dlnd_face_generation-zh

December 18, 2019

1 Face Generation

Generative Adversarial Nets ### - MNIST - CelebA
CelebA GANs MNIST GANs
FloydHub, data_dir "/input" FloydHub data ID "R5KrjnANiKVhLWAkpXhNBe".

In [16]:
```
data_dir = '/data'
!pip install matplotlib==2.0.2
# 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)
```

```
Requirement already satisfied: matplotlib==2.0.2 in /opt/conda/lib/python3.6/site-packages (2.0.
Requirement already satisfied: python-dateutil in /opt/conda/lib/python3.6/site-packages (from m
Requirement already satisfied: six>=1.10 in /opt/conda/lib/python3.6/site-packages (from matplot
Requirement already satisfied: pyparsing!=2.0.0,!=2.0.4,!=2.1.2,!=2.1.6,>=1.5.6 in /opt/conda/li
Requirement already satisfied: pytz in /opt/conda/lib/python3.6/site-packages (from matplotlib==
Requirement already satisfied: numpy>=1.7.1 in /opt/conda/lib/python3.6/site-packages (from matp
Requirement already satisfied: cycler>=0.10 in /opt/conda/lib/python3.6/site-packages/cycler-0.1
Found mnist Data
Found celeba Data
```

1.1 Explore the Data

1.1.1 MNIST

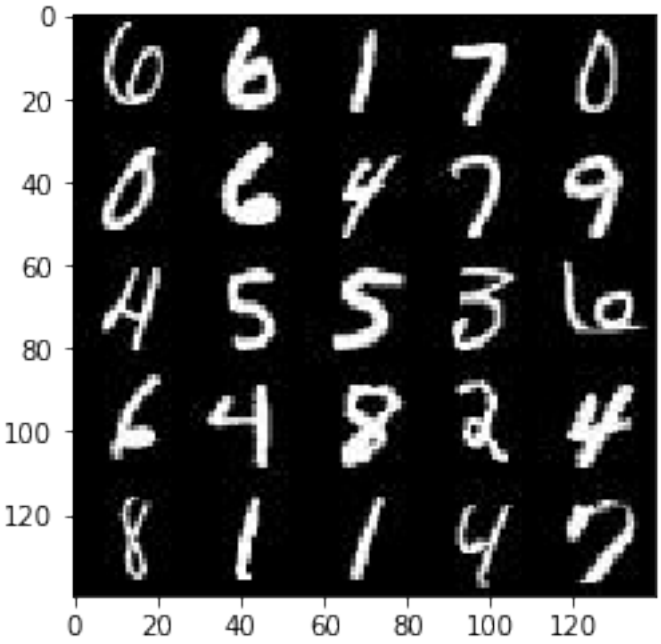
MNIST show_n_images

In [17]:
```
show_n_images = 25


"""
DON'T MODIFY ANYTHING IN THIS CELL
"""
%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_n_ima
pyplot.imshow(helper.images_square_grid(mnist_images, 'L'), cmap='gray')
```

Out[17]: <matplotlib.image.AxesImage at 0x7f462d79a908>



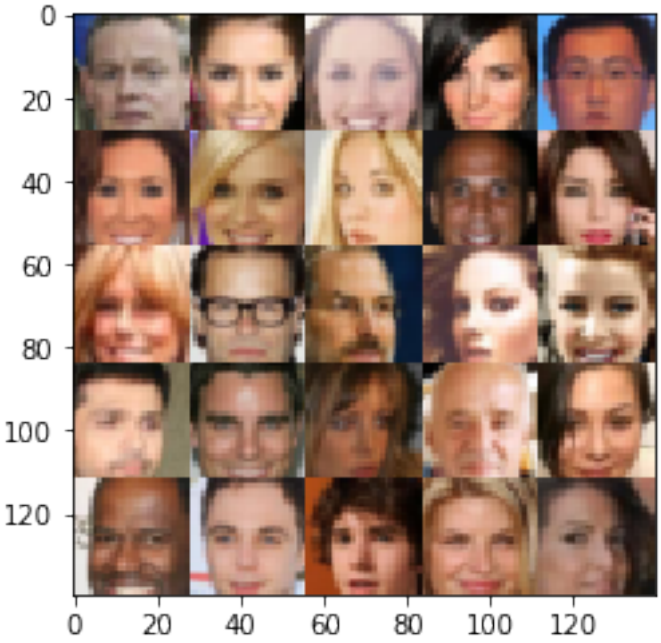
1.1.2 CelebA

CelebFaces Attributes Dataset (CelebA) 20 `show_n_images`

In [18]:
```
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/*.jpg'))[
pyplot.imshow(helper.images_square_grid(mnist_images, 'RGB'))
```

Out[18]: <matplotlib.image.AxesImage at 0x7f462c3e69b0>



1.2 Preprocess the Data

GANs
MNIST CelebA 28Œ28 [-0.5, 0.5] CelebA 28x28
MNIST [](https://en.wikipedia.org/wiki/Channel_(digital_image%29)CelebA [RGB](https://en.wikipedia.org/wiki/Channel_(digital_image%29#RGB_Images)

1.3 Build the Neural Network

GANs : - `model_inputs` - `discriminator` - `generator` - `model_loss` - `model_opt` - `train`

1.3.1 TensorFlow GPU

TensorFlow GPU

In [19]:
```
"""
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 TensorFlow vers
```

```
        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: 1.3.0
Default GPU Device: /gpu:0
```

1.3.2 Input

model_inputs (TF Placeholders) - : image_widthimage_height image_channels rank 4 - Z : rank 2 z_dim - : rank 0

(tensor of real input images, tensor of z data, learning rate)

```
In [20]: 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 rate)
            """
            # TODO: Implement Function
            inputs_real = tf.placeholder(tf.float32, (None, image_width, image_height, image_ch
            inputs_z  = tf.placeholder(tf.float32, (None, z_dim), name = 'input_z')
            learn_rate = tf.placeholder(tf.float32, shape=[])
            return inputs_real, inputs_z, learn_rate


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

```
Tests Passed
```

1.3.3 Discriminator

discriminator images tf.variable_scope "discriminator"

(tensor output of the discriminator, tensor logits of the discriminator)

```
In [21]: def discriminator(images, reuse=False, alpha = 0.2):
             """
             Create the discriminator network
             :param image: 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 discrim
             """
             # TODO: Implement Function
             with tf.variable_scope('discriminator', reuse = reuse):
                 x1 = tf.layers.conv2d(images,64, 5, strides = 2, padding = 'same')
                 relu1 = tf.maximum(alpha*x1, x1)

                 x2 = tf.layers.conv2d(relu1, 128, 5, strides = 2, padding = 'same')
                 bn2 = tf.layers.batch_normalization(x2, training = True)
                 relu2 = tf.maximum(alpha*bn2,bn2)

                 x3 = tf.layers.conv2d(relu2, 256, 5, strides = 2, padding='same')
                 bn3 = tf.layers.batch_normalization(x3, training= True)
                 relu3 = tf.maximum(alpha*bn3, bn3)

                 flat = tf.reshape(relu3, (-1,4*4*256))
                 logits = tf.layers.dense(flat, 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
```

1.3.4 Generator

generator z `tf.variable_scope` "generator"
28 x 28 x `out_channel_dim`

```
In [23]: def generator(z, out_channel_dim, is_train=True, alpha=0.2):
             """
             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
        keep_prob=0.5
        with tf.variable_scope('generator', reuse=not is_train):
            x1 = tf.layers.dense(z, 7*7*1024)

            # Reshape it to start the convolutional stack
            x1 = tf.reshape(x1, (-1, 7, 7, 1024))
            x1 = tf.layers.batch_normalization(x1, training=is_train)
            x1 = tf.maximum(alpha * x1, x1)
            x1 = tf.nn.dropout(x1, keep_prob=keep_prob)
            # 7x7x1024 now

            x2 = tf.layers.conv2d_transpose(x1, 512, 5, strides=2, padding='same')
            x2 = tf.layers.batch_normalization(x2, training=is_train)
            x2 = tf.maximum(alpha * x2, x2)
            x2 = tf.nn.dropout(x2, keep_prob=keep_prob)
            # 14x14x512 now

            x3 = tf.layers.conv2d_transpose(x2, 256, 5, strides=2, padding='same')
            x3 = tf.layers.batch_normalization(x3, training=is_train)
            x3 = tf.maximum(alpha * x3, x3)
            x3 = tf.nn.dropout(x3, keep_prob=keep_prob)
            # 28x28x256 now

            # Use strides=1 to preserve 28x28
            x4 = tf.layers.conv2d_transpose(x3, 128, 5, strides=1, padding='same')
            x4 = tf.layers.batch_normalization(x4, training=is_train)
            x4 = tf.maximum(alpha * x4, x4)
            x4 = tf.nn.dropout(x4, keep_prob=keep_prob)
            # 28x28x128 now

            # Output layer
            # Use strides=1 to preserve 28x28
            logits = tf.layers.conv2d_transpose(x4, out_channel_dim, 5, strides=1, padding=
            # 28x28x3 now

            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
```

1.3.5 Loss

`model_loss` GANs (discriminator loss, generator loss)
- `discriminator(images, reuse=False)` - `generator(z, out_channel_dim, is_train=True)`

```
In [24]: 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)
             """
             smooth = 0.2

             g_model = generator(input_z, out_channel_dim)
             d_model_real, d_logits_real = discriminator(input_real)
             d_model_fake, d_logits_fake = discriminator(g_model, reuse=True)

             d_loss_real = tf.reduce_mean(
                 tf.nn.sigmoid_cross_entropy_with_logits(logits=d_logits_real, labels=tf.ones_li
             d_loss_fake = tf.reduce_mean(
                 tf.nn.sigmoid_cross_entropy_with_logits(logits=d_logits_fake, labels=tf.zeros_l
             g_loss = tf.reduce_mean(
                 tf.nn.sigmoid_cross_entropy_with_logits(logits=d_logits_fake, labels=tf.ones_li

             d_loss = d_loss_real + d_loss_fake

             return d_loss, g_loss


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

```
Tests Passed
```

1.3.6 Optimization

`model_opt` GANs `tf.trainable_variables` `discriminator` `generator` (discriminator training operation, generator training operation)

```
In [25]: 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 operation
        """
        # TODO: Implement Function
        # TODO: Implement Function

        t_vars = tf.trainable_variables()
        d_vars = [var for var in t_vars if var.name.startswith('discriminator')]
        g_vars = [var for var in t_vars if var.name.startswith('generator')]

        # Optimize
        with tf.control_dependencies(tf.get_collection(tf.GraphKeys.UPDATE_OPS)):
            d_train_opt = tf.train.AdamOptimizer(learning_rate, beta1=beta1).minimize(d_los
            g_train_opt = tf.train.AdamOptimizer(learning_rate, beta1=beta1).minimize(g_los

        return d_train_opt, g_train_opt


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

```
Tests Passed
```

1.4 Neural Network Training

1.4.1

(Generator) GANs

In [26]:
```
"""
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()
```

1.4.2

train GANs - 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)
show_generator_output generator
(batch) show_generator_output notebook 100 generator

```
In [27]: def train(epoch_count, batch_size, z_dim, learning_rate, beta1, get_batches, data_shape
    """
    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
    steps = 0
    _, image_width, image_height, image_channels = data_shape
    input_real, input_z, l_r = model_inputs(image_width, image_height, image_channels,
    d_loss, g_loss = model_loss(input_real, input_z, image_channels)
    d_opt, g_opt = model_opt(d_loss, g_loss, l_r, beta1)
    d_loss_vec = []
    g_loss_vec = []

    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
                batch_images *= 2 # Scale from [-0.5, 0.5] to [-1, 1]
                steps += 1
```

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

                # Run optimizers
                _ = sess.run(d_opt, feed_dict={input_real: batch_images, input_z: batch

                # Optimize twice for generator so discriminator loss does not go to 0
                _ = sess.run(g_opt, feed_dict={input_z: batch_z, input_real: batch_imag
                _ = sess.run(g_opt, feed_dict={input_z: batch_z, input_real: batch_imag

                # Store losses every 10 steps for plotting
                if steps % 10 == 0:
                    train_loss_d = d_loss.eval({input_z: batch_z, input_real: batch_ima
                    train_loss_g = g_loss.eval({input_z: batch_z})
                    d_loss_vec.append(train_loss_d)
                    g_loss_vec.append(train_loss_g)

                # Display loss and generator output every 100 steps
                if steps % 100 == 0:
                    print("Epoch {}/{}...".format(epoch_i+1, epoch_count),
                          "Discriminator Loss: {:.4f}...".format(train_loss_d),
                          "Generator Loss: {:.4f}".format(train_loss_g))

                    show_generator_output(sess, 25, input_z, image_channels, data_image
```

1.4.3 MNIST

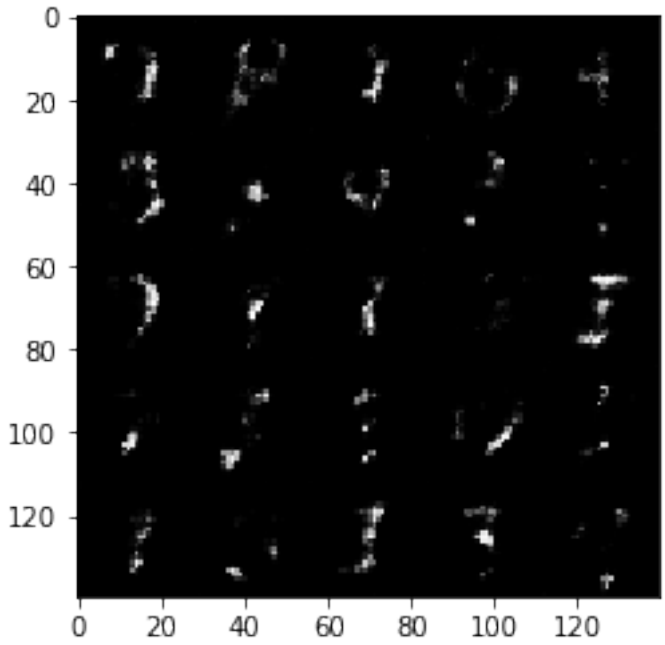
MNIST GANs 2 GANs (generator) (discriminator) 0

```
In [28]: batch_size = 32
         z_dim = 256
         learning_rate = 0.0008 # between 0.0002 and 0.0008
         beta1 = 0.4 # between 0.2 and 0.5

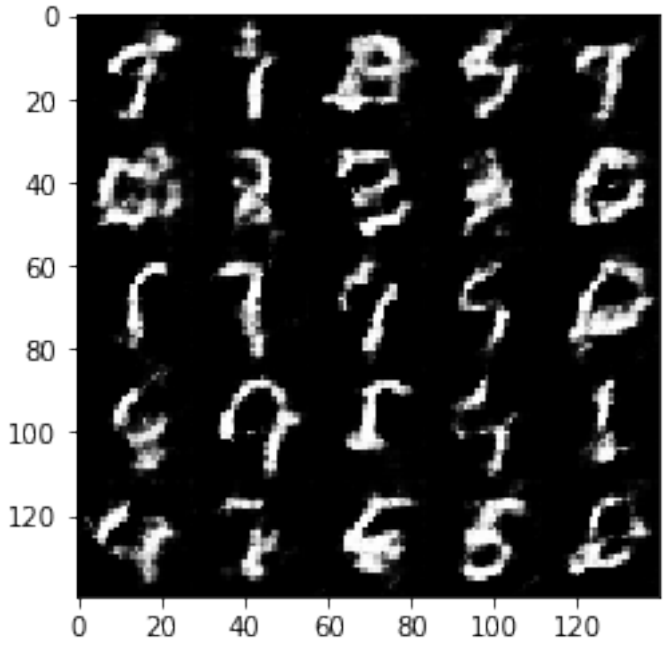
         """
         DON'T MODIFY ANYTHING IN THIS CELL THAT IS BELOW THIS LINE
         """
         epochs = 2

         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_batches,
                   mnist_dataset.shape, mnist_dataset.image_mode)
```

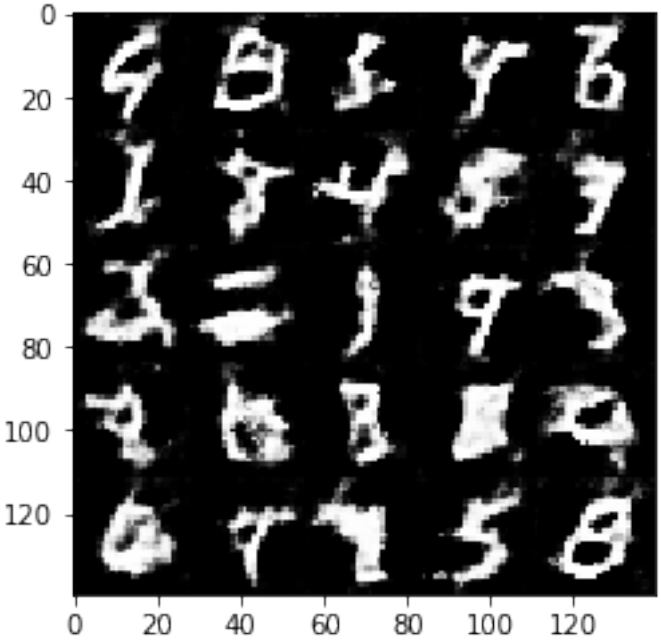
```
Epoch 1/2... Discriminator Loss: 1.8471... Generator Loss: 0.5753
```



