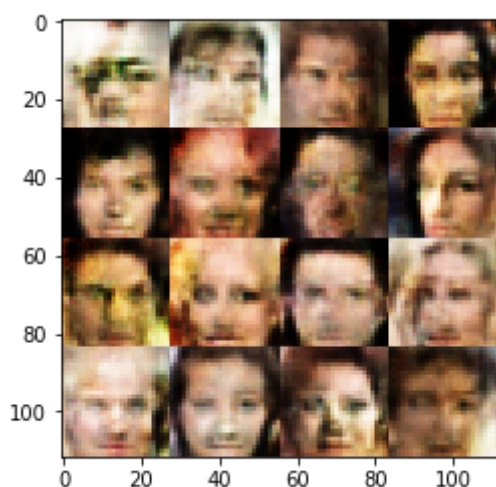


```
Epoch 1/1... Discriminator Loss: 1.3785... Generator Loss: 0.7875
Epoch 1/1... Discriminator Loss: 1.3696... Generator Loss: 0.8426
Epoch 1/1... Discriminator Loss: 1.3717... Generator Loss: 0.7224
Epoch 1/1... Discriminator Loss: 1.3995... Generator Loss: 0.6225
Epoch 1/1... Discriminator Loss: 1.3805... Generator Loss: 0.9088
Epoch 1/1... Discriminator Loss: 1.3649... Generator Loss: 0.6612
Epoch 1/1... Discriminator Loss: 1.3884... Generator Loss: 0.6851
Epoch 1/1... Discriminator Loss: 1.3331... Generator Loss: 0.7691
Epoch 1/1... Discriminator Loss: 1.3869... Generator Loss: 0.7499
Epoch 1/1... Discriminator Loss: 1.3309... Generator Loss: 0.7272
```
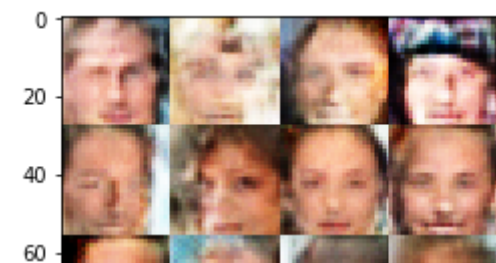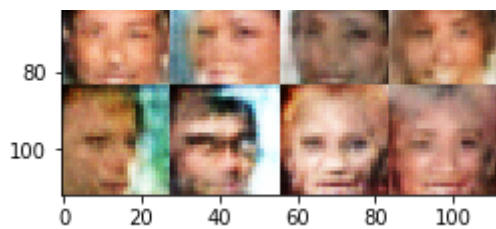
```
Epoch 1/1... Discriminator Loss: 1.3846... Generator Loss: 0.7772
Epoch 1/1... Discriminator Loss: 1.4492... Generator Loss: 0.5691
Epoch 1/1... Discriminator Loss: 1.3803... Generator Loss: 0.7500
Epoch 1/1... Discriminator Loss: 1.3246... Generator Loss: 0.8409
Epoch 1/1... Discriminator Loss: 1.4185... Generator Loss: 0.6775
Epoch 1/1... Discriminator Loss: 1.4113... Generator Loss: 0.7626
Epoch 1/1... Discriminator Loss: 1.4114... Generator Loss: 0.6830
Epoch 1/1... Discriminator Loss: 1.3981... Generator Loss: 0.6992
Epoch 1/1... Discriminator Loss: 1.4304... Generator Loss: 0.7428
Epoch 1/1... Discriminator Loss: 1.3926... Generator Loss: 0.7901
```
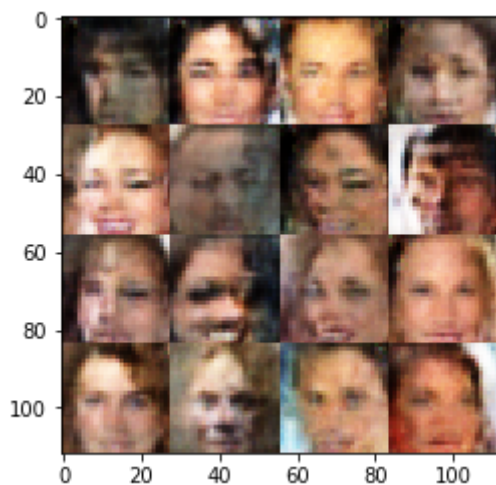


```
Epoch 1/1... Discriminator Loss: 1.3695... Generator Loss: 0.8468
Epoch 1/1... Discriminator Loss: 1.2868... Generator Loss: 0.8784
Epoch 1/1... Discriminator Loss: 1.3772... Generator Loss: 0.7191
Epoch 1/1... Discriminator Loss: 1.3878... Generator Loss: 0.6998
Epoch 1/1... Discriminator Loss: 1.4023... Generator Loss: 0.7328
Epoch 1/1... Discriminator Loss: 1.4599... Generator Loss: 0.5176