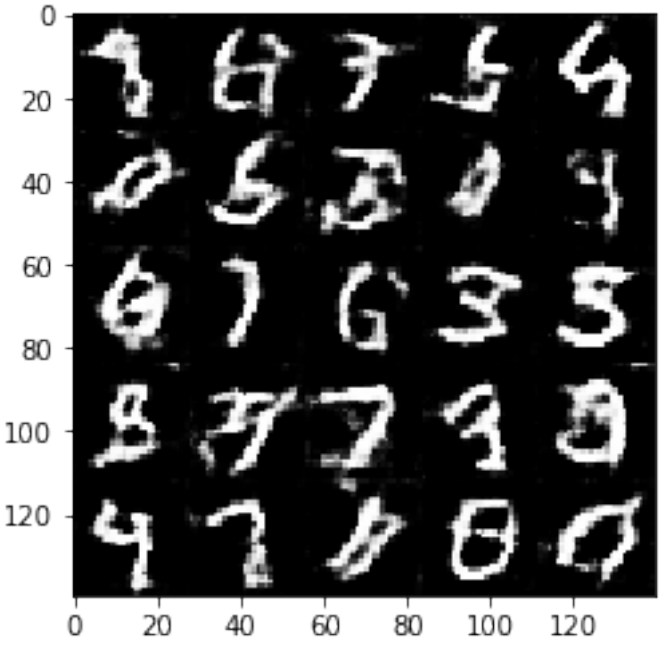

```
Epoch 1/2... Discriminator Loss: 1.6768... Generator Loss: 0.4889
```



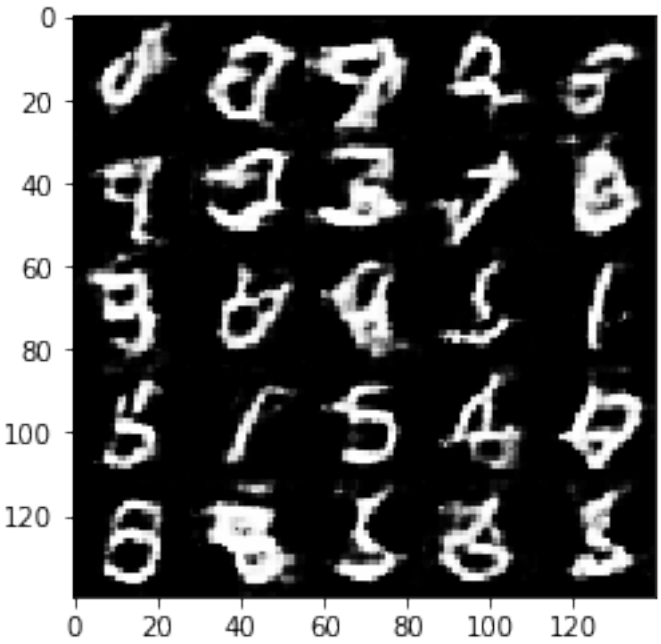
```
Epoch 1/2... Discriminator Loss: 1.4483... Generator Loss: 0.8351
```



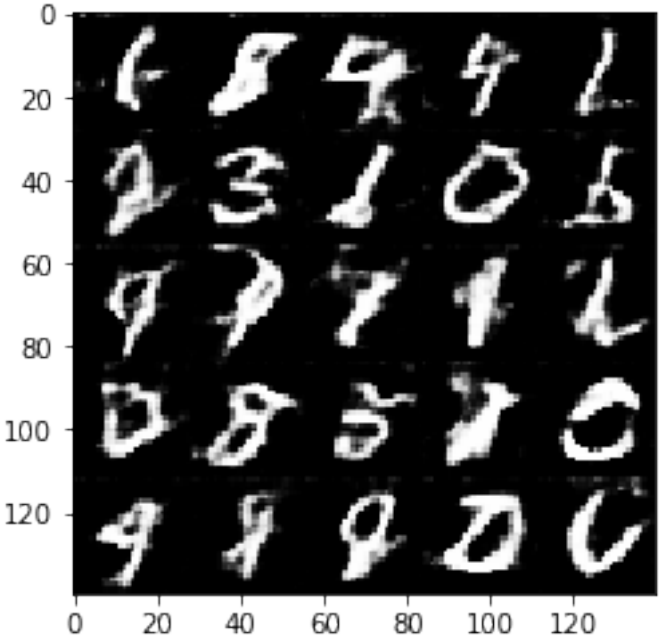

```
Epoch 1/2... Discriminator Loss: 1.6323... Generator Loss: 0.5284
```



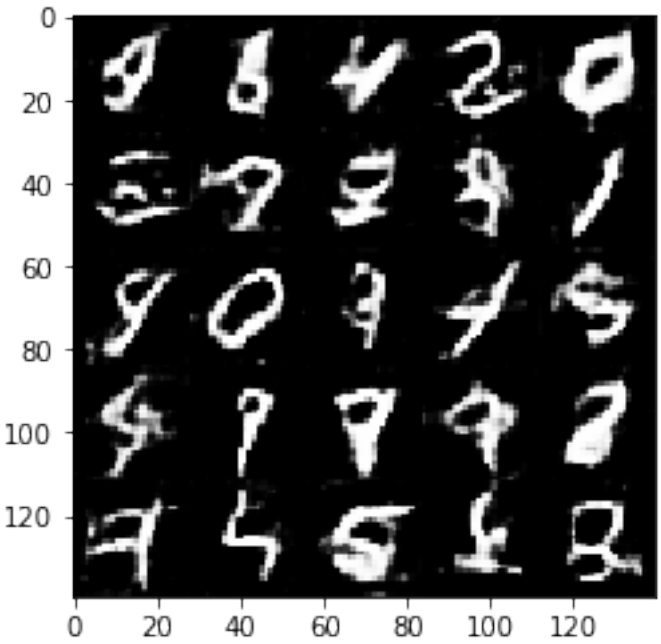
```
Epoch 1/2... Discriminator Loss: 1.5343... Generator Loss: 0.6572
```



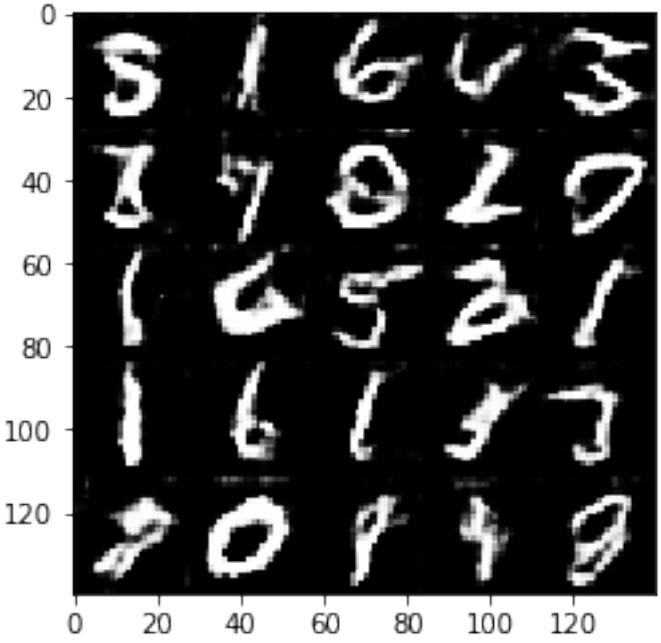

```
Epoch 1/2... Discriminator Loss: 2.0290... Generator Loss: 0.2888
```



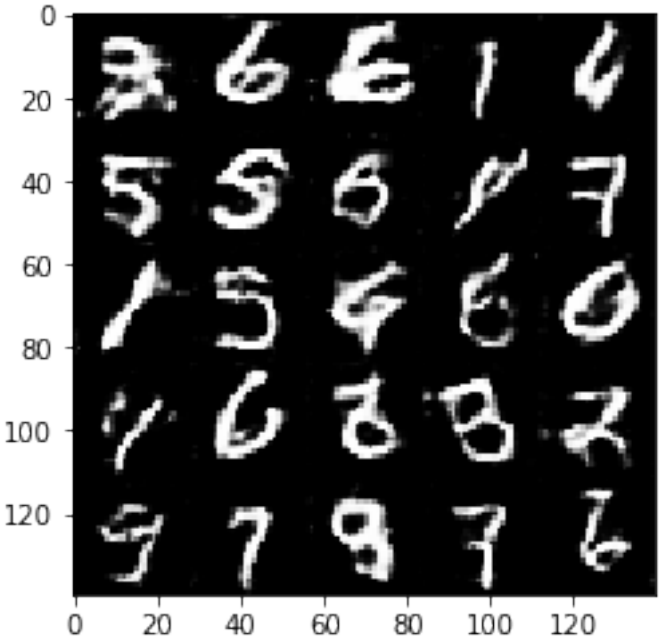
```
Epoch 1/2... Discriminator Loss: 1.6175... Generator Loss: 0.4845
```



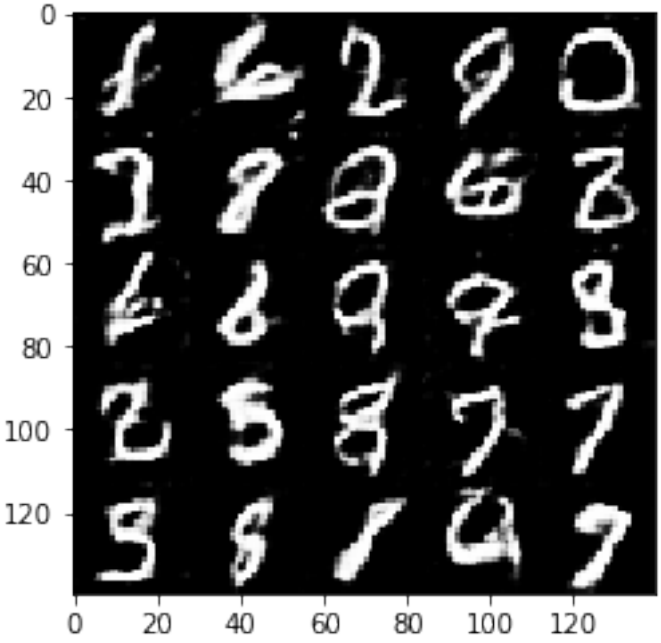

```
Epoch 1/2... Discriminator Loss: 1.6009... Generator Loss: 0.5104
```



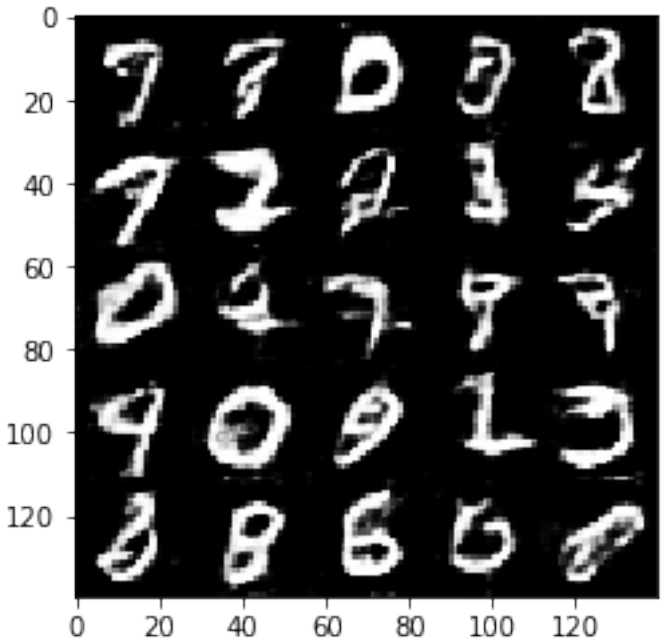
```
Epoch 1/2... Discriminator Loss: 1.6720... Generator Loss: 1.4527
```



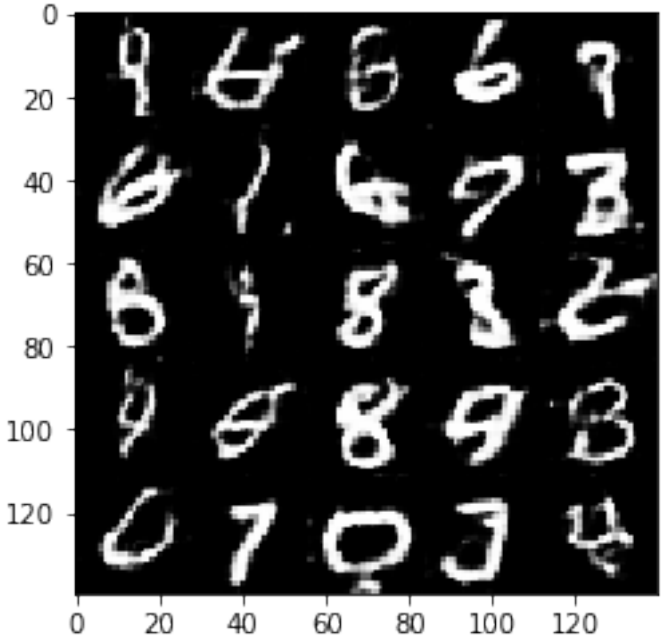

```
Epoch 1/2... Discriminator Loss: 1.7895... Generator Loss: 0.4422
```



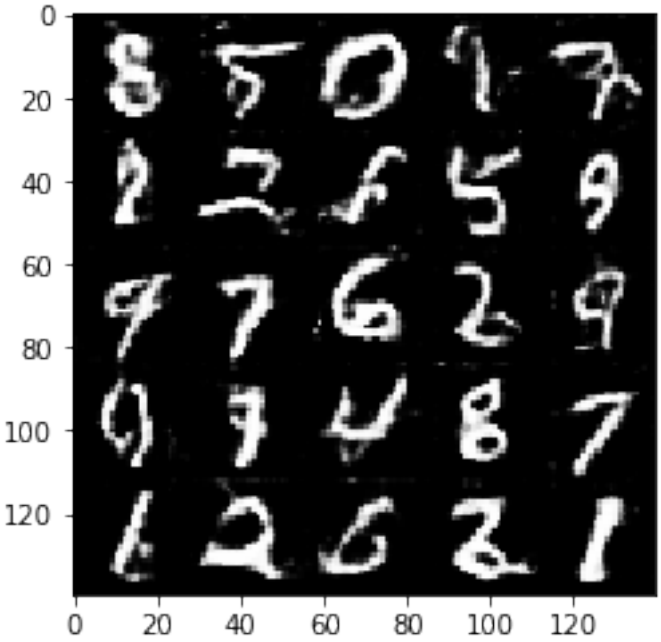
```
Epoch 1/2... Discriminator Loss: 1.4498... Generator Loss: 0.6302
```



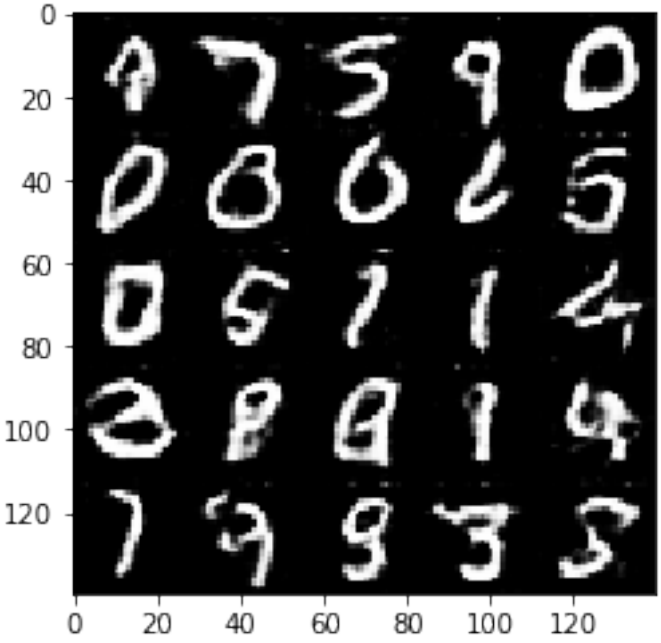

```
Epoch 1/2... Discriminator Loss: 1.1938... Generator Loss: 1.0049
```



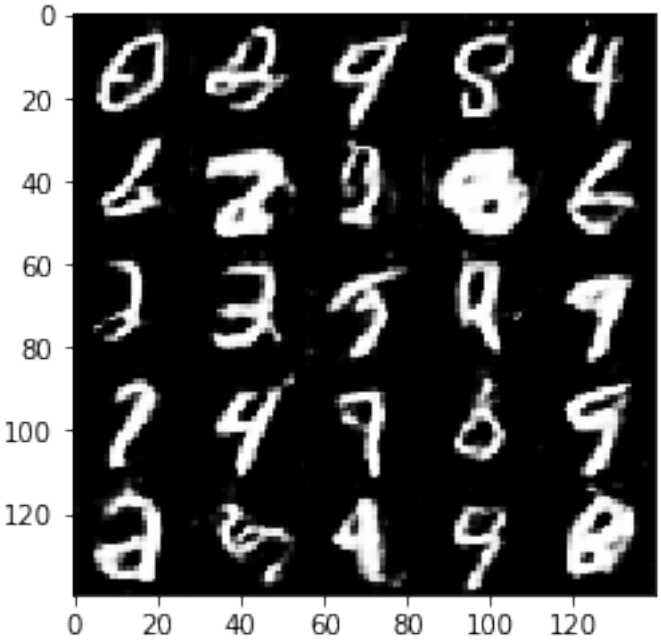
```
Epoch 1/2... Discriminator Loss: 1.2642... Generator Loss: 1.1617
```



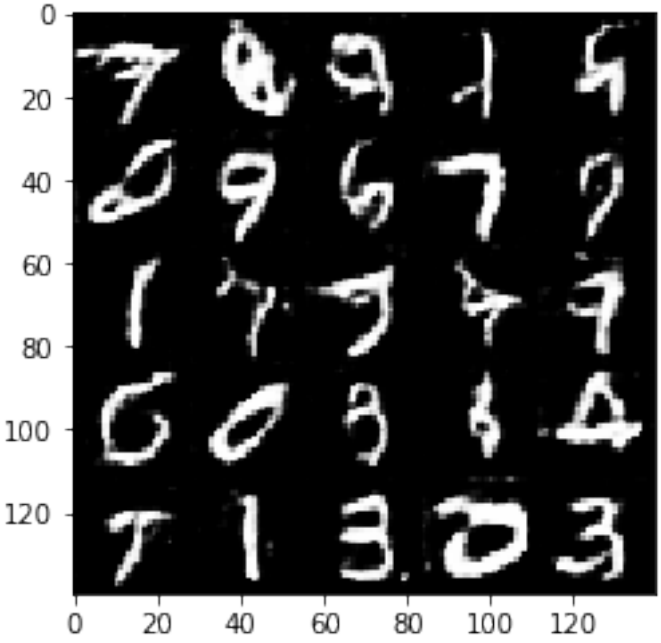

```
Epoch 1/2... Discriminator Loss: 1.6547... Generator Loss: 0.5110
```



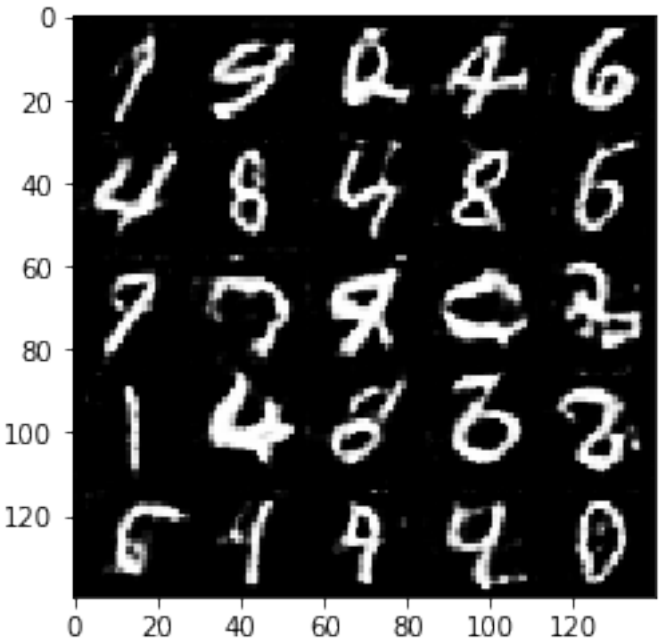
```
Epoch 1/2... Discriminator Loss: 1.4272... Generator Loss: 0.6948
```



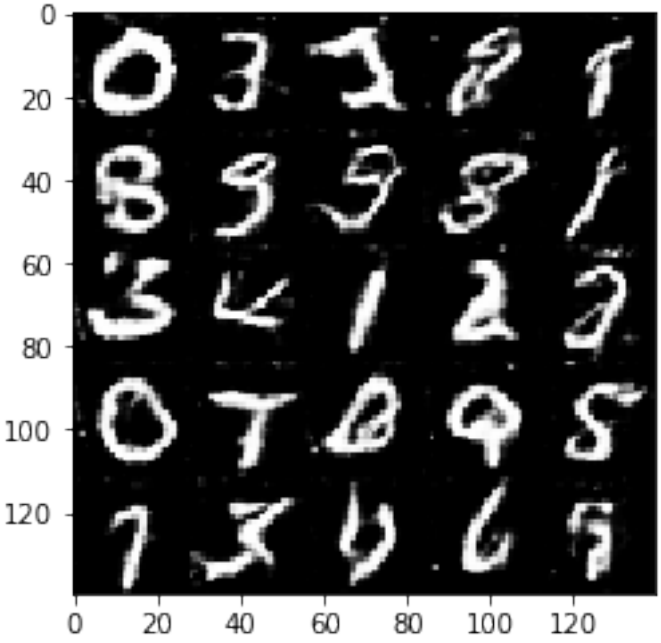

```
Epoch 1/2... Discriminator Loss: 1.1549... Generator Loss: 0.8894
```



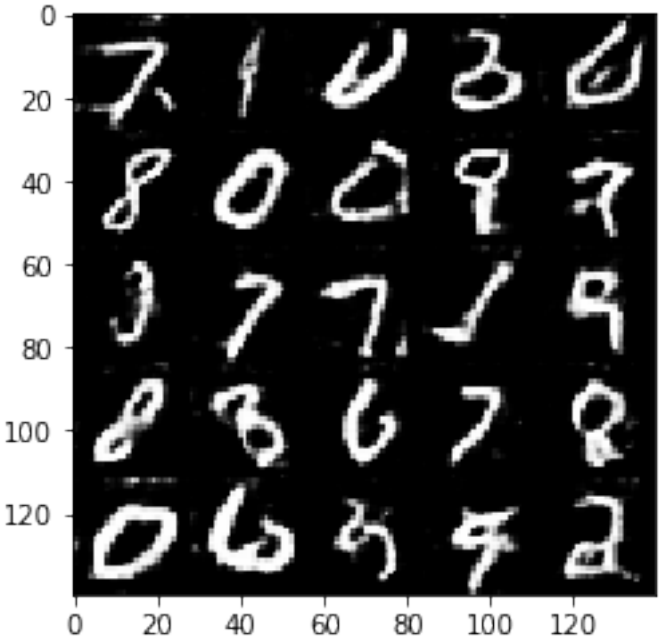
```
Epoch 1/2... Discriminator Loss: 1.1497... Generator Loss: 0.7455
```



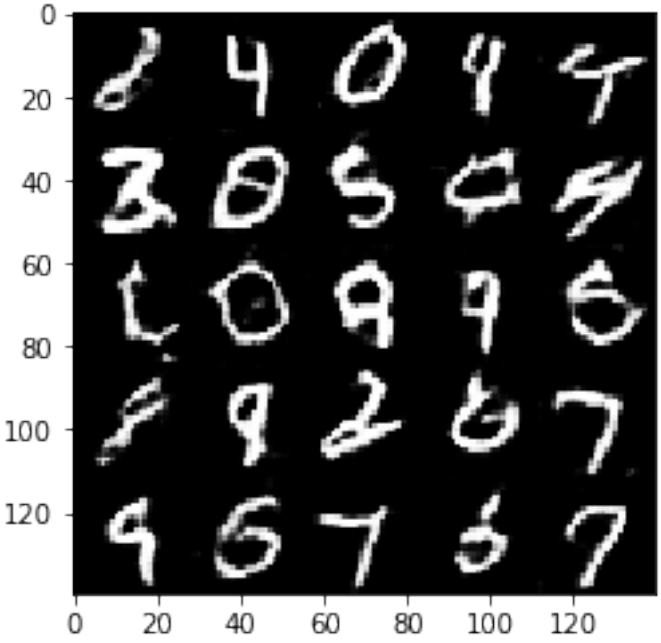

```
Epoch 1/2... Discriminator Loss: 1.1269... Generator Loss: 0.9037
```



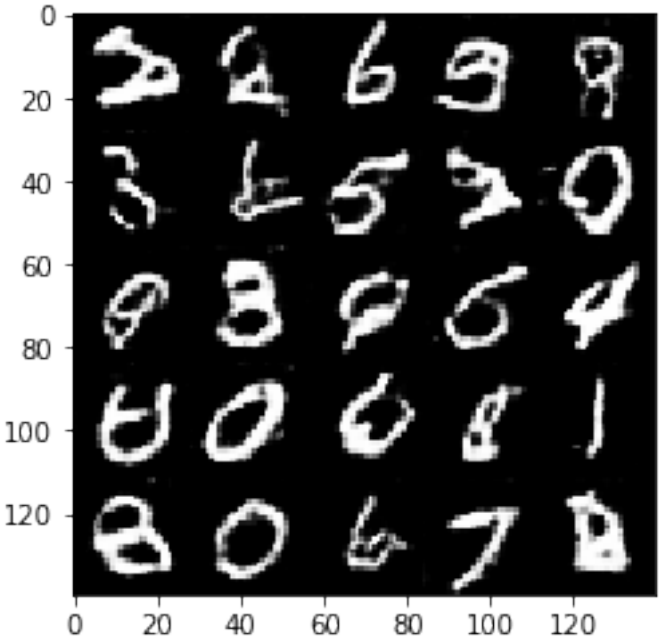
```
Epoch 2/2... Discriminator Loss: 1.3222... Generator Loss: 0.7090
```



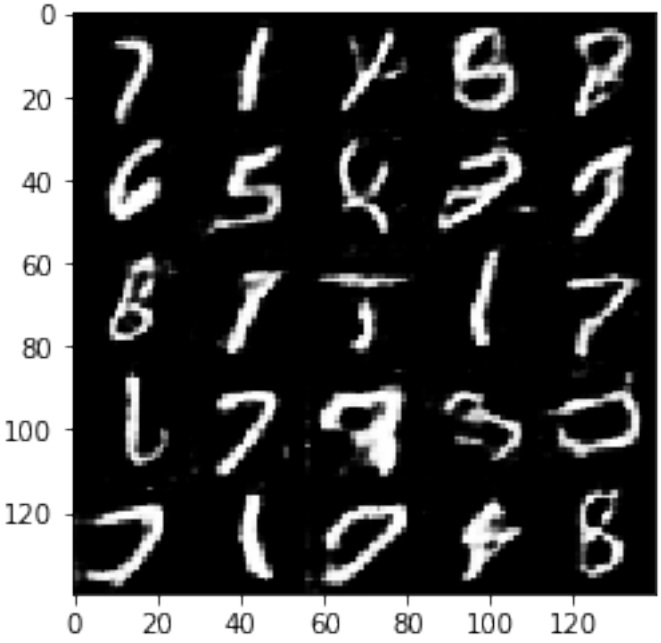

```
Epoch 2/2... Discriminator Loss: 1.1429... Generator Loss: 1.1160
```



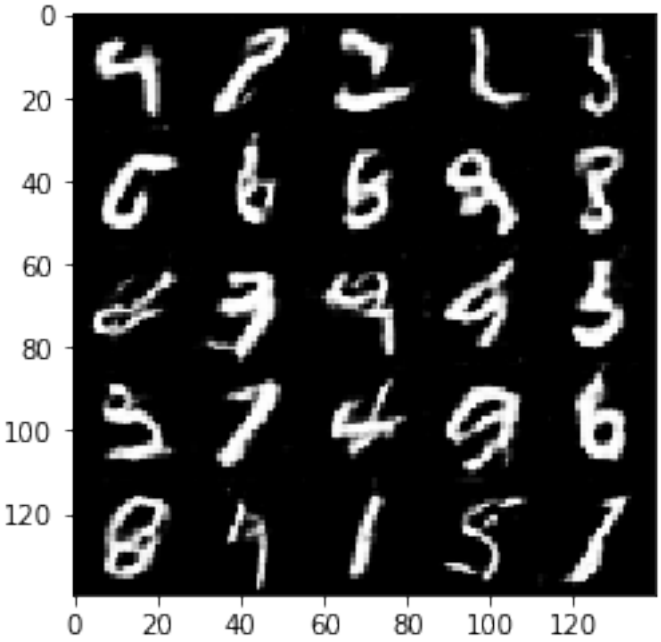
```
Epoch 2/2... Discriminator Loss: 1.4152... Generator Loss: 0.5755
```



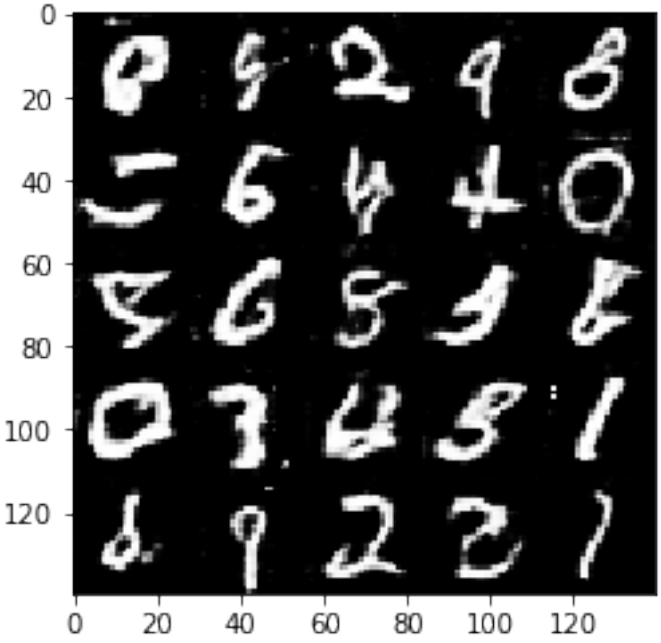

```
Epoch 2/2... Discriminator Loss: 1.3066... Generator Loss: 0.5953
```



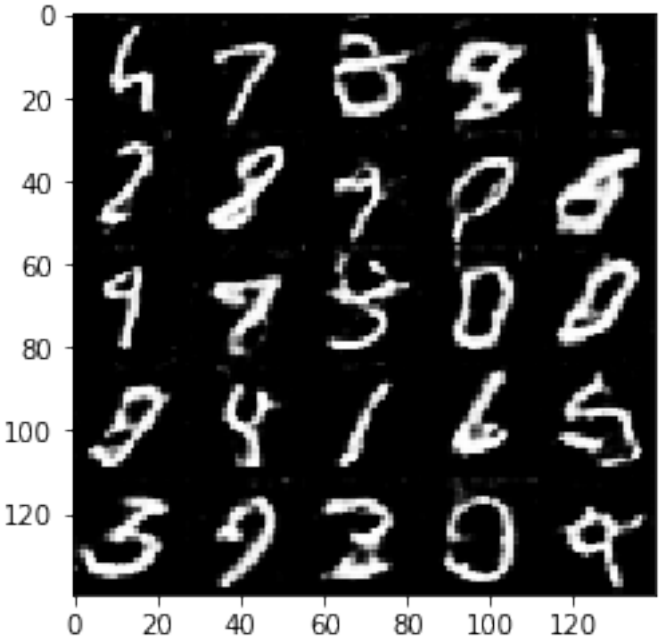
```
Epoch 2/2... Discriminator Loss: 1.2528... Generator Loss: 0.6917
```



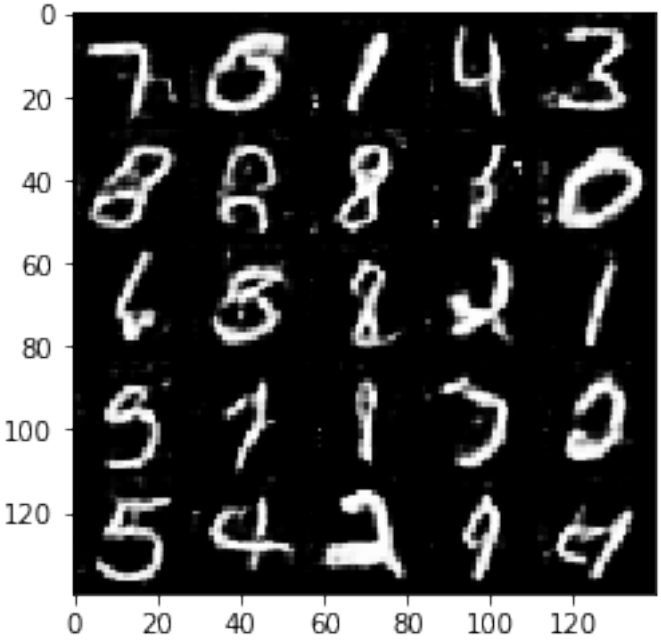

```
Epoch 2/2... Discriminator Loss: 1.2560... Generator Loss: 1.0030
```



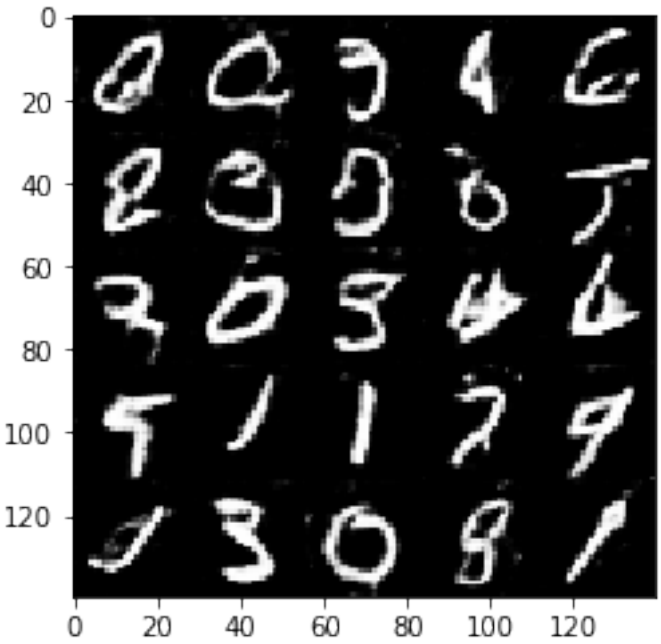
```
Epoch 2/2... Discriminator Loss: 1.2217... Generator Loss: 1.0742
```



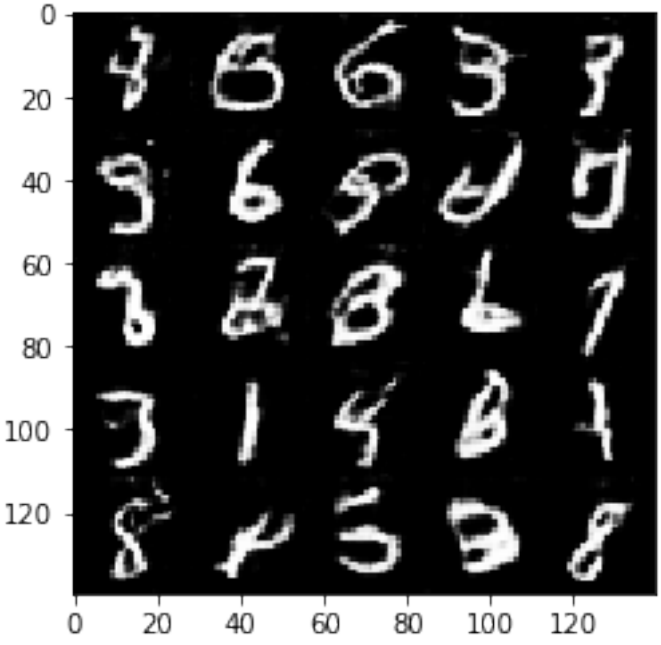

```
Epoch 2/2... Discriminator Loss: 1.2872... Generator Loss: 0.7967
```