Epoch 1/1... Discriminator Loss: 1.3603... Generator Loss: 0.7386
Epoch 1/1... Discriminator Loss: 1.3884... Generator Loss: 0.7332
Epoch 1/1... Discriminator Loss: 1.3497... Generator Loss: 0.9190
Epoch 1/1... Discriminator Loss: 1.4204... Generator Loss: 0.7422
```
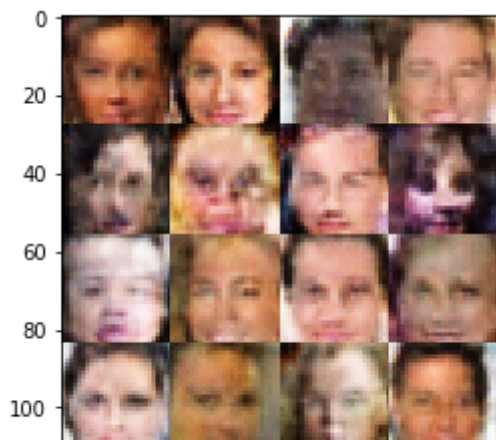
```
Epoch 1/1... Discriminator Loss: 1.3505... Generator Loss: 0.7359
Epoch 1/1... Discriminator Loss: 1.3602... Generator Loss: 0.7181
Epoch 1/1... Discriminator Loss: 1.3490... Generator Loss: 0.7204
Epoch 1/1... Discriminator Loss: 1.4779... Generator Loss: 0.6799
Epoch 1/1... Discriminator Loss: 1.3634... Generator Loss: 0.6786
Epoch 1/1... Discriminator Loss: 1.3976... Generator Loss: 0.8329
Epoch 1/1... Discriminator Loss: 1.4351... Generator Loss: 0.7043
Epoch 1/1... Discriminator Loss: 1.3884... Generator Loss: 0.7045
Epoch 1/1... Discriminator Loss: 1.3122... Generator Loss: 0.8686
Epoch 1/1... Discriminator Loss: 1.3984... Generator Loss: 0.8774
```
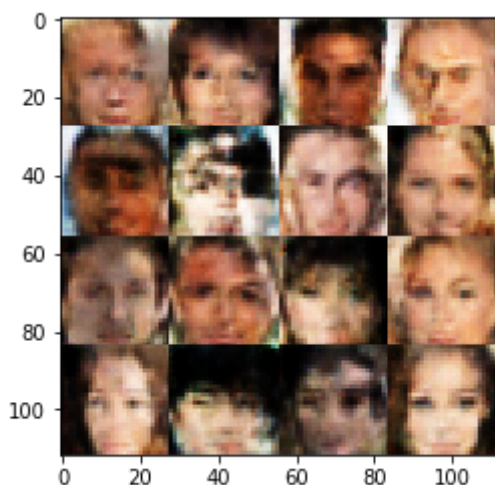


```
Epoch 1/1... Discriminator Loss: 1.3593... Generator Loss: 0.6681
Epoch 1/1... Discriminator Loss: 1.3485... Generator Loss: 0.7971
Epoch 1/1... Discriminator Loss: 1.3288... Generator Loss: 0.8574
Epoch 1/1... Discriminator Loss: 1.3841... Generator Loss: 0.8501
Epoch 1/1... Discriminator Loss: 1.4723... Generator Loss: 0.5713
Epoch 1/1... Discriminator Loss: 1.3885... Generator Loss: 0.7318
Epoch 1/1... Discriminator Loss: 1.3999... Generator Loss: 0.7898
Epoch 1/1... Discriminator Loss: 1.3953... Generator Loss: 0.7128
Epoch 1/1... Discriminator Loss: 1.3650... Generator Loss: 0.7525
Epoch 1/1... Discriminator Loss: 1.3830... Generator Loss: 0.7575
```
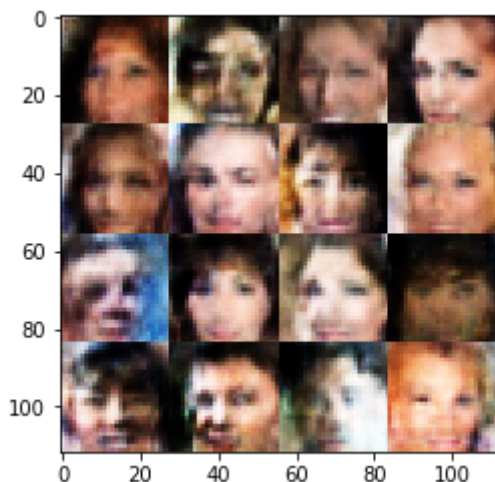
```
Epoch 1/1... Discriminator Loss: 1.3766... Generator Loss: 0.7065
Epoch 1/1... Discriminator Loss: 1.3784... Generator Loss: 0.7207