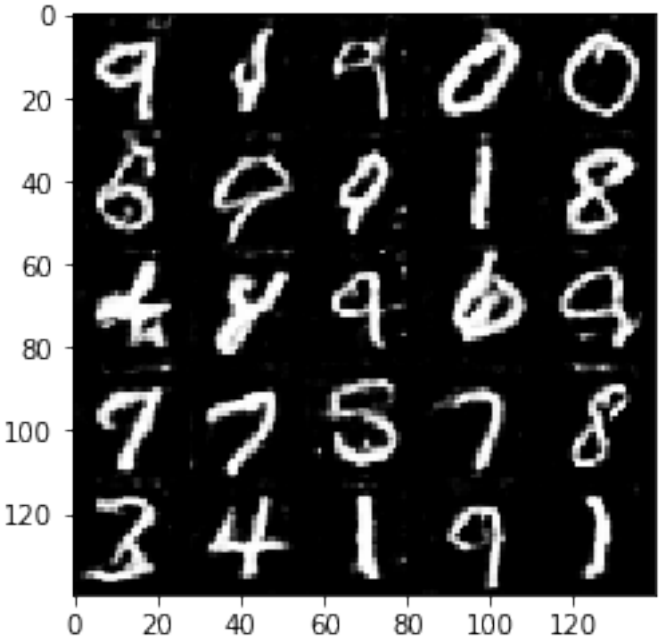
```
Epoch 2/2... Discriminator Loss: 1.0347... Generator Loss: 1.5695
```



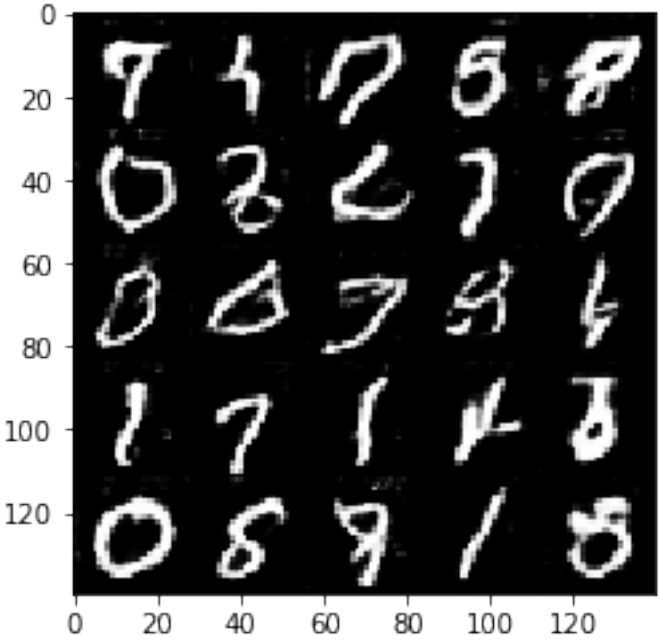

```
Epoch 2/2... Discriminator Loss: 1.6021... Generator Loss: 0.5147
```



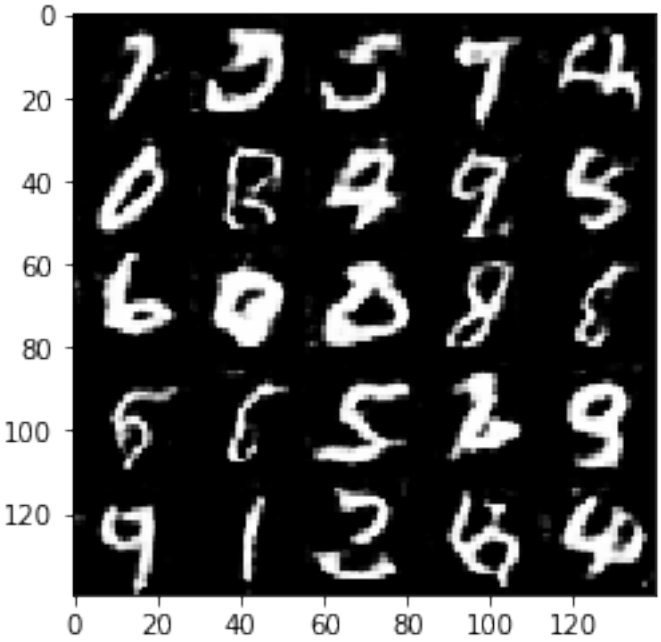
```
Epoch 2/2... Discriminator Loss: 0.9826... Generator Loss: 0.9895
```



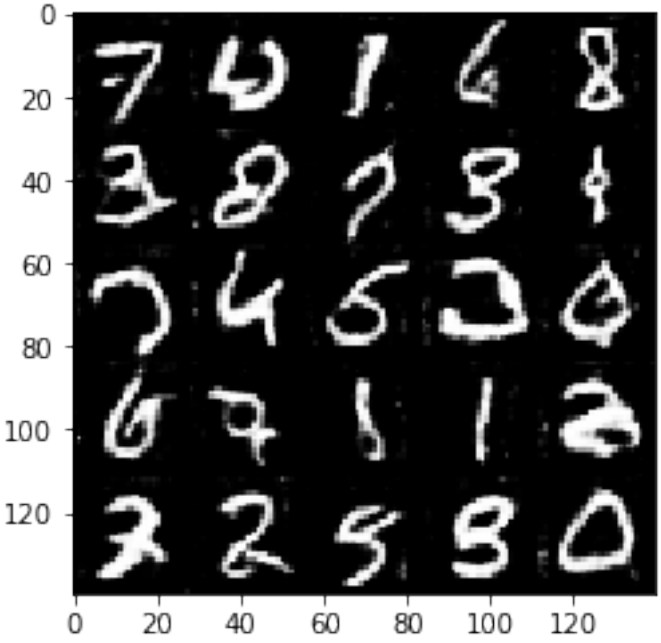

```
Epoch 2/2... Discriminator Loss: 0.9598... Generator Loss: 1.2598
```



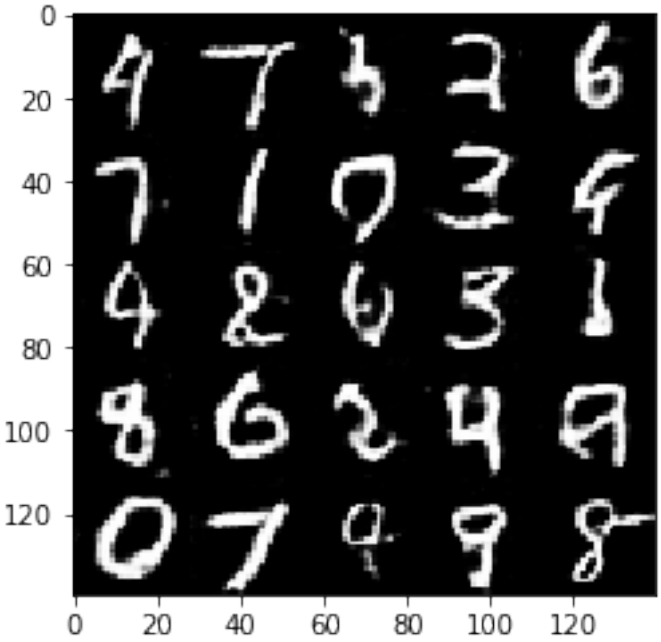
```
Epoch 2/2... Discriminator Loss: 1.2309... Generator Loss: 1.1132
```



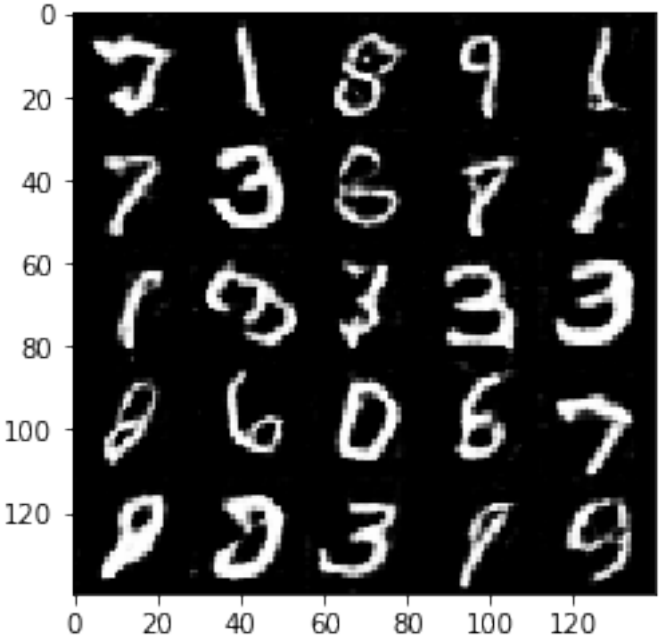

```
Epoch 2/2... Discriminator Loss: 0.9042... Generator Loss: 1.5393
```



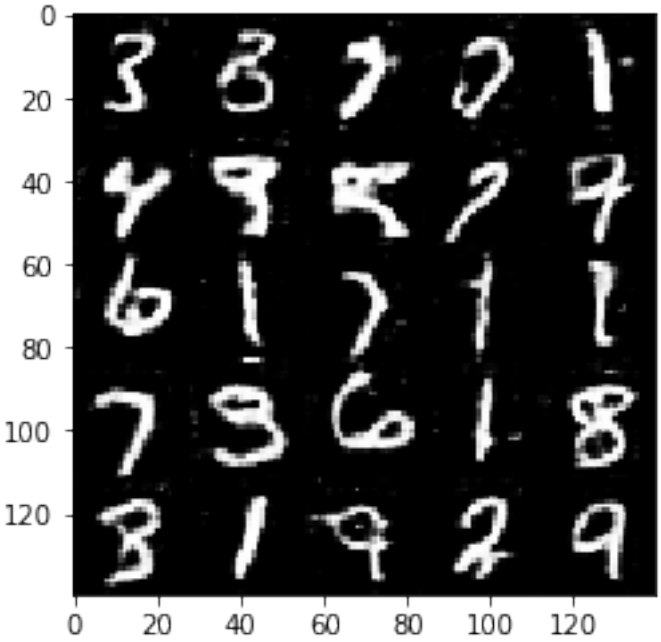
```
Epoch 2/2... Discriminator Loss: 0.9918... Generator Loss: 1.3611
```



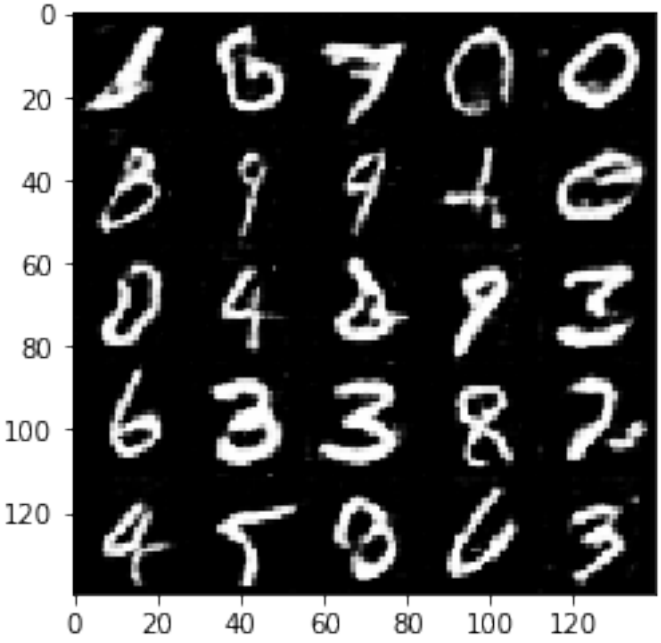

```
Epoch 2/2... Discriminator Loss: 0.9187... Generator Loss: 1.3112
```



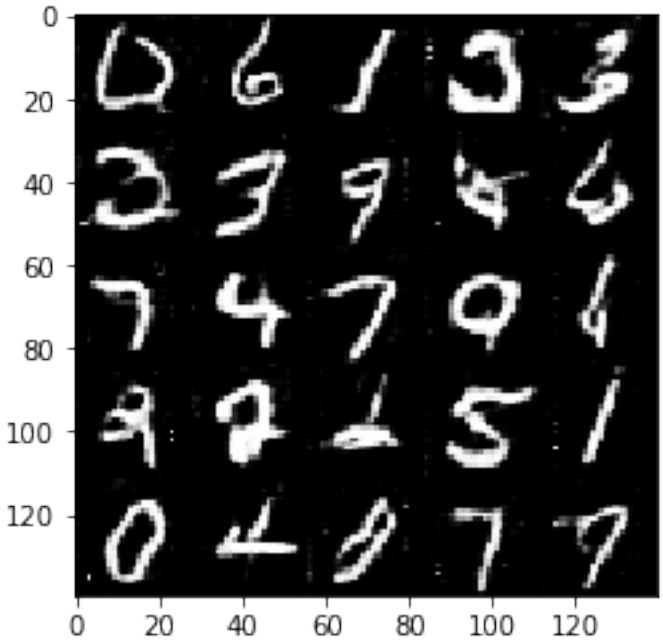
```
Epoch 2/2... Discriminator Loss: 1.0566... Generator Loss: 1.0371
```




```
Epoch 2/2... Discriminator Loss: 0.8657... Generator Loss: 1.5768
```



```
Epoch 2/2... Discriminator Loss: 1.3720... Generator Loss: 0.9738
```



1.4.4 CelebA

CelebA GANs GPU 20 GANs

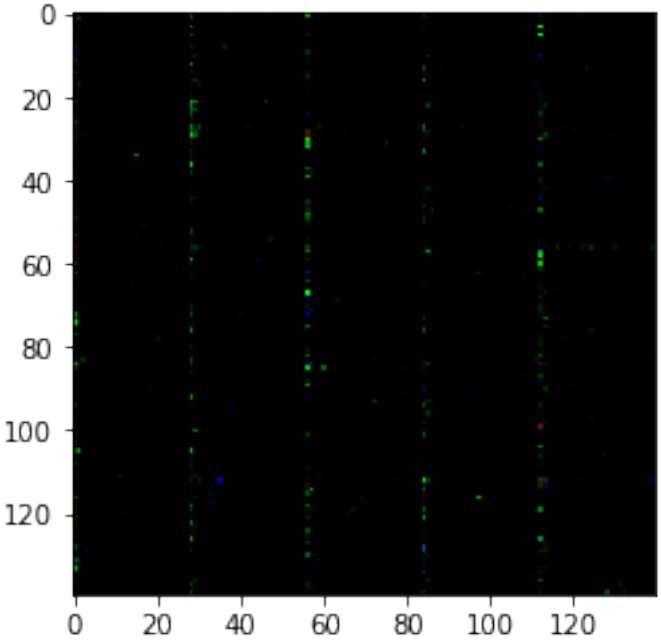
```
In [ ]: batch_size = 32 # start experimenting between 16 and 32
        z_dim = 128 # 128 - 256
        learning_rate = 0.0003 # between 0.0002 and 0.0008
        beta1 = 0.4 # between 0.2 and 0.5



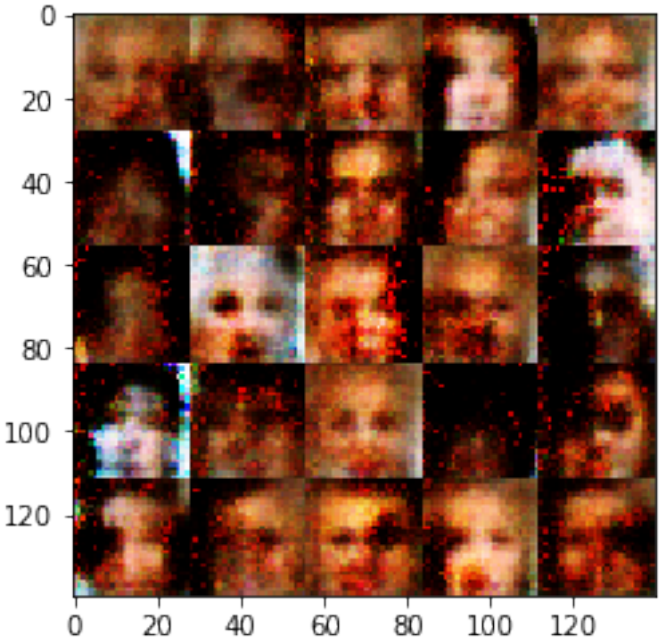
        """
        DON'T MODIFY ANYTHING IN THIS CELL THAT IS BELOW THIS LINE
        """
        epochs = 1

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

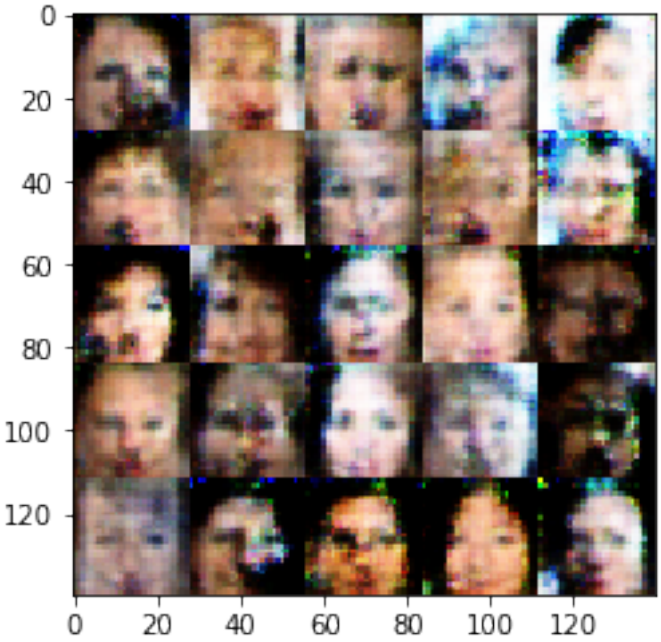
```
Epoch 1/1... Discriminator Loss: 1.0021... Generator Loss: 1.2706
```



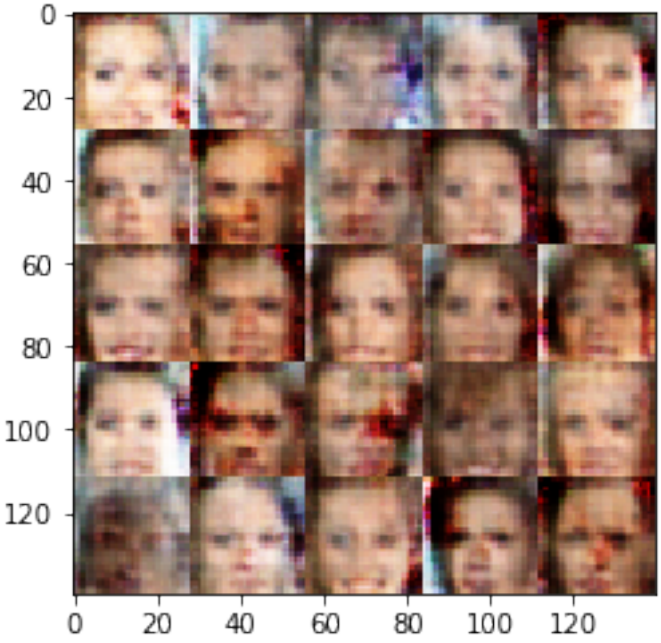

```
Epoch 1/1... Discriminator Loss: 1.3322... Generator Loss: 1.8281
```



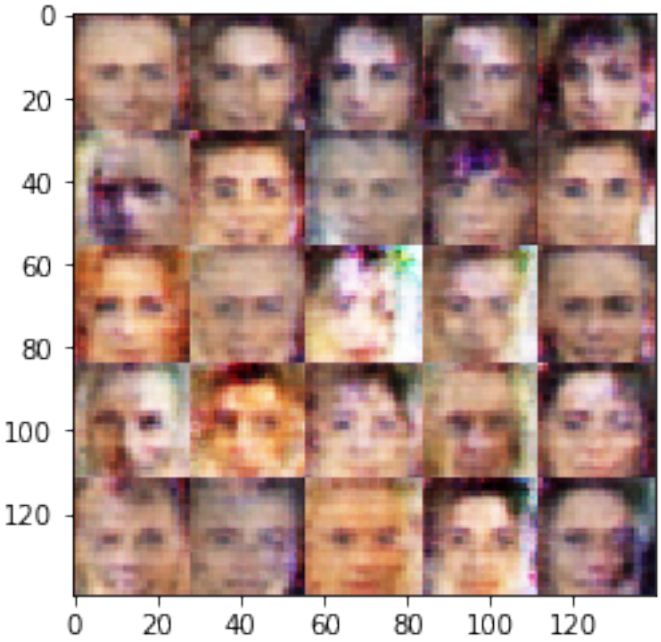
```
Epoch 1/1... Discriminator Loss: 1.2323... Generator Loss: 0.8478
```



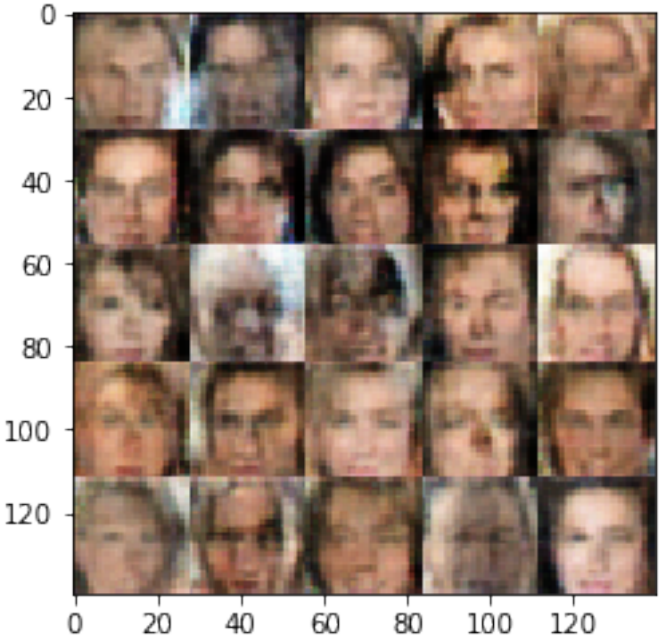

```
Epoch 1/1... Discriminator Loss: 1.5152... Generator Loss: 0.6402
```



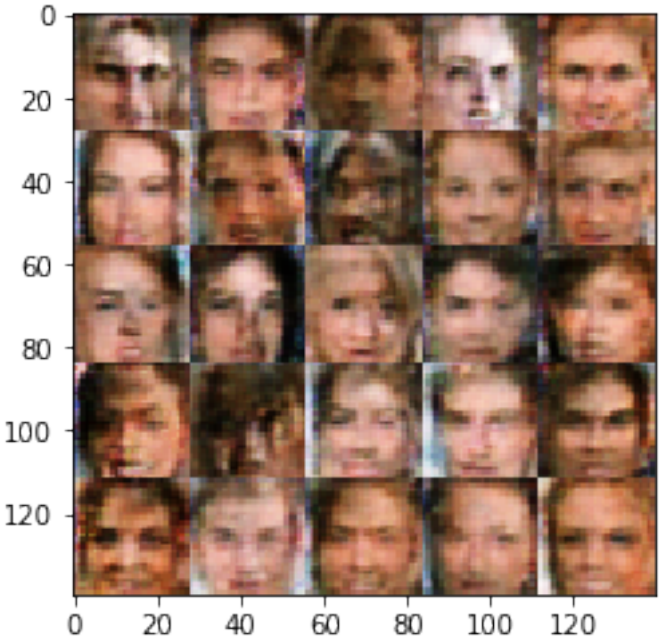
```
Epoch 1/1... Discriminator Loss: 1.4035... Generator Loss: 0.9153
```



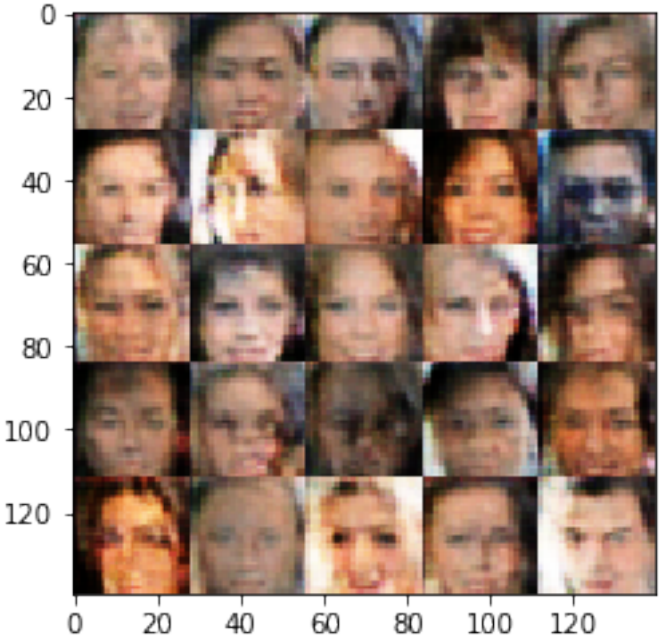

```
Epoch 1/1... Discriminator Loss: 1.4664... Generator Loss: 0.7653
```



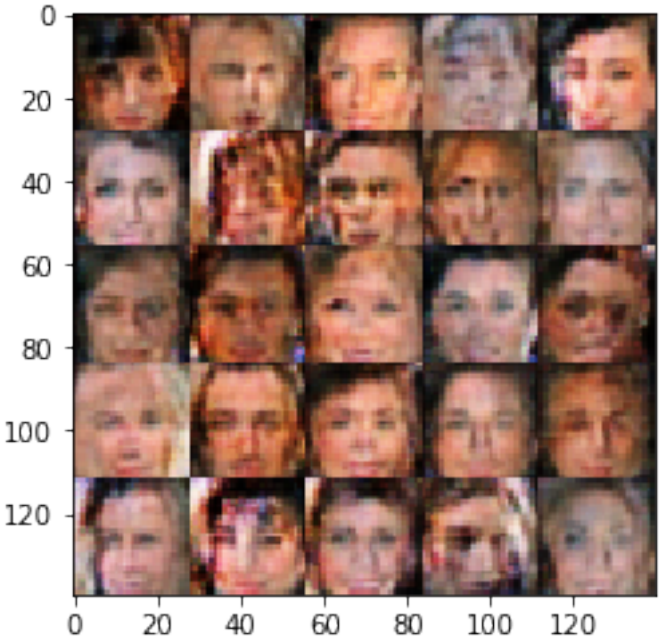
```
Epoch 1/1... Discriminator Loss: 1.4699... Generator Loss: 0.8190
```



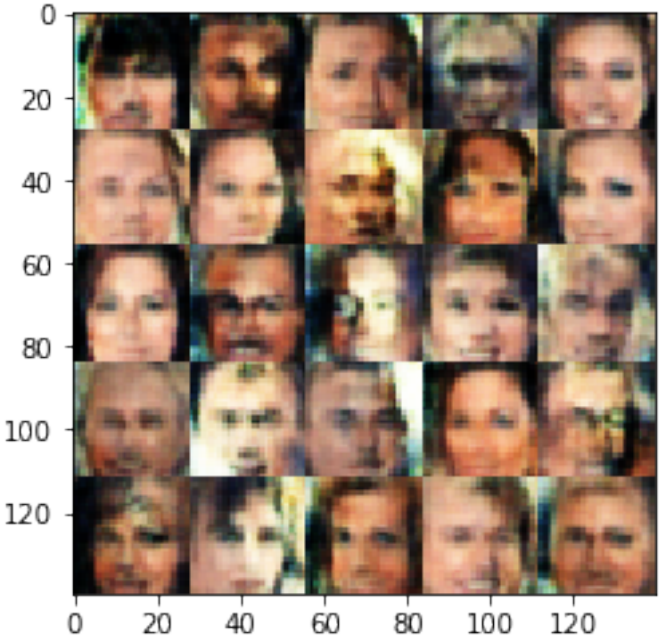

```
Epoch 1/1... Discriminator Loss: 1.3993... Generator Loss: 0.7912
```



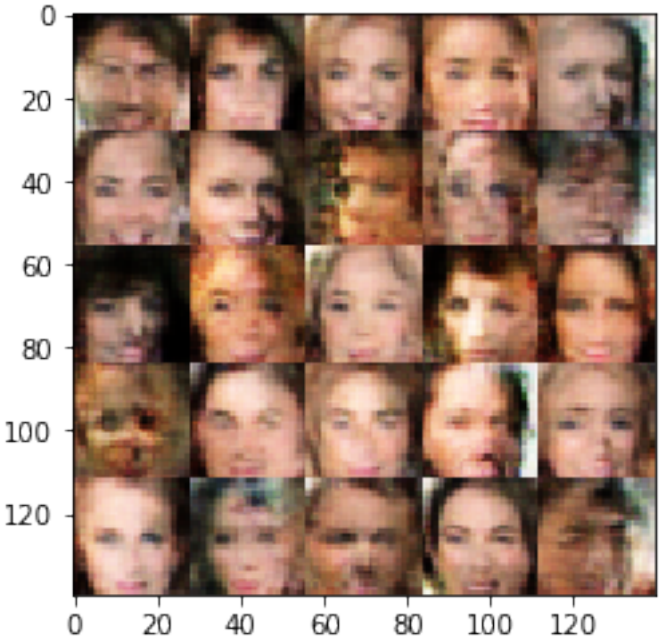
```
Epoch 1/1... Discriminator Loss: 1.4515... Generator Loss: 0.7607
```



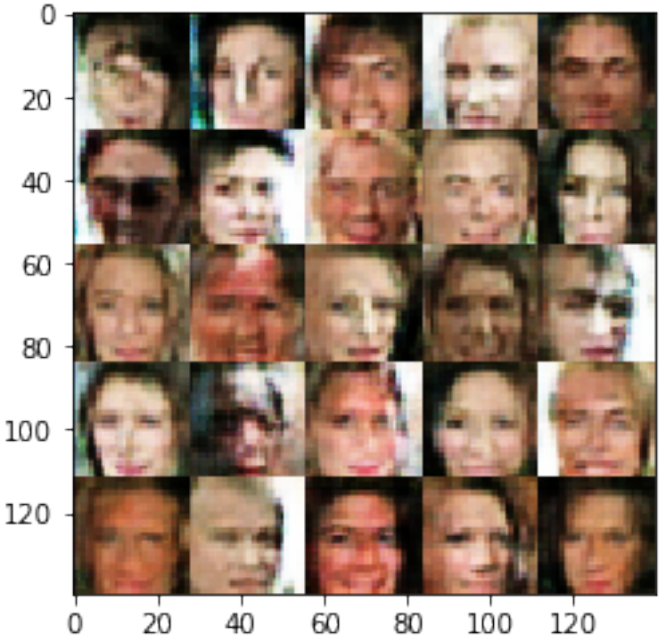

```
Epoch 1/1... Discriminator Loss: 1.4174... Generator Loss: 0.7780
```



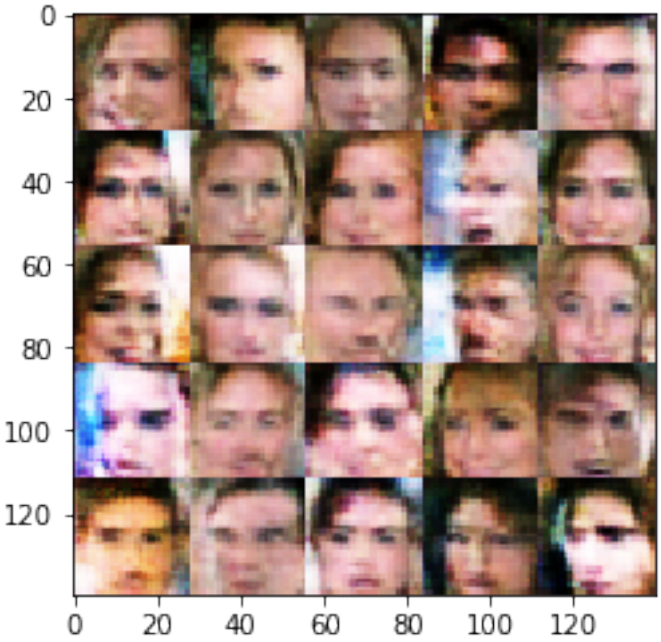
```
Epoch 1/1... Discriminator Loss: 1.4209... Generator Loss: 0.8069
```



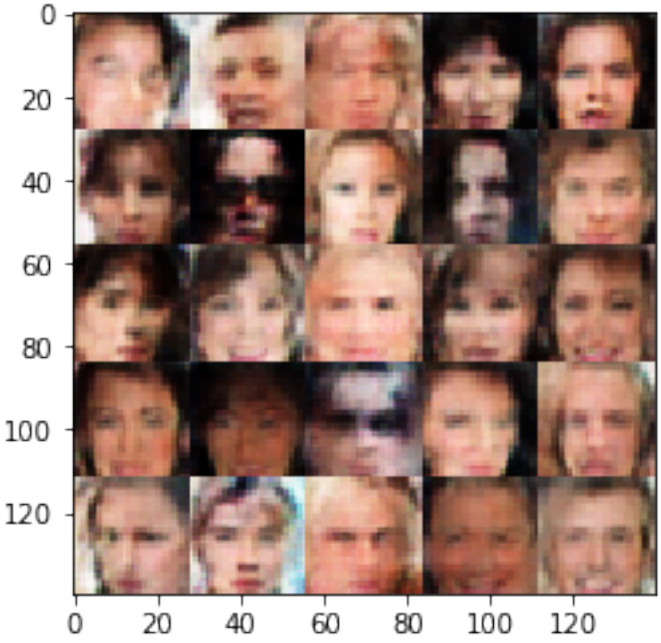

```
Epoch 1/1... Discriminator Loss: 1.4359... Generator Loss: 0.7490
```



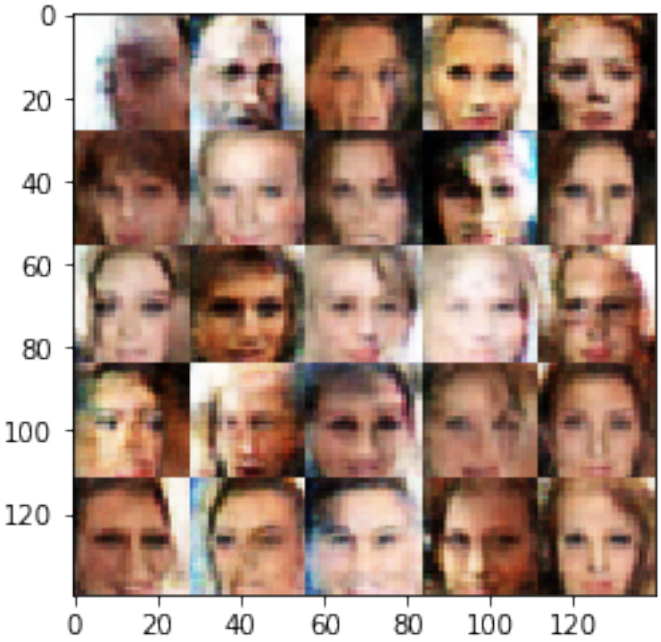
```
Epoch 1/1... Discriminator Loss: 1.3875... Generator Loss: 0.7724
```



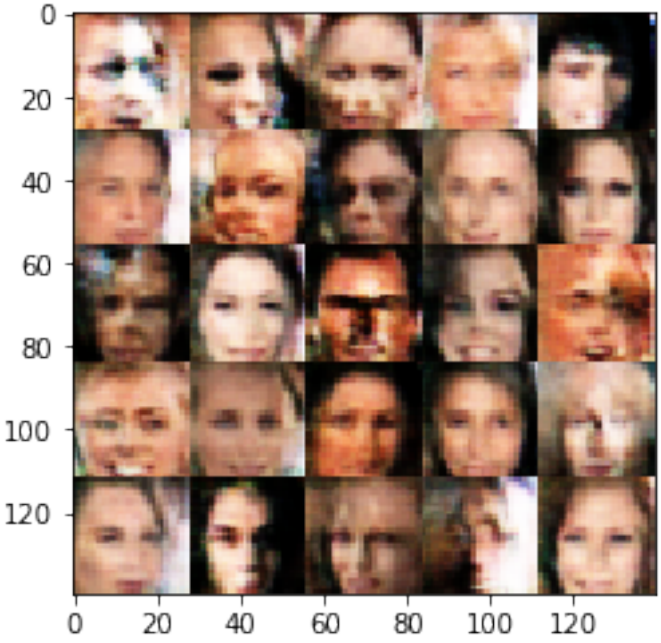