Epoch 1/1... Discriminator Loss: 1.4369... Generator Loss: 0.7338
Epoch 1/1... Discriminator Loss: 1.3889... Generator Loss: 0.8373
Epoch 1/1... Discriminator Loss: 1.3387... Generator Loss: 0.8547
Epoch 1/1... Discriminator Loss: 1.3968... Generator Loss: 0.6149
Epoch 1/1... Discriminator Loss: 1.4319... Generator Loss: 0.8441
Epoch 1/1... Discriminator Loss: 1.3739... Generator Loss: 0.7866
Epoch 1/1... Discriminator Loss: 1.4218... Generator Loss: 0.6074
Epoch 1/1... Discriminator Loss: 1.3853... Generator Loss: 0.7562
```



```
Epoch 1/1... Discriminator Loss: 1.3409... Generator Loss: 0.7581
Epoch 1/1... Discriminator Loss: 1.4222... Generator Loss: 0.6851
Epoch 1/1... Discriminator Loss: 1.3493... Generator Loss: 0.8474
Epoch 1/1... Discriminator Loss: 1.3249... Generator Loss: 0.8528
Epoch 1/1... Discriminator Loss: 1.3944... Generator Loss: 0.7432
Epoch 1/1... Discriminator Loss: 1.3973... Generator Loss: 0.6984
Epoch 1/1... Discriminator Loss: 1.3717... Generator Loss: 0.6661
Epoch 1/1... Discriminator Loss: 1.3844... Generator Loss: 0.6997
Epoch 1/1... Discriminator Loss: 1.3881... Generator Loss: 0.7688
Epoch 1/1... Discriminator Loss: 1.3800... Generator Loss: 0.8424
```



```
Epoch 1/1... Discriminator Loss: 1.4338... Generator Loss: 0.8482
Epoch 1/1... Discriminator Loss: 1.3546... Generator Loss: 0.8404
Epoch 1/1... Discriminator Loss: 1.3784... Generator Loss: 0.7216
```

```
Epoch 1/1... Discriminator Loss: 1.3451... Generator Loss: 0.8180
Epoch 1/1... Discriminator Loss: 1.3893... Generator Loss: 0.6875
Epoch 1/1... Discriminator Loss: 1.4098... Generator Loss: 0.7435
```

Submitting This Project

When submitting this project, make sure to run all the cells before saving the notebook. Save the notebook file as "dlnd_face_generation.ipynb" and save it as a HTML file under "File" -> "Download as". Include the "helper.py" and "problem_unittests.py" files in your submission.