```
Epoch 1/1... Discriminator Loss: 1.3767... Generator Loss: 0.7875
```



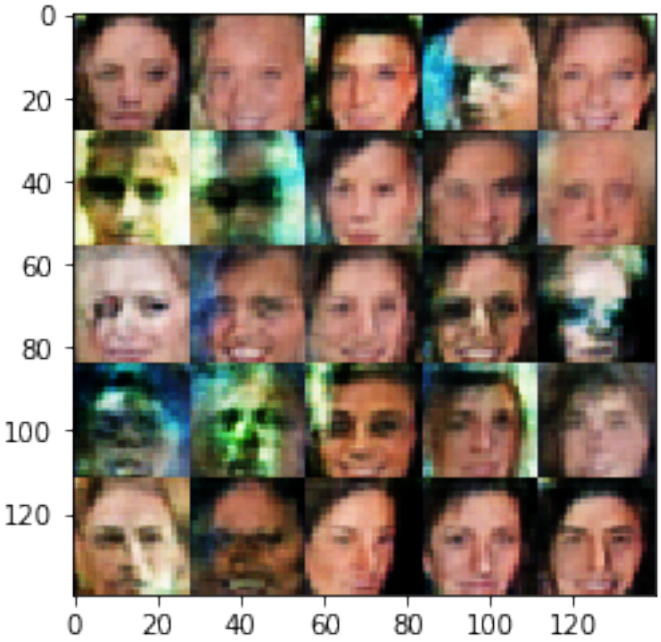
```
Epoch 1/1... Discriminator Loss: 1.4786... Generator Loss: 0.6987
```



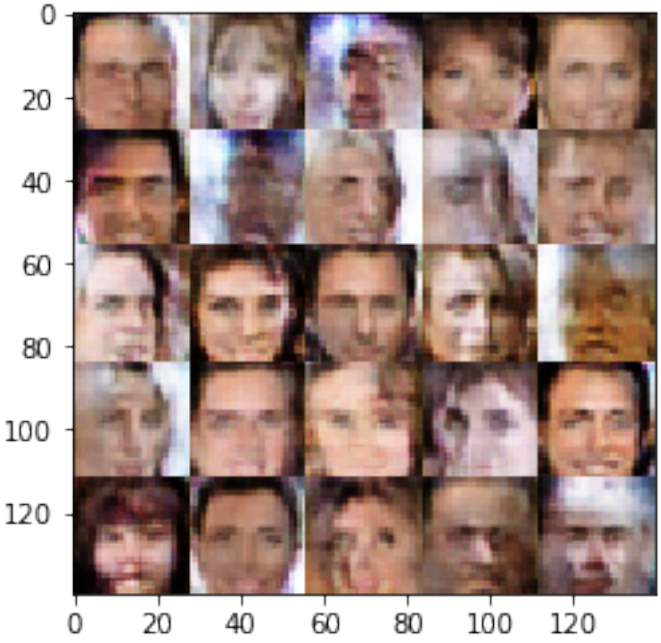

```
Epoch 1/1... Discriminator Loss: 1.4009... Generator Loss: 0.8036
```



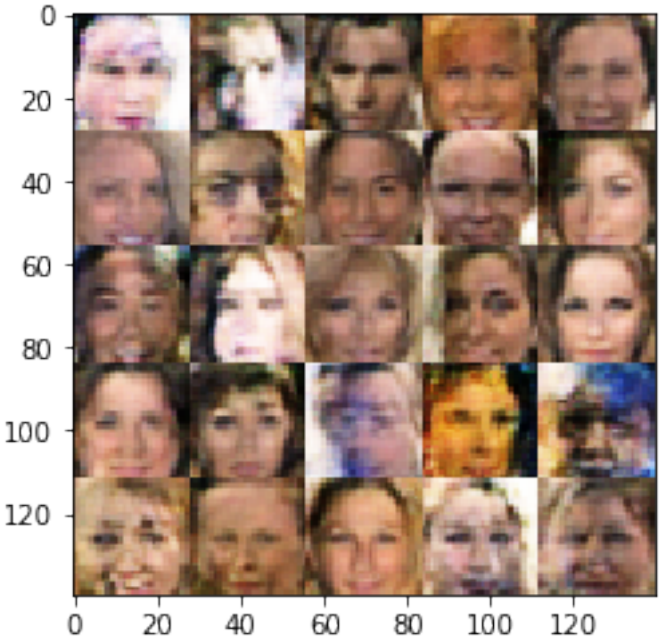
```
Epoch 1/1... Discriminator Loss: 1.4039... Generator Loss: 0.7485
```



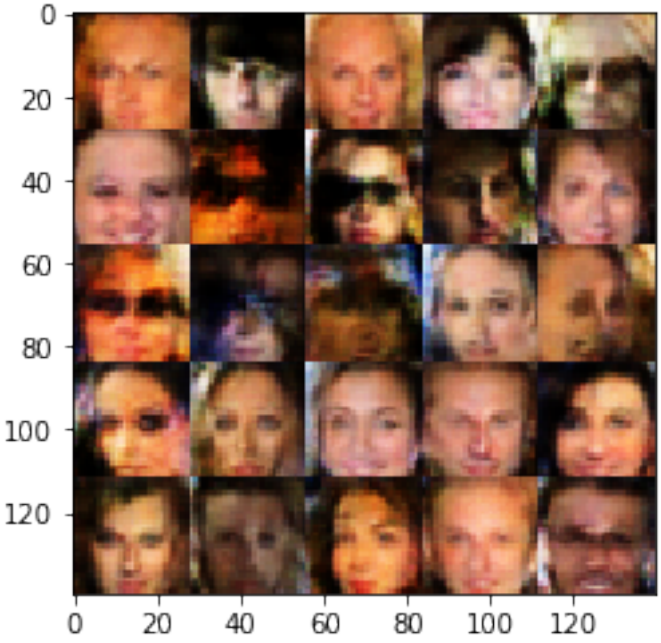

```
Epoch 1/1... Discriminator Loss: 1.3440... Generator Loss: 0.8721
```



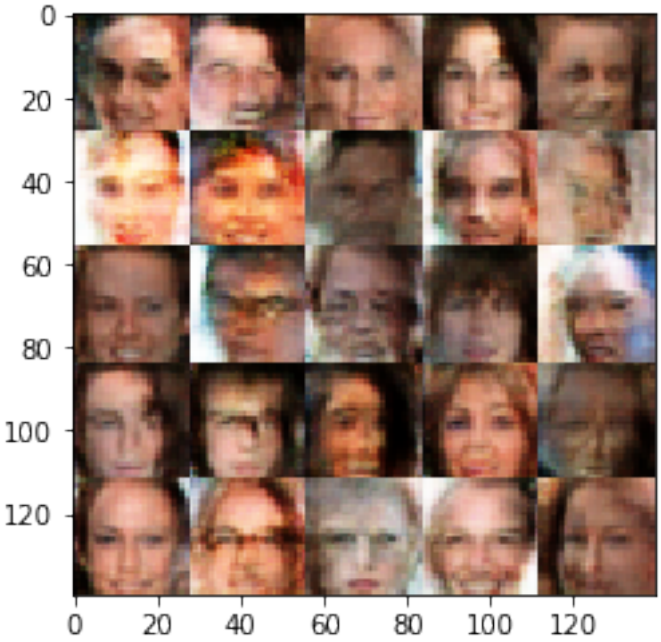
```
Epoch 1/1... Discriminator Loss: 1.4209... Generator Loss: 0.8973
```



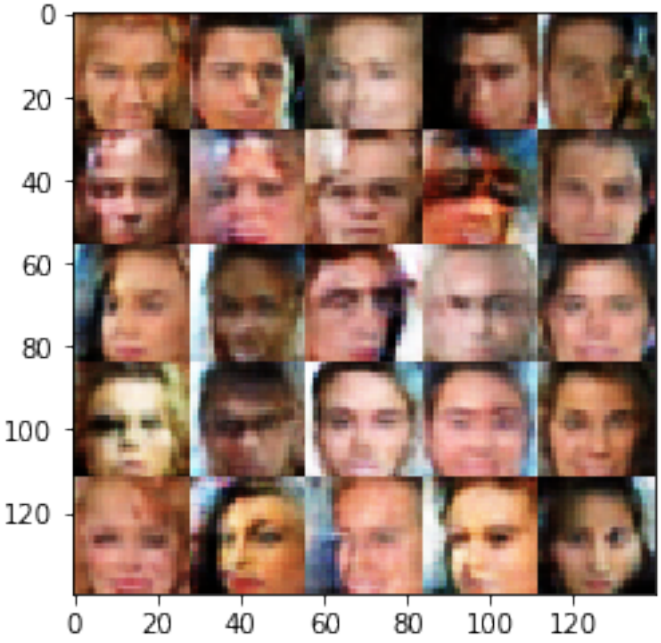

```
Epoch 1/1... Discriminator Loss: 1.3673... Generator Loss: 0.8634
```



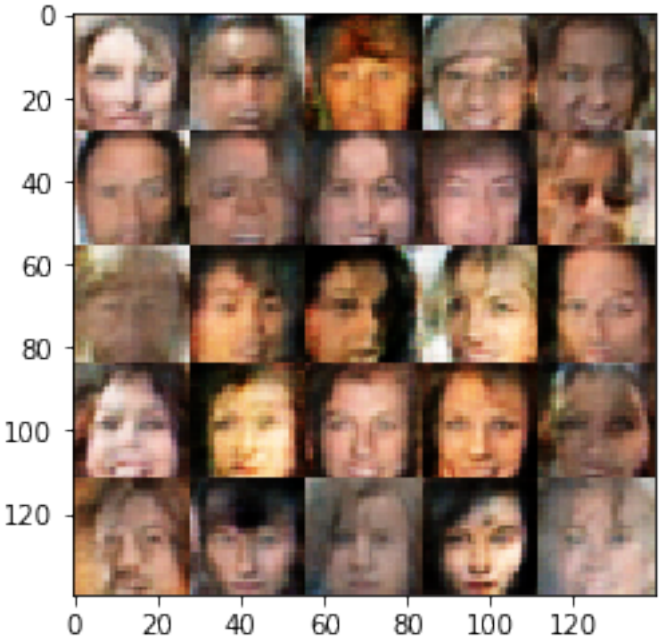
```
Epoch 1/1... Discriminator Loss: 1.4079... Generator Loss: 0.7768
```



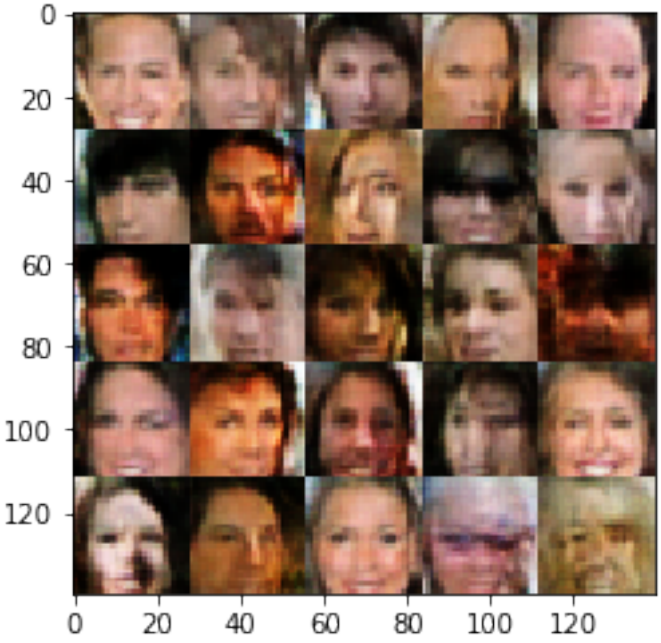

```
Epoch 1/1... Discriminator Loss: 1.4894... Generator Loss: 0.7846
```



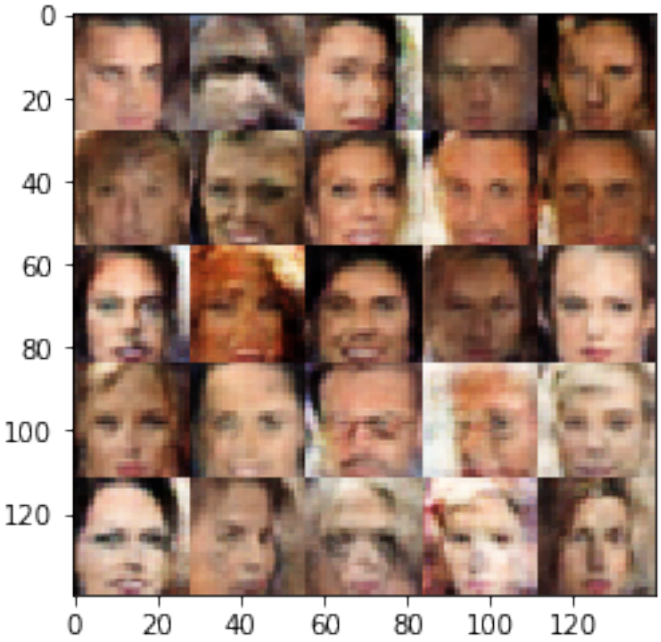
```
Epoch 1/1... Discriminator Loss: 1.4077... Generator Loss: 0.7999
```




```
Epoch 1/1... Discriminator Loss: 1.3650... Generator Loss: 0.8136
```



```
Epoch 1/1... Discriminator Loss: 1.3636... Generator Loss: 0.7824
```

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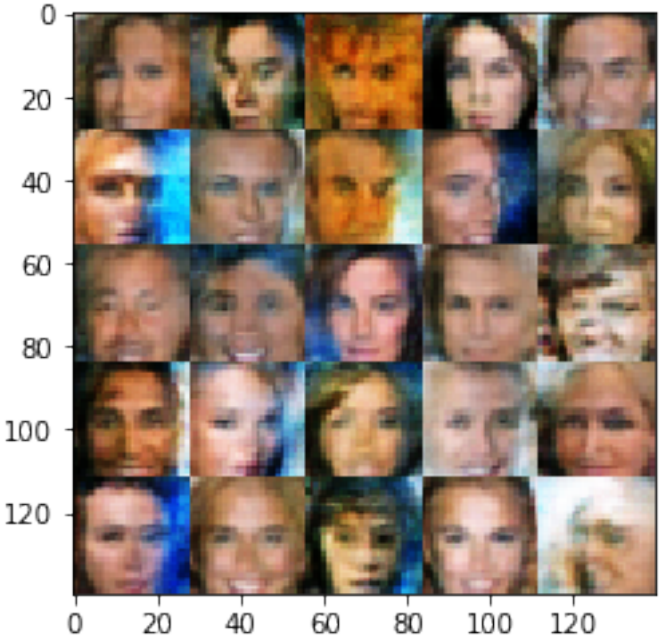
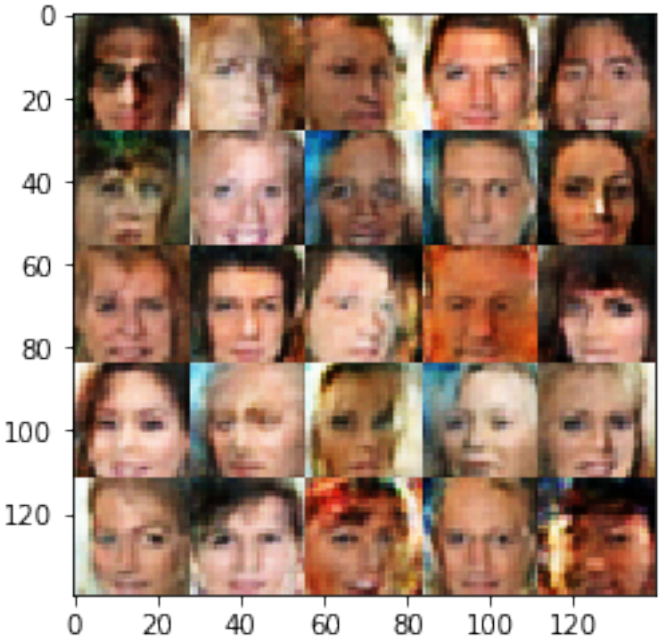
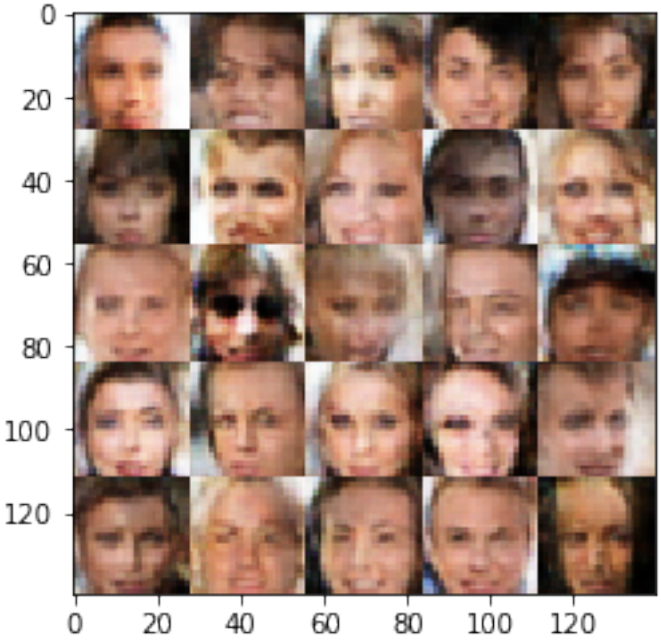
Epoch 1/1... Discriminator Loss: 1.4667... Generator Loss: 0.7247
```



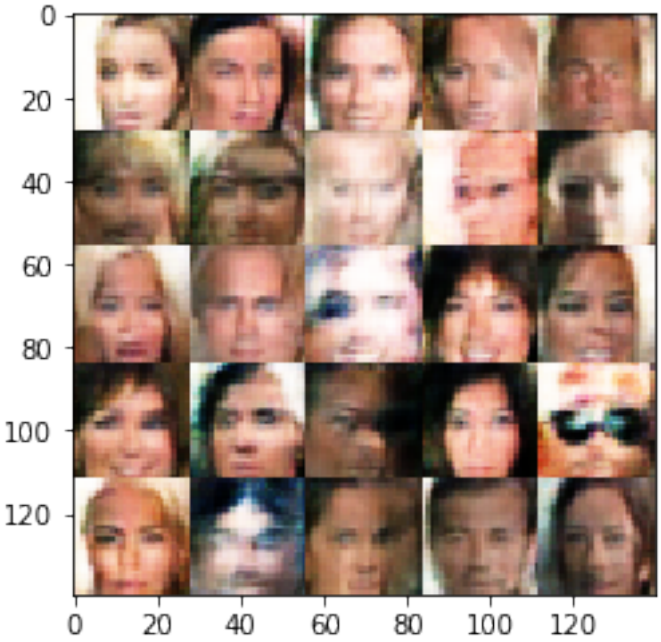
```
Epoch 1/1... Discriminator Loss: 1.4520... Generator Loss: 0.6956
```



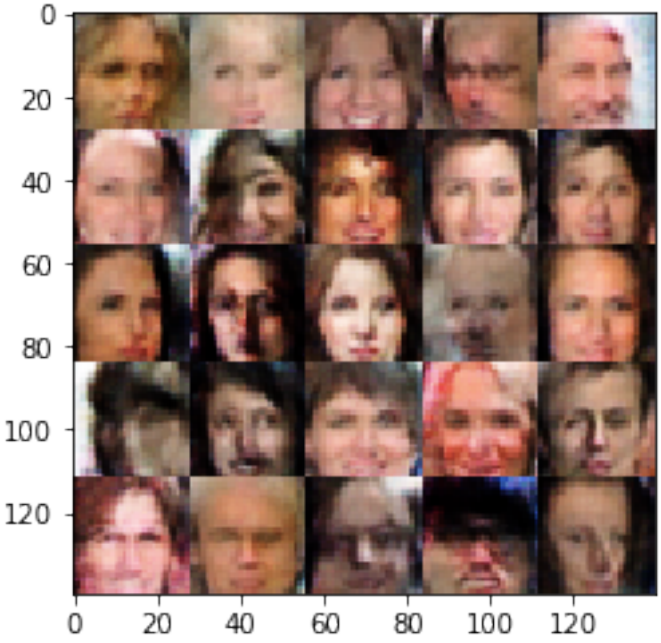

```
Epoch 1/1... Discriminator Loss: 1.4264... Generator Loss: 0.7929
```



```
Epoch 1/1... Discriminator Loss: 1.3535... Generator Loss: 0.9219
```




```
Epoch 1/1... Discriminator Loss: 1.4019... Generator Loss: 0.8563
```



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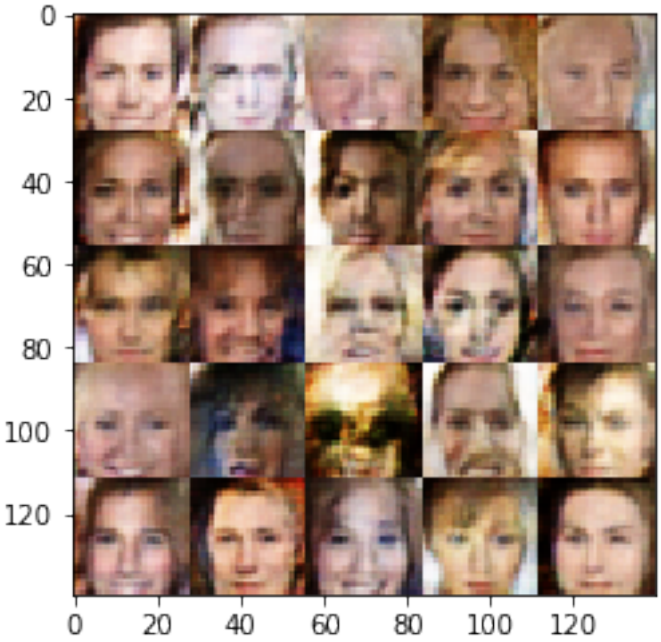
Epoch 1/1... Discriminator Loss: 1.4276... Generator Loss: 0.8024
```

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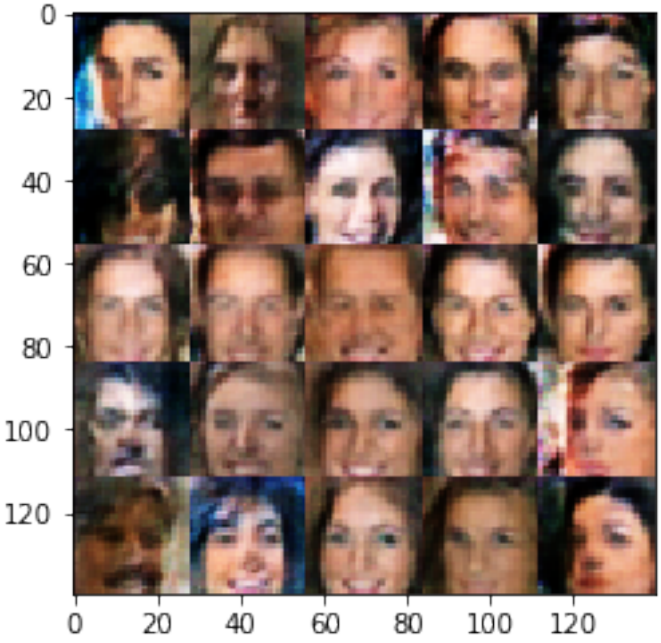
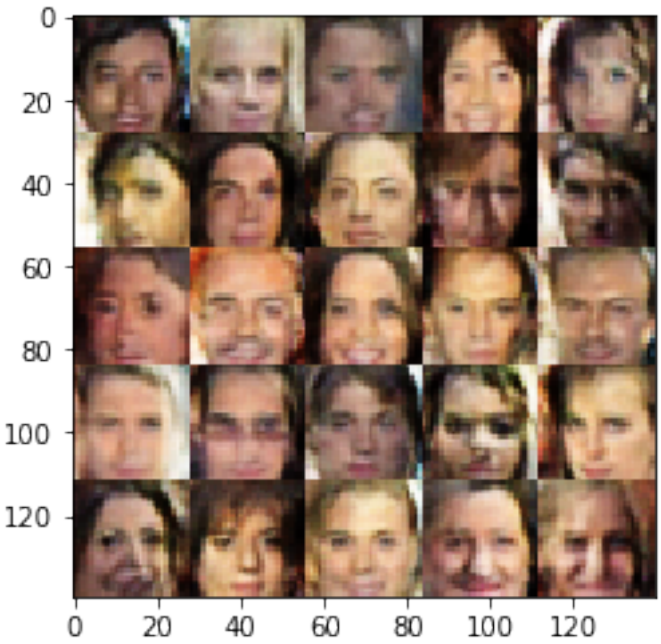
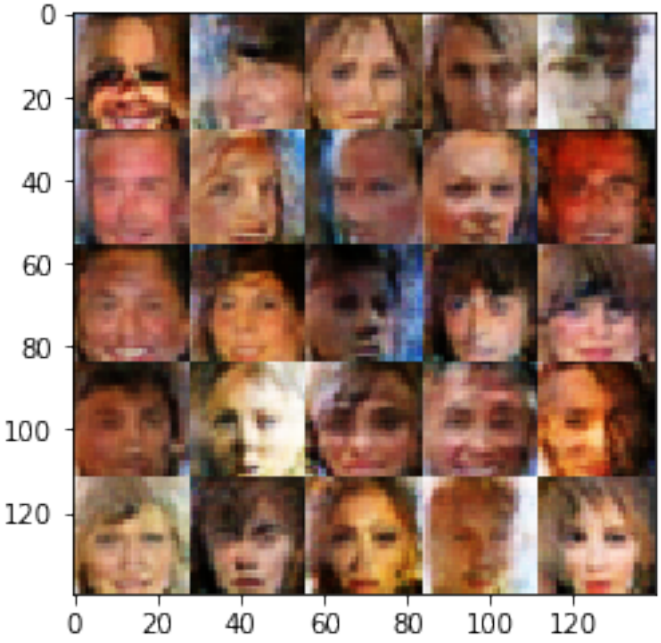
Epoch 1/1... Discriminator Loss: 1.3295... Generator Loss: 0.9193
```



```
Epoch 1/1... Discriminator Loss: 1.3548... Generator Loss: 0.8727
```




```
Epoch 1/1... Discriminator Loss: 1.3942... Generator Loss: 0.8432
```



```
Epoch 1/1... Discriminator Loss: 1.3978... Generator Loss: 0.7882
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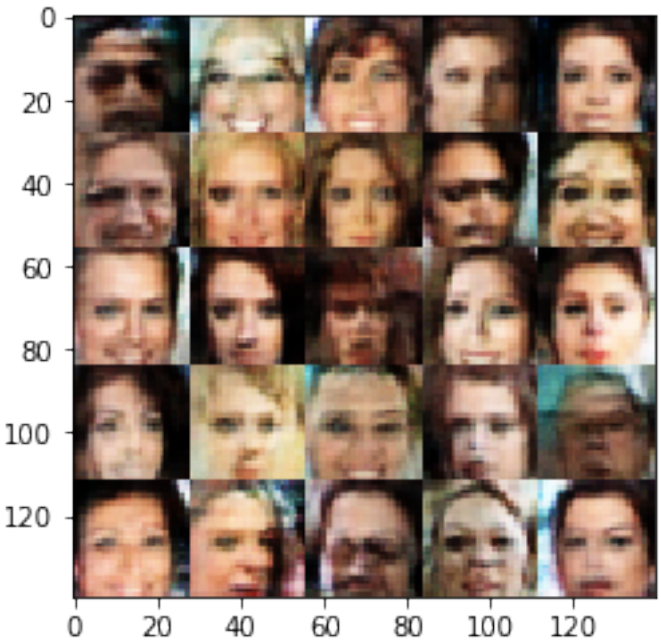


```
Epoch 1/1... Discriminator Loss: 1.4042... Generator Loss: 0.7412
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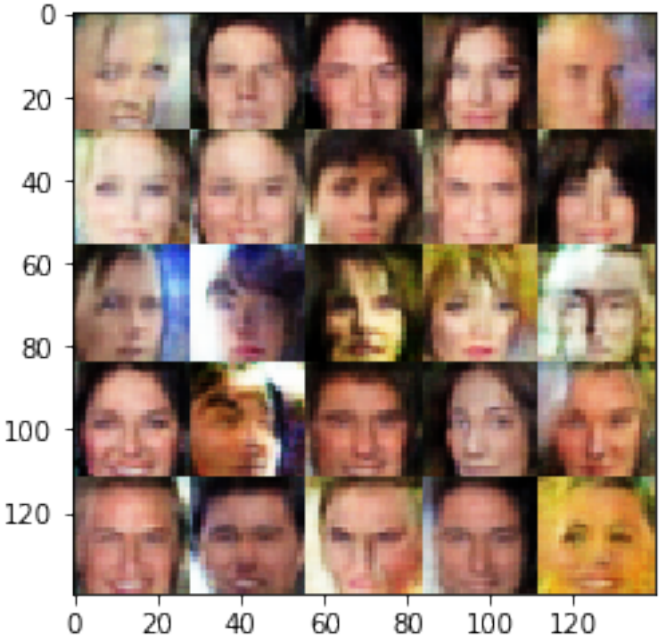

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Epoch 1/1... Discriminator Loss: 1.3910... Generator Loss: 0.8268
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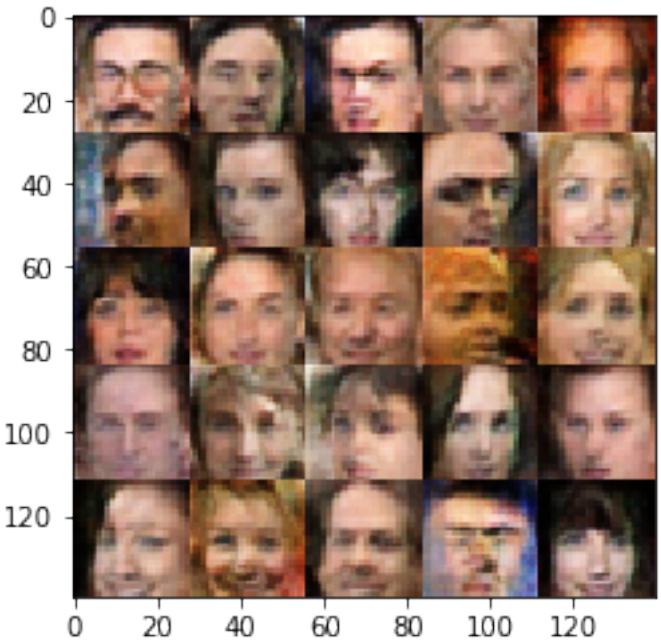


```
Epoch 1/1... Discriminator Loss: 1.3583... Generator Loss: 0.8494
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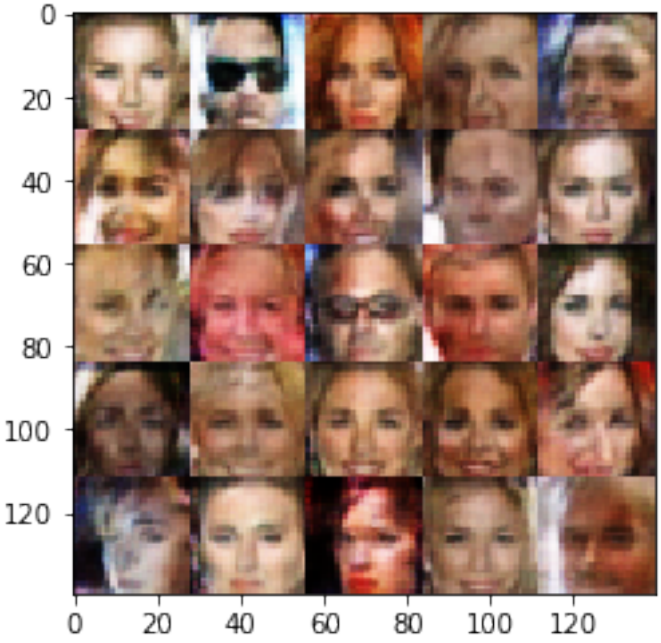
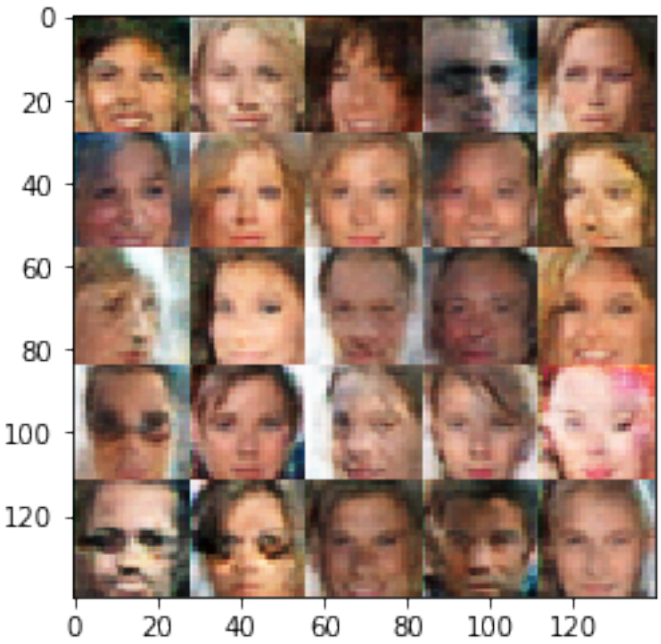
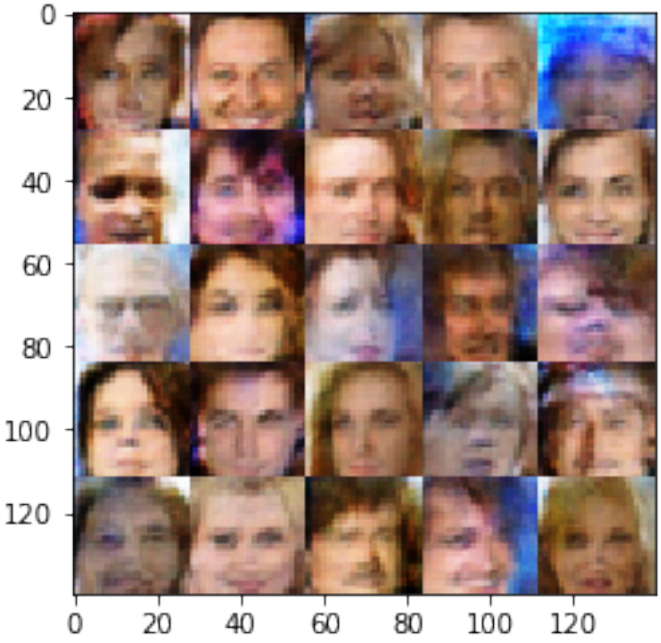


```
Epoch 1/1... Discriminator Loss: 1.3756... Generator Loss: 0.8567
```




```
Epoch 1/1... Discriminator Loss: 1.3898... Generator Loss: 0.8320
```



```
Epoch 1/1... Discriminator Loss: 1.3560... Generator Loss: 0.8342
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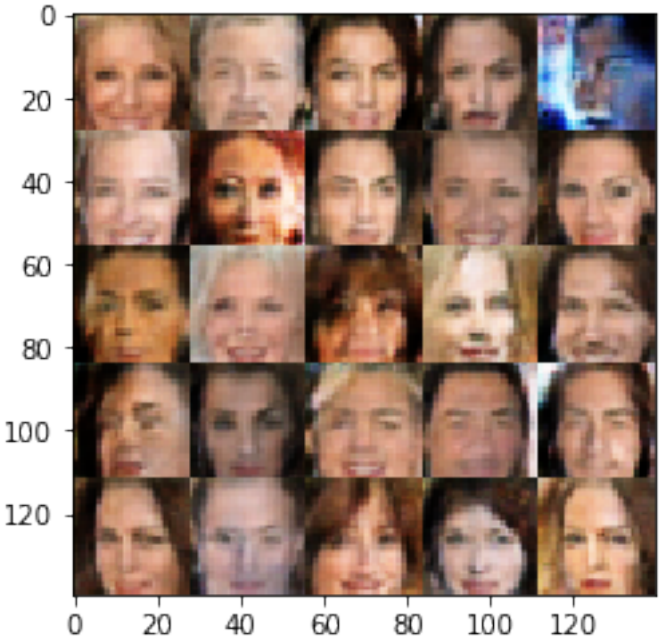
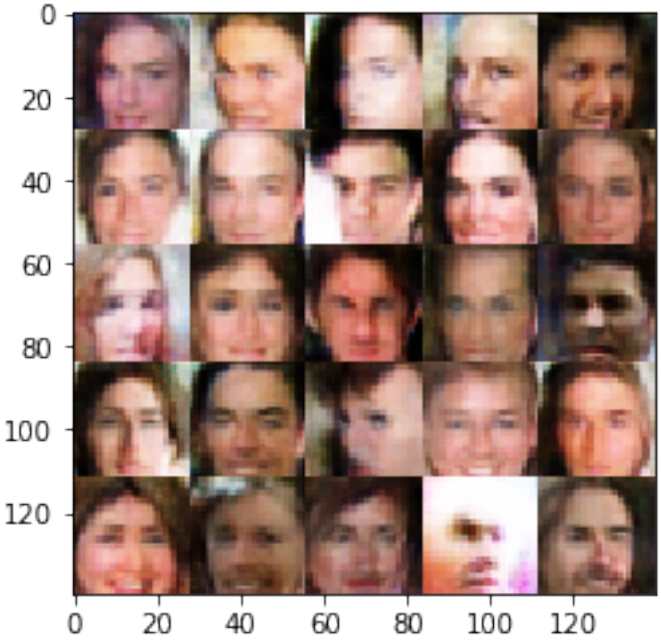



```
Epoch 1/1... Discriminator Loss: 1.3868... Generator Loss: 0.7759
```



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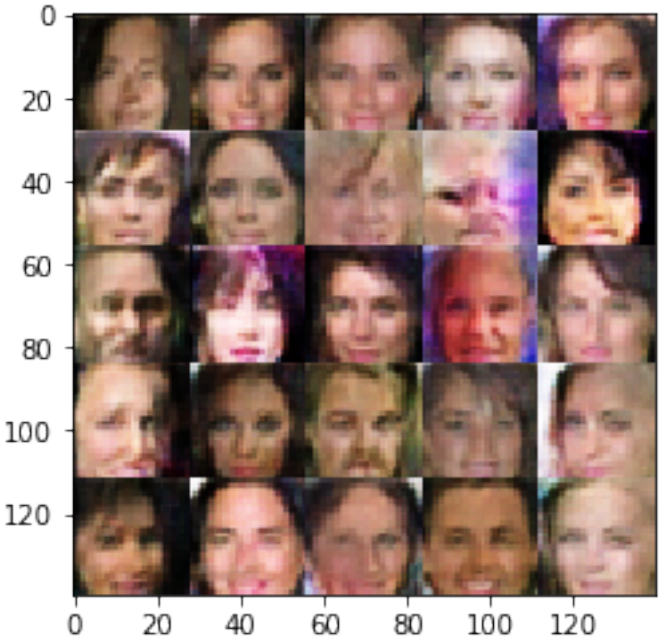
Epoch 1/1... Discriminator Loss: 1.4495... Generator Loss: 0.7638
```

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Epoch 1/1... Discriminator Loss: 1.3984... Generator Loss: 0.8072
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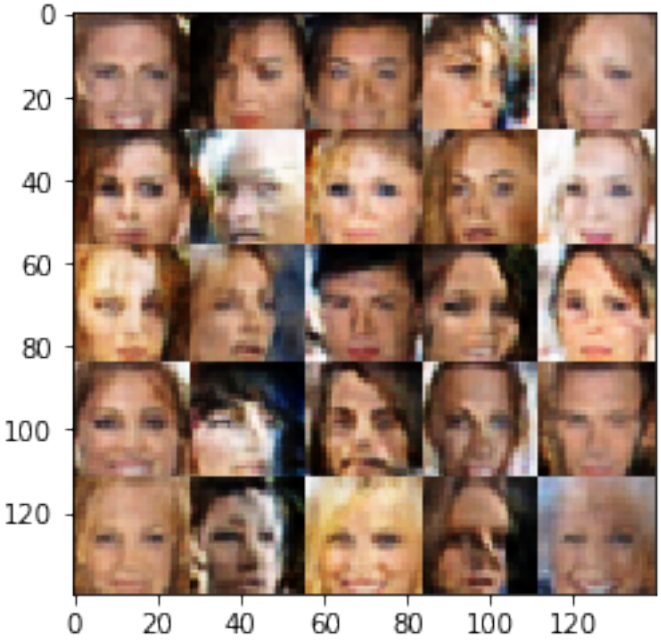
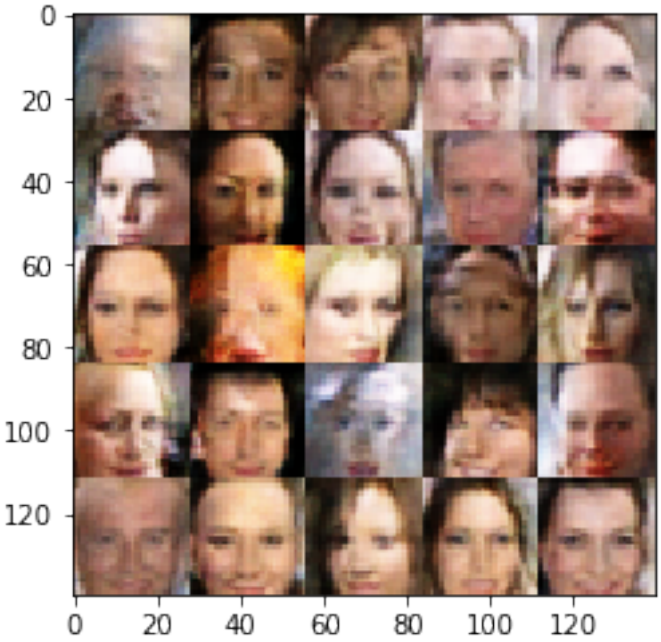


```
Epoch 1/1... Discriminator Loss: 1.4299... Generator Loss: 0.8869
```

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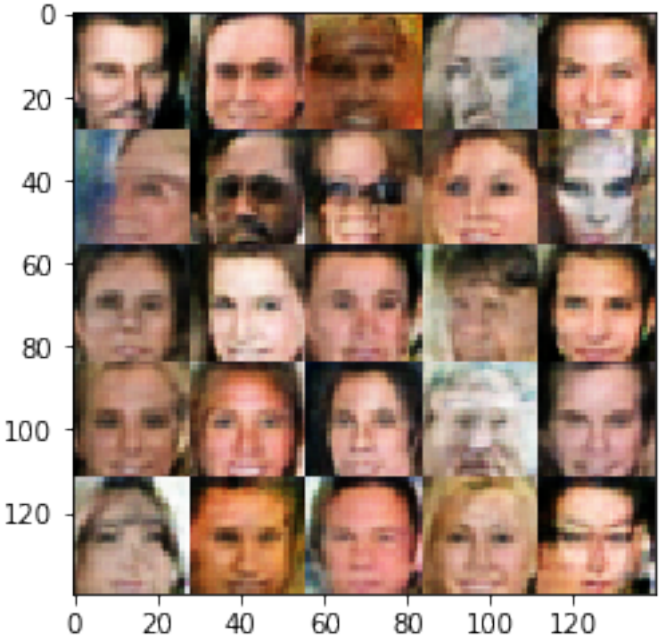
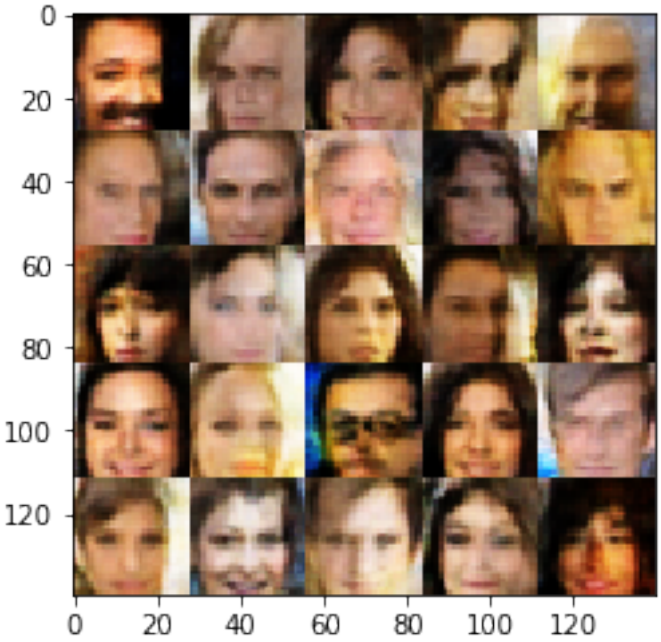
Epoch 1/1... Discriminator Loss: 1.3740... Generator Loss: 0.7755
```



```
Epoch 1/1... Discriminator Loss: 1.3653... Generator Loss: 0.8096
```

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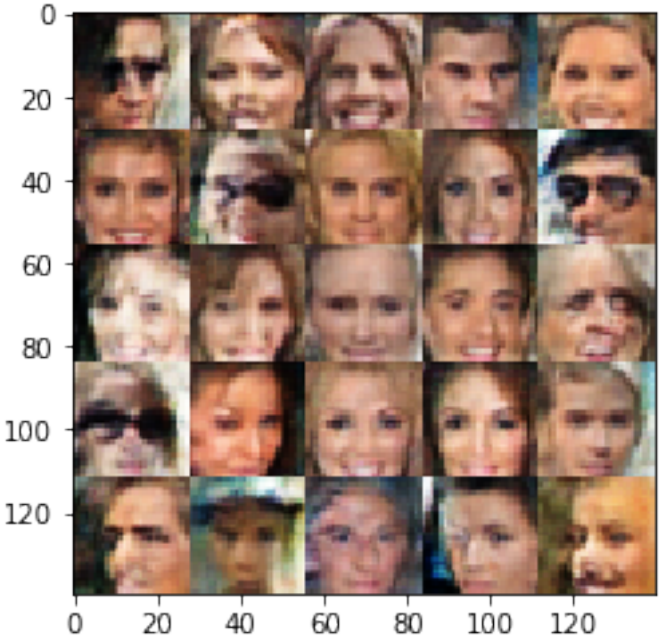
Epoch 1/1... Discriminator Loss: 1.3801... Generator Loss: 0.8332
```



```
Epoch 1/1... Discriminator Loss: 1.3591... Generator Loss: 0.7858
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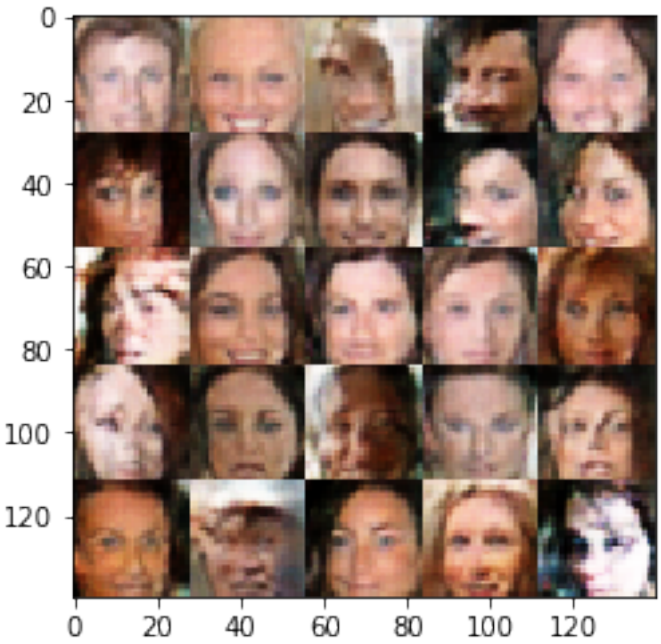


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Epoch 1/1... Discriminator Loss: 1.4055... Generator Loss: 0.7585
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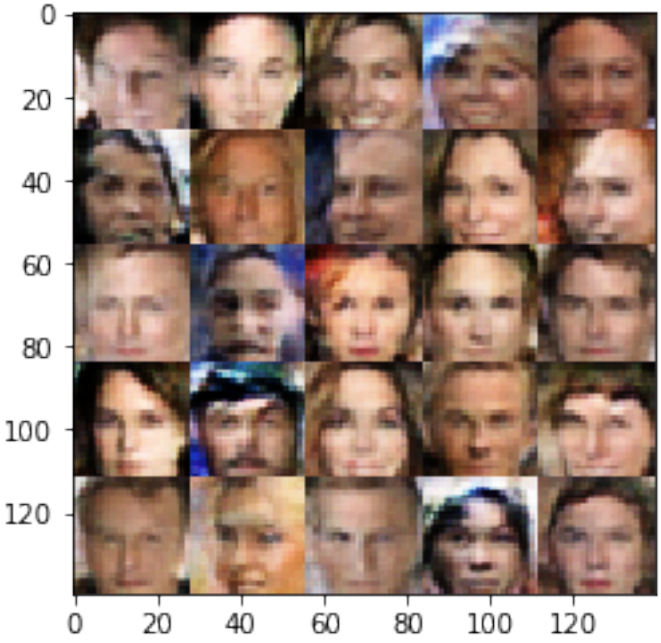

```
Epoch 1/1... Discriminator Loss: 1.3670... Generator Loss: 0.9155
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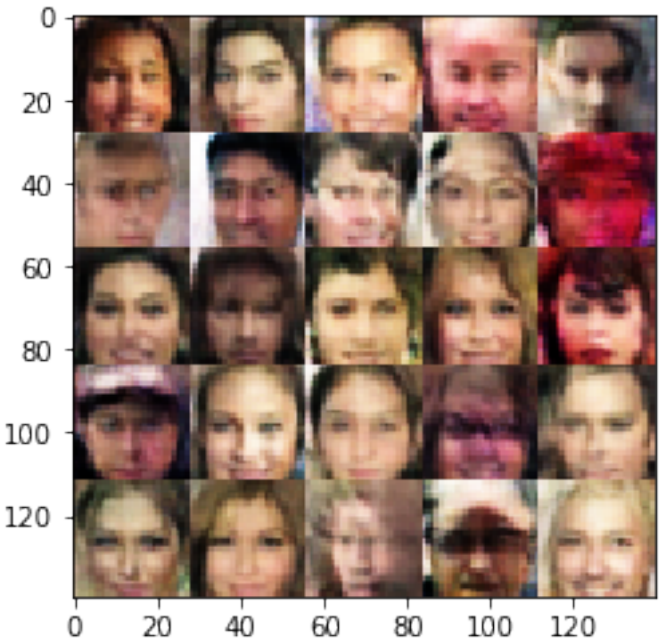


```
Epoch 1/1... Discriminator Loss: 1.3806... Generator Loss: 0.8910
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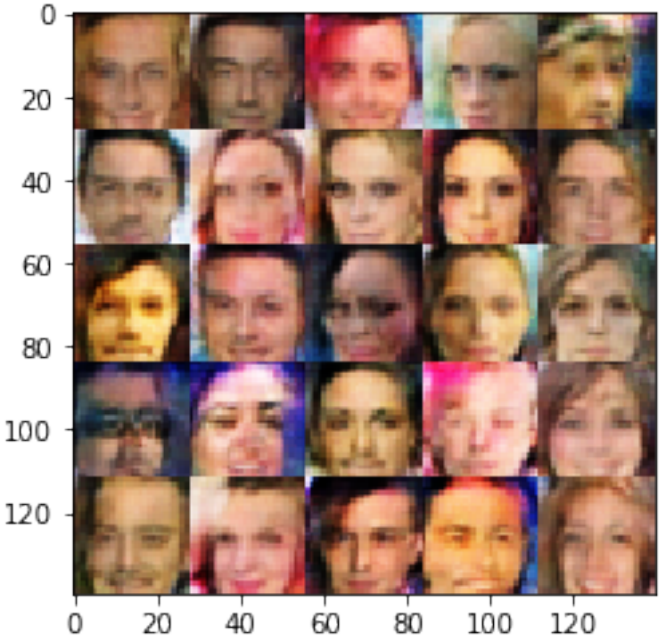

1.4.5

cells

"dlnd_face_generation.ipynb" HTML "File" -> "Download as" "helper.py" "problem_unittests.py